A NEW CALIBRATION TECHNIQUE FOR VALUE OF TRAVEL TIME IN URBAN NETWORKS

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ABSTRACT

A successful assessment of infrastructure investment decisions and transport policies in general requires an accurate estimation of user value of time and transport requirement characteristics. Moreover, value of time is an important factor for studying the Toll sensitivity. The feasibility study for a proposed sea-link in the city of Mumbai, India was carried out. As in many traditional studies, the value of time was found out from the SP survey conducted prior to year 2000. The after analysis of this completed project was carried out by validating the network link counts which turned out to be significantly different from the ground counts. The main objective was to recalibrate the value of time and see that the real world scenario is replicated as accurately as possible. A Stated Preference survey has been conducted before the construction of the Bandra Worli Sea Link (BWSL), an urban freeway in Mumbai, India. A Logit Model conditioned on existing route has been estimated from the SP data and the value of time is determined. A four stage travel demand model was developed for estimating the likely traffic on proposed sea link. As the link is constructed and operational during 2008, actual traffic realised is significantly less than originally forecasted volume. In four stage model, the Generalised Cost component of equilibrium assignment step, the Value of Time has been varied to get the observed traffic flow on the sea link. The Value of Time (VOT) calculated from the SP survey is high when compared with the realistic Value of Time (VOT) obtained from the four stage model through recalibration to reproduce the observed volumes. This clearly indicates the advantage of the proposed technique over the traditional methods and throws insights on the much needed recalibration techniques of the value of time. But this recalibration technique requires before and after traffic volumes on a proposed urban freeway. Usually, SP survey is used for calibrating the value of time & predicting the performance of a network in most of the studies. But, when applied to the ground reality scenario and observed, it may not always be true that this methodology will be producing accurate results. It is with this background a new base year recalibration technique is proposed & presented in this paper which turned out to be very efficient.

Keywords: Calibration of Value of Time, Stated Preference experiment, Logit model

INTRODUCTION

The value of travel time savings (VTTS), often abbreviated as 'value of time' (VOT) is of central interest in transport research. The VTTS is often among the bigger benefit components in the assessment of transport investments. It is also an important parameter in the analysis of travel behaviour and in traffic assignment models. There are many empirical studies on the estimation of values of travel time savings (VTTS), with varying degrees of rigour and relevance, mostly based on the observation that travellers are prepared to spend money to save time. These values are applied to both forecasting the effects of speed changes on behaviour and also for estimation of the social benefit of such savings, in order to calculate value for money of spending public funds on transport investments. The sources of empirical information on such values are not always compatible with the models and software within which the results are used. In recent years, an increasingly important application has been to calculate the potential revenue from tolled roads, and networks with user charges, which offer high speeds at a higher price.

It seems to be frequently (perhaps always) the case that the models used for forecasts and appraisal have had some or many differences in theoretical base, assumptions, or algorithms of convenience as compared with the empirical studies of Willingness To Pay (WTP). We have, for example, seen many cases such as:

- Traffic assignment models only concerned with change of route, using a generalised cost framework using values of travel time savings (VTTS) derived from empirical studies of choice of mode;
- Apparent differences of VTTS calculated in a way that is confounded with differences in comfort, convenience, status, effort spent or stress, applied to choices where those attributes are quite different;
- VTTS calculated from stated preference methods that must logically be based on very short term (immediate) preference structures, applied to equilibrium models that implicitly deal with behavioural response, which takes some years to evolve;
- Relationships between VTTS and other influencing variables (notably income) assumed to develop overtime in ways, which are inconsistent with other evidence on such relationships, e.g. direct demand aggregate estimations.

Existing literature on the value of time provides a wide range of estimation methods. Becker (1965) was probably the first to introduce the allocation of time over various activities in the analysis of consumer behaviour, thus offering the micro-economic framework needed to establish the shadow price of time savings. Further contributions from Johnson (1966) who introduced work time in the utility function, Oort (1969) who did the same for travel time, and DeSerpa (1971) who added technical constraints, showed that the VOT at various activities does not need to be equal to the wage rate – justifying further research into the empirical estimation of VTTS. In such research, the VTTS is usually derived as the marginal rate of substitution between travel time and cost coefficients, typically as found in discrete-choice models of stated-preference data, revealed-preference data, or a combination of these (e.g., Small et al.,2005). This ratio is exactly the VTTS in DeSerpa's (1971) framework (Bates, 1987).

One of the techniques most commonly applied to work travel is to consider travel time as part of the working day, so that any travel time savings may be assessed in terms of opportunity cost, that is, gross salary. In the case of leisure travel, the value of time has usually been calculated as a percentage (between 60% and 80%) of the user's gross salary. Hensher (1977) propounds an alternative technique for the calculation of work-related value of travel time which solves some of the problems giving rise to the above criticism. He suggests dividing the valuing of time into four components: output loss, journey-induced uselessness, loss in leisure time and, finally, any compensation transfer that may occur between employer and employee.

