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APPLICATION OF GPS IN TRAVEL TIME RELIABILITY FOR ARTERIAL ROAD -A CASE STUDY MUMBAI-PUNE HIGHWAY (URBAN SECTION)

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ABSTRACT

Travellers like short travel times. So, from the traveller's perspective, it seems fair to use the mean travel time or mean speed in order to measure the traffic flow performance of a route. However, short travel times might not be the only aspect which is of importance to travellers. It is hypothesized that predictable travel times are also of value to travellers. Hence, the size of variation in travel times, or in other words, Travel Time Reliability (TTR) plays a role in the way that travellers judge the performance of a route, and it is likely that it influences the behaviour of travellers as well. When the mean travel time is used as an indicator for the performance of a route, no insight is gained into the size of the variation in travel times within the observed period.

The goal of this research is to study Travel Time Reliability in (Mumbai Pune Highway,urban section). Reasons for this research are: (a) it is hypothesized that TTR influences road user behaviour, and insight into this relation provides valuable information for road managers and traffic engineers in order to improve the performance of traffic networks, (b) the field of TTR is fairly unexplored territory, and (c) it is possible to perform extensive data analyses, due to the recent increase in travel time data collection possibilities. A literature survey is conducted to serve as a first step in reaching this goal. The literature study shows that there has not been much investigation into TTR in urban areas / arterial road. The reasons for this are that (a) generally, motorways are most equipped with instruments for data collection, and (b) urban environments are more difficult to investigate, because these have more complex traffic interactions than motorways. Another important conclusion from the literature research is that there are three levels of time frames on which TTR can be approached: inter-day, inter-period, and inter-vehicle. For this research, inter-day variations are observed, because deviations from a daily pattern will influence TTR from a road user perspective. Inter-period variations will be known by road users and inter-vehicle variations only have a small influence on travel times. Literature also shows that TTR is defined as: "The ability of the transport system to provide the expected level of service quality, upon which users have organized their activities." This implies that a high TTR does not necessarily mean that travel times on a route are constant during a day, but that travel times that are experienced by road users are approximately equal to their expected travel times.

I have done TTR study on Mumbai Pune Highway, urban section. It is very important section of highway, which connects western India to Mumbai. Frequent congestion due to variation in traffic density, weather and timing is common. Study will help to mitigate congestion problem in the section.

Keywords— Travel Time Reliability, Congestion, Travel Time, Buffer Index, Mumbai Pune Highway.

Fig No List of Figures/Graphs

A. Table Captions

Chapter-1
INTRODUCTION

Reliability is a topic of great interest today. With the impacts of congestion, incidents, and other unforeseen circumstances, people are concerned about being able to get to work on time, catch flights, get to doctor's appointments, get children to and from day-care centers, and other events where being on time matters. Shippers are concerned that deliveries need to be on time, or penalties may be incurred and production processes may be disrupted. If the transportation system was 100% reliable, with the same travel times all the time, none of this would be an issue. But such is not the case.

Reliability information is desired by various audiences in different ways. Those with an interest in information range from decision makers, operators, and developers of reliability monitoring systems, to road users and shippers. For example, travelers and shippers want to know when they need to leave, or when the truck has to depart, in order to make an on-time arrival. Both groups also want to know what paths they should use to minimize the likelihood of encountering unforeseeable delays. Managing agencies want to know where the problem spots lie; where the network segments are that make the travel times vary. Travelers demand short, but also reliable travel times. Complex logistic processes also require companies to have reliable travel times. This research focuses on Travel Time Reliability (TTR) and investigates how TTR can be used to assess the performance of urban routes. The mean travel time or mean speed that is realized on a route is regularly used in practice as a performance indicator. However, this method has a flaw. Travel times on a route can strongly fluctuate within a measurement period. Observing the mean speed does not give insight into the size of this variation. Moreover, a large variation in travel times can make it very hard for travellers to predict travel times.

It is hypothesized that the size of this variation in travel times influences the behaviour of road users (König and Axhausen, 2002). This might have an effect on: destination choice, route choice, departure time choice, and mode choice. The relation between variation in travel times and road user behaviour is important to road network managers and traffic engineers, because this provides them with possibilities to influence the behaviour of road users, in order to improve the performance of a road network.

Travel Time Reliability is defined as: "the extent to which travellers are able to correctly predict travel times". Most travellers will – knowingly or unknowingly – predict the travel time of a trip they will make, so that it can be fitted into their planning (Bogers, 2009). This prediction is influenced by factors, such as: familiarity with the route, time of day, traffic information, and weather. When the variation in travel times increases, the chance that the realized travel time deviates from the predicted travel time increases, and therefore TTR decreases. In such a case, travellers will either have an increased probability of arriving late at their destination or they will have to plan extra time for their trip in order to make sure that they will arrive on time. Arriving late is inconvenient and planning extra time virtually increases the travel time. Therefore, from a traveller's perspective, a high TTR is desirable.

Important Definition:

"*Travel time reliability* can be defined as consistency of travel time over time".

The ability of the transport system to provide the expected level of service quality, upon which users have organized their activities."

90th or 95th Percentile Travel Time: in other words, out of 100 travel times on a given corridor, the 90th or 95th longest.

Travel Time Index: the average amount of time it takes to travel during peak hours compared to free flow conditions computed as average travel time divided by free flow travel time.

Buffer Index: the extra time that travellers add to travel to make sure they are on time most of the time, computed as the difference between the 95th percentile travel time and the average travel time, divided by average travel time.

Planning Time Index: the total time needed to plan for an on-time arrival 95% of the time, computed as 95th percentile travel time divided by free-flow travel time.

Frequency that congestion exceeds some expected threshold: the percentage of days when the average travel speed falls below a certain value, or the number of days when travel time is higher than a certain number of minutes.
This study uses the buffer index as the primary measure of travel time reliability because it is nuanced enough to give a percentage that travellers can relate to and is more likely than congestion frequency or the travel time index to reflect the kinds of decisions that travellers make. For example: if a traveller knows that the travel time at midnight on a given roadway is ten minutes and she or he wishes to use that same roadway at 4 PM, then knowing that the buffer index on that roadway at 4 PM is 30% will allow that traveller to make a well-informed decision to allow thirteen minutes of travel on the roadway at that time.
Travel Rates in Addition to Travel Times: A TTRMS should focus on analysing travel rates as well astravel times. The travel rate is obtained by dividing the traveltime by the distance travelled. Travel rates make it possible tocompare the performance of one segment with another andone route with another (in terms of the distribution of thetravel rates involved). Spot rates, which are the inverses ofspot speeds, are also important to study. They are measuredat a specific location by observing the speed and computingthe inverse.

Value of Travel Time Reliability as a Measure of Congestion
Travel time reliability measures can be used as a valuable supplement to existing measures of congestion in the transportation system. Many transportation professionals have begun to realize the importance of evaluating travel time reliability, particularly for commuters and industries that depend on definite travel times to deliver their goods.
Recker, Liu, and Xiaozheng assert that the reliability of a given route is an important determinant of mode choice for individuals, and that travellers perceive travel time in terms of mode. For example, using a logit model-based evaluation of traveller survey data, they found that the cost of travel delay for taxi users was much higher than for car users.
However, the second definition implies something different, since a traveller can trust on an on-time arrival when travel times are predictable. This does not necessarily imply a constant travel time for a route, because different circumstances can influence expectations of the traveller. For example, in case of a heavy snow storm, car drivers will generally expect a longer travel time than in a situation with good weather conditions.
This predictability is an important feature. FHWA (2005) states that by its very nature, road way performance is consistent and repetitive, and yet highly variable and unpredictable. It is consistent and repetitive in the sense that peak usage periods occur regularly and can be predicted with a high degree of reliability, both by traffic engineers and road users. For instance, the relative size and timing of morning and evening peaks is well known in most communities. At the same time, roadway performance is highly variable and unpredictable. On any given day, unforeseeable circumstances such as a small increase in traffic intensity, individual road user behaviour, crashes and other calamities, bad weather, and road works, can dramatically change the performance of the roadway, affecting both travel speeds and throughput volumes.

Chapter – 2

AIMS AND OBJECTIVE

Research Gap:

A literature survey is conducted to serve as a first step in reaching this goal. The literature study shows that there has not been much investigation into travel time reliability (TTR) in urban areas / arterial road / highway passing from urban section, particularly in critical condition (rainy season and weekend high traffic density), particularly in Asian countries. In India also, very limited studies and research have been done. Travel time reliability is associated with the efficiency and effective functionality of the highway and road network. With this fact, we decided to undertake the research study on Travel Time Reliability measures of Mumbai Pune Highway, urban section. This highway is very important for the development and growth of the country. It connects western India and western part of Maharashtra including, Pune, Kolhapur, Satara, Sangli and other growth centers. Even rural and industrial economy of Goa, Belgam, and Konkan region of Maharashtra depend on efficiency and effective functioning of Mumbai Pune Highway. On time delivery of vegetables, milk, fruits and other perishable goods is done to Mumbai via this highway.

This fact has encouraged us to undertake research topic of TTR, pertaining to urban section, which has been frequently affected with traffic congestion.

Problem Definition:

Travel time reliability study for western countries is different than the developing countries like India. Problem in Mumbai Pune road network is different due to unique problem in the section due to following reason:

Traffic density is very high on working days (Monday to Friday) towards Mumbai. Most of the road users returning from western Maharashtra, Pune, Kolhapur to Mumbai.

On weekends people are moving out from Mumbai to their native place in western Maharashtra. Also, large no of people go out for tourist visits to Pune, Lonavala and other religious places.

Due to large no of cars, buses, oil tankers and heavy trucks traffic are passing through urban section of this highway and connecting Taloja MIDC, Thane Belapur MIDC, JNPT, many road sections witness unpredicted jam, congestion, accidents and causes delay.

It causes delay to the road users. Situation is unique for the travelers and variation in total travel time from Navi Mumbai to Dehu Road (entry point of Pune) varies from one and half hours to three hours.

Problem for road users is that due to absence of specific information on travel time reliability study, they cannot forecast and predict the delay for this section. Some time they reach without any delay and as per schedule and sometime delay by one to two hours.

However, with the proper travel time reliability study, it will be useful for users to predict the delay, especially in rainy season and in weekends. They can plan the travelling schedule according to the weather, days and time of travelling.
Aims Objective of the study:

Aims: To study and evaluate the Travel Time Reliability (TTR) for Mumbai Pune (urban section of Mumbai Pune Highway, Vashi- Kharghar) for specific duration.

Objective: Considering the preceding information and reasoning, the main objective of this Master Thesis is:

1. Study travel time reliability in Mumbai Pune Highway (arterial road), mainly the portion which passes from urban area.
2. Study and assess the TTR of the section of the highway with the application of GPS.

Study TTR of Mumbai Pune Highway section in urban area with application of GPS system. GPS fitted private vehicles, taxis will be used for collection of field data.

Focus on the road user perspective:

Network managers and road users might have different interests in, and views on route performance.

For instance, a network manager will focus on the performance of the complete network and the traffic flow mechanisms and phenomena that occur. Furthermore, the network manager might have an interest in the economic performance of the network or route. Conversely, a road user will focus on its individual travel times on a single route. This study will use the road user perspective, because it is impossible to investigate multiple aspects in this thesis.

Focus on inter-day variation:

There are different levels on which TTR can be studied. The first level is a variation in travel times between individual vehicles. However, it is assumed that these variations are minor and do not influence the judgment of the route performance by travelers. Also, there is a variation in travel times within a day. Nonetheless, it is assumed that these variations are more or less predictable and hence do not influence the type of TTR.

This study focuses on the third level of variation, namely inter-day variation. This is the variation in travel times between different days, which is less predictable and hence influences the judgment of the road users.

Chapter – 3

LITERATURE REVIEW

Literature review on TTR done to understand the following sub topic and to know the status of study and research gap.

1. Problem formulation in travel time, travel time reliability.

2. Data collection

3. Data evaluation

4. Analysis and interpretation

5. Public presentation

Following research papers have been reviewed for the problem identification, TTR study, methodology and analysis.

Research Paper-1

Value of travel time reliability: A review of current evidence

By: Carlos Carrion , David Levinson

Department of Civil Engineering, University of Minnesota,

500 Pillsbury Drive SE, Minneapolis, MN 55455, USA

Journal homepage: www.elsevier.com/locate/tra

In this study, the value of travel time reliability was reviewed along with the current approaches. The main theoretical approaches are: centrality-dispersion (or mean-variance) and scheduling models. The mean-variance is generally more commons it requires only knowledge of day-to-day travel time distributions unlike scheduling models that also require the knowledge of preferred arrival times (or the day-to-day distributions of arrival times). In addition, mean-variance models assume symmetric (i.e. equal) penalties for travel time variability (independent of the dispersion measure used). This assumption is strong especially for commuters that are arriving to their jobs. It is likely that they have asymmetrical penalties as lateness is less preferred compared to earliness. Thus, scheduling models should be preferred. In addition, the equivalence between mean-variance and scheduling models has been proved theoretically, and it has been observed empirically (lossof statistical significance when variables of both models are included in utility specifications). Moreover, the mean-variance approach is currently preferred to the scheduling models on practical grounds such as: the estimation of a value of reliability (instead of values of scheduling delay early and late); the estimation of a reliability ratio (VOR/VOT); and the ease of computing the required variables (centrality and dispersion measures) compared to scheduling models.

GAP:

1. Most researchers have not focused on validating such understanding, and it has become difficult to ascertain which estimates are more plausible than others (especially as there are few revealed preference studies).
2. Travel Time Reliability varies with the climate, weather, peak hours (hours of the day), days of the week, public or private transport, Light or heavy transport vehicle.
3. Differentiation / separation of heavy transport vehicle and light vehicle (Cars) not done in this study.

Research Paper-2

Using Bus Probe Data for Analysis of Travel Time Variability

NobuhiroUno , Fumitaka Kurauchi , Hiroshi Tamura &Yasunori Iida
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Journal of Intelligent Transportation Systems
homepage: http://www.tandfonline.com/loi/gits20
http://dx.doi.org/10.1080/15472450802644439
Researchers suppose that no one might deny the importance and significance in evaluating the LOS of network utilizing the real observation. This kind of evaluation is expected to lead to improvement in management and control for road network. Although the most of road networks has been equipped with various types of sensors, such as loop detectors, ultrasonic detectors, and automated vehicle identifiers, the information obtained from these devices are limited to the observations at a certain location or section. Accordingly, the information obtained by the conventional devices mentioned above might not be fully suitable for analyzing the spatial and temporal changes in traffic condition on road network. Because of the rapid progress and deployment of ITS, the innovative change in sensing technologies has occurred for a last decade. Among the various sensing technologies developed in the area of ITS, the probe vehicle survey using GPS is regarded as one of the most practical and effective methodologies to obtain the information on the spatial and temporal changes in traffic condition on road network. In this sense, firstly we discussed and summarized various applications of GPS data in transport analysis. GPS data are merely a sequence of locations, and further data transformations such as map-matching, data reduction, processing, and reporting are needed to make them meaningful to transport analysts. The methodologies and issues affecting these transformation techniques were summarized in this article. The major advantages of probe data analysis are automatic data observation, real-time processing, and direct observation of travel time. The drawbacks can be data handling and transaction cost if real-time observations are required. Probe data can be applied to automatic incident detection, supporting diary surveys, and observations of travel time and its variability. This work is on travel time reliability based on bus probe data.

Research Paper-3

Establishing Monitoring Programs for Travel Time Reliability

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Institute for Transportation Research and Education
TRANSPORTATION RESEARCH BOARD
WASHINGTON, D.C.
Published Year 2014
www.TRB.org
This paper provides the detail idea about TTR monitoring programme.

Research Paper-4

Valuation of travel time reliability in freight transportation: A review and meta-analysis of stated preference studies

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www.sciencedirect.com (online)
In an effort to advance the understanding of value of reliability (VOR) in freight transportation, this paper provides a comprehensive review of existing studies. This study focused on reliability measures adopted by various studies, the theoretical and mathematical foundation of modeling the valuation of reliability, and the contributing factors that influence the values. Since nearly all the studies in VOR analysis employed stated preference (SP) surveys and the survey design directly affects the study elements and modeling approaches, this synthesis pays close attention to the various survey design components. Through a comparative analysis among existing studies, this paper aims to shed some lights on the potential factors that contribute to the variations in VOR estimation. The results indicated that the estimated VOR values varied largely from one study to another; probably due to the use of different units, reliability measures and survey design approaches. This review showed the complexity and challenges faced when studying freight users' VOR. Insufficient data has also been cited as a major obstacle to advances in the understanding of how the freight industry values travel time reliability. Furthermore, the large variations in the VOR values indicate the need for further research efforts in this area.

Chapter- 4

METHODOLOGY:

Measures of Travel Time Reliability

Measures of TTR of all of these approaches is that they reflect average or expected conditions and do not reflect the impact of the variability of these conditions. One reason for this is that models become much more complicated when this variability would be included. Also, a vast amount of data from a long period of time is needed. Unfortunately, collecting data is often costly and time-consuming.

Hellinga (2011) also observes that more recently; there has been an increasing interest in the reliability of transportation networks. It is hypothesized that reliability has value to transportation network users and may also impact user behavior. Influence on traveler behavior may include: destination choice, route choice, time of departure choice, and mode choice. It is useful for road managers and planners to have knowledge about the relations between TTR and road user behavior, because this can be used to predict or even deliberately influence this behavior by applying traffic management measures.

Consequently, there has been an effort to better understand the issues surrounding reliability, and to answer a number of important questions such as:
1. How is transportation network reliability defined?
2. How can/should network reliability be measured in the field?
3. What factors influence reliability and how?
4. What instruments are available to network managers, policy makers, and network users that impact reliability and what are the characteristics of these causal relationships?
5. What is the value of reliability to various transportation network users (e.g. travelers, freight

carriers, etc.) and how is this value affected by trip purpose?
6. How do transportation network users respond to reliability in terms of their travel behavior? (E.g. departure time choice, mode choice, route choice etc.)
7. How can reliability (and its effects) be represented within micro and macro level models? (Microscopic models focus on individual vehicles, while macroscopic models pertain te the properties of the traffic flow as a whole.)
8. How important is it to consider the impact of reliability in transportation project benefit/cost evaluations?

Available Measures of Travel Time Reliability

Hellinger (2011) has given an overview of TTR measures which are used in practice. These are presented here, together with explanations and examples. All the measures are calculated per route and per direction.

Buffer Index (BI)

The Buffer Index is the difference between the 95th percentile travel time and the average travel time, normalized by the average travel time.

$$BI = \frac{t^{95\%} - \bar{t}}{\bar{t}}$$

Planning Time Index (PTI)

The Planning Time Index is the ratio of the 95th percentile travel time to the free flow travel time.

$$PTI = \frac{t^{95\%}}{t^{f}}$$

This value represents the time required to ensure that the traveler arrives on-time in at least 95% of the trips, expressed as a percentage of the free flow travel time. The larger this percentage, the larger the relative difference between the free flow travel time and the 95-percentile travel time.

Example: It is known that on a certain route the free flow travel time is 4 minutes and the 95- percentile is at 12 minutes. This means that a travel time which is 375% of the free flow travel time is needed in order to be on time in 95% of the cases.

Elements of the Project Method

In this section, the three elements of the project method (respectively average travel times, variation in travel times and extreme travel times) are discussed and for each of these elements an appropriate measure is chosen. Together, these elements will form the project method.
Two assumptions are used as a starting point for developing a project method. First, recall that a good TTR means that travelers are able to correctly predict travel times. Second, the assumption was made that the travel time which is predicted by road users equals the average travel time on a route.
Note that although the latter assumption is used, it is sensible to validate or correct this by means of further research. It is likely that travel time expectations are influenced by factors such as: weather, time of the year, holidays, road works, events, traffic information, and familiarity with the route.
In order to assess TTR based on the previously mentioned assumptions, the average travel time should be approximately constant within the observed period. Therefore, the day is split up into three periods in which the average travel time is approximately constant: morning peak, evening peak and the period between the peaks (inter-peak period). The times when these periods start and end are determined on the basis of expert opinion.
However, if the method is implemented, it is recommended that an unambiguous definition of these periods is defined.
Data collection is focussed on the basis of TTR performance indicator for the three-peak duration. Namely morning peak, interpeak and evening peak and off time/free flow time.

Data Collection Methods:

Data can be collected by various methods. Which have been tabulated in following table (name of computing software also mentioned (used normally in USA and Canada. In our study, we have used GPS enabled vehicle for data collection.

1. Probe Vehicles (GPS Fleet, GPS enabled, Bluetooth data)
2. Proprietary Sensors
3. Govt Sensors
4. Incident Data

5. Event Data
6. Historical Data
7. Highway imbedded sensors

NavTeq, TRANSCOM uses different methods for data collection. Intrix uses mostly fleet data, fleet data, historical data. NavTeq uses GPS fleet, phone data, Bluetooth data, event data, historical data and various other methods for data collection. In advanced studies, during the process various field data can be collected, which includes speeds, spot speeds, average speed, travel times, OD pairs, incident data, weather data etc.

GPS System for Data Collection For TTR:

Overall, the GPS technique investigated in this study appears to be the best approach for limited scale travel time data collection. However, for major region wide data collection it is recommended that a different approach be utilized. The recommended approach should eliminate the need for paid vehicle operators and should feature wireless transmission of GPS data from the vehicle to a remote storage location, eliminating the need to store the data on board the vehicle. There are several emerging wireless technologies that enable such an approach, in some cases using GPS, as further discussed below.

Chapter – 5

STUDY AREA IDENTIFICATION

Mumbai Pune Highway (urban Stretch)

Mumbai region includes Mumbai (MCGM), Thane, Navi Mumbai, Panvel, Mira Bhyandar, Vasai Virar and other satellite townships within 60 km of Mumbai with total population over 3 crores. It has over 16 Municipal corporations and municipalities. Mumbai Pune Highway (under national highway) is one of the oldest highway and important link to connect western Maharashtra, south India (Karnataka, Andhra Pradesh Tamilnadu, Goa and Pondicherry). Large no of light vehicles, trucks, buses, TEUs are entering to Mumbai city and going out.

This has been a difficult task for selecting a stretch of 4 km to 10 km from over 120 km of Mumbai Pune Highway. Actual urban section starts from Sion and ends at Panvel (Due to fast development urbanization is also changing very fast and many rural areas have come under urban development and municipal corporation in Mumbai region., now the urban development has taken place till KhalapurJn,). From Panvel Mumbai Pune highway (old section) and Mumbai Pune Expressway bifurcated in to different routes. Sion Panvel section of Highway was initially 6 lane road, which was converted into ten lanes in 2015. All the Pune bound traffic, which uses Mumbai Pune Highway converges at Chembur and Mankhurd and pass through Vashi Toll Plaza, Vashi Gaon, Sanpada, Turbhe, Juinagar, Nerul, CBD Belapur, Kharghar, Kamothe, Kalamboli, Khanda colony and Panvel. Sion Panvel Highway bifurcated at Kalamboli into Mumbai Pune Highway and Mumbai Pune Expressway. We have considered old Mumbai Pune Highway as our study area. Expressway is excluded from any type of TTR study and not within the scope of our thesis. For selection of thesis study area, we included the highway section between Vashi Toll Plaza to Kalamboli. Basically, we wanted 4 km to 6 km highway section, where travel data can be collected easily and safely without hindering the traffic movement.

Traffic from Thane and TTC Industrial area converges at Turbhe Naka, which witness frequent congestion and traffic jam. Similarly, slow moving traffic is very common near Vashi Fly over, LP junction Nerul, Taloja Junction and few more section. Section with inconsistent travel time and problematic area were not kept under preferred section, while selecting the study area.

Fig. : Mumbai Pune Highway Section Near Nerul, Navi Mumbai

TRAVEL TIME DATA ;TTR-DATA COLLECTION
Route 1/1 : NL-KH ; Route 1/2 : KH-NL
Nerul (UranPhata)- to Kharghar (Hiranandani Jn): *NL indicate Nerul, KH indicates Kharghar*
Route Length: 6.3 km.
Note: "b" indicate beginning. "e" indicate ending. "bmonth" means beginning of month.

DAY-1 (8 am -9.30 am), Morning Peak

trip id	travtime	Area location id	year	bmonth	bday	bhour	bmin	bsec	Bspd (kmph)
		NL-KH							
12220	6.10		16	12	2	8	06	40	61.46
12221	6.42		16	12	2	8	25	45	58.40
12222	8.50		16	12	2	8	35	35	44.47
12223	7.38		16	12	2	8	56	46	50.53
12224	7.10		16	12	2	9	15	38	59.43
		KH-NL							
12225	6.25		16	12	2	8	15	30	60.48
12226	6.53		16	12	2	8	30	40	57.88
12227	7.36		16	12	2	8	42	50	51.36
12228	9.10		16	12	2	9	00	22	41.53
12229	6.40		16	12	2	9	25	45	59.06

Inter Peak (9.30-16.30 hrs)

trip id	travtime	Area location id	Year	bmonth	bday	bhour	bmin	bsec	Bspd (kmph)
		NL-KH							
12230	6.50		16	12	2	9	47	40	58.15
12231	6.10		16	12	2	10	28	20	61.97
12232	8.60		16	12	2	10	58	32	43.95
12233	8.92		16	12	2	11	40	41	42.38
12234	8.55		16	12	2	13	36	35	44.21
		KH-NL							
12235	6.30		16	12	2	10	15	20	60.00
12236	7.53		16	12	2	10	38	45	50.20
12238	9.36		16	12	2	11	05	50	40.38
12239	6.10		16	12	2	12	15	28	61.97
12240	5.40		16	12	2	14	50	40	70.00

Data collected for over 15 days for various peak and different section for travel time, speed and volume.

After data collection, travel time, travel rate, volume and speed data used to calculate BI, PTI and other TTR measures to assess the reliability of highway section. Reliability is slightly affected due to new junction and development of congestion zones.

I. CONCLUSIONS

Travel time reliability of Mumbai Pune Highway (urban stretch) is easily compared with the designed travel time and speed. It has been observed that few congestion pockets have been created in last few years and congestion takes place specially on weekends (towards Pune) and On Monday (towards Mumbai). People are returning to Mumbai from holiday.

Proper traffic planning measures and staggering of the working times and vehicle segregation, use of flexible lane divider etc can improve the efficiency of highway.

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