It is also worth pointing out that transport economics has experienced an outstanding development of other methods capable of valuing time according to the choices made by individuals when opting for a specific means of transport. Thus, the choice of a more expensive faster means of transport or, conversely, a cheaper slower one, is an implicit consequence of a certain time appraisal; this constitutes a problem that may be solved empirically. Techniques using individual data are associated to discrete choice models. Revealed preference models obtain their information from direct observation of the choices made by individuals. Stated preference models, on the other hand, obtain their information from questionnaires where users chose from various, mostly hypothetical, scenarios which change the values of the relevant variables affecting their decisions. The advantages of the latter model are obvious: a lot of information may be obtained from a single individual, thus reducing information gathering costs; questionnaires may be designed with truly independent variables whose relative significance is more accurately measurable than those of other models; and the model allows the design of situations including actually unavailable alternatives or means of transport. Other advantages are related to a better definition of the tradeoff between variables: introducing qualitative variables, leaving out irrelevant ones, or even assuming non-existent markets. Hence the increase in recently published studies in this field has been very important, despite the complexity of the method.

However, stated preference models also have drawbacks which need to be properly assessed. The existing error risk or bias (both random and system) may have a considerable effect on both estimations and results. Several factors may affect the random bias, such as a poor understanding of the exercise, tiredness or failure to take the questionnaire seriously, all of which are peculiar to each polled individual. In any case, this type of bias tends to be cancelled out in a sufficiently representative sample. System errors (which may hardly be cancelled out by the various interviewees) occur when a bias is introduced by an attempt to justify or affirm decisions—whether those already made in real life or a systematic justification of a certain choice. Decisions may also be influenced by interviewees' behavioural habits, the initial scenario defined by the questionnaire or any other effect which may cause this type of estimation error.

The Value of Time is mostly or always estimated from the SP experiment which turns out to be on a relatively higher/lower from the realistic world scenario. Hence, the proposed method to recalibrate the value of time proves to be of vital importance. However, for this method the before and after traffic volumes on a toll road are required which is sometimes a limitation.

STUDY AREA

The study area is considered as Mumbai Metropolitan Region (MMR)/Mumbai Metropolitan Area (Figure 1), comprising of 7 municipal corporations, 13 councils, and rural areas which is also the largest urban agglomeration in India. The MMR is spread over an area of 4355 square kilometres and has a population of approximately 21.3 million according to 2011 census which is accounting for 20% population of total Maharashtra and about 2% population of India. It is expected to grow to 34 million by the year 2031. Primary among the constituents of MMR is the Greater Mumbai which is referred as financial capital of India, hence the employment is very much high in MMR.

The transportation system of Mumbai Metropolitan Region is dominated mainly by the public transportation mode. Public transport systems in Mumbai include the Mumbai Suburban Railway, Brihanmumbai Electric Supply and Transport (BEST) buses and Intermediate public transport (IPT) modes like taxis and auto rickshaws. About 78% of the trips (53.3% of trips by suburban rail and 24.8% by bus) are carried by public transport modes and remaining trips by the private vehicles (Car and Two wheelers) and IPT modes. Nearly 63% of the trips moving out of the region originated from Greater Mumbai.

The Western Freeway Sea Link is an ambitious project proposed by the Maharashtra State Road Development Corporation (MSRDC) that envisions the construction of multiple bridges over Arabian sea to reduce traffic-congestion between the suburbs and the island city. The first phase of the project, known as the Bandra-Worli Sea Link, was completed in June 2009, and links Bandra in the north and Worli to the south with a cable stayed bridge spanning the Mahim Bay. This development has relieved the congestion on the Mahim Causeway, which until then had been the only road between the suburbs and the main city of Mumbai on the western sea front. The Sea Link reduces travel time between Bandra and Worli from 45–60 minutes to 7 minutes. The link has an average daily traffic of around 50,000 PCUs per day. The toll charged is ₹55 (US$1.04) for one-way and ₹82.50 (US$1.56) for a return journey. The second and third phases include the extension from Worli end to Haji Ali Junction and from Haji Ali to Nariman Point (CBD in the island city).

From the earlier studies it is found that about 50% of the traffic going towards South Mumbai is originating from suburbs beyond Bandra like Andheri, Goregaon, Borivali, Versova (Figure 2). With the construction of Versova -Bandra Sea Link (VBSL), the traffic of northern suburbs need not go on the city roads i.e., S.V. Road, Link Road, Western Express Highway, etc. This constituted the need for feasibility study of VBSL.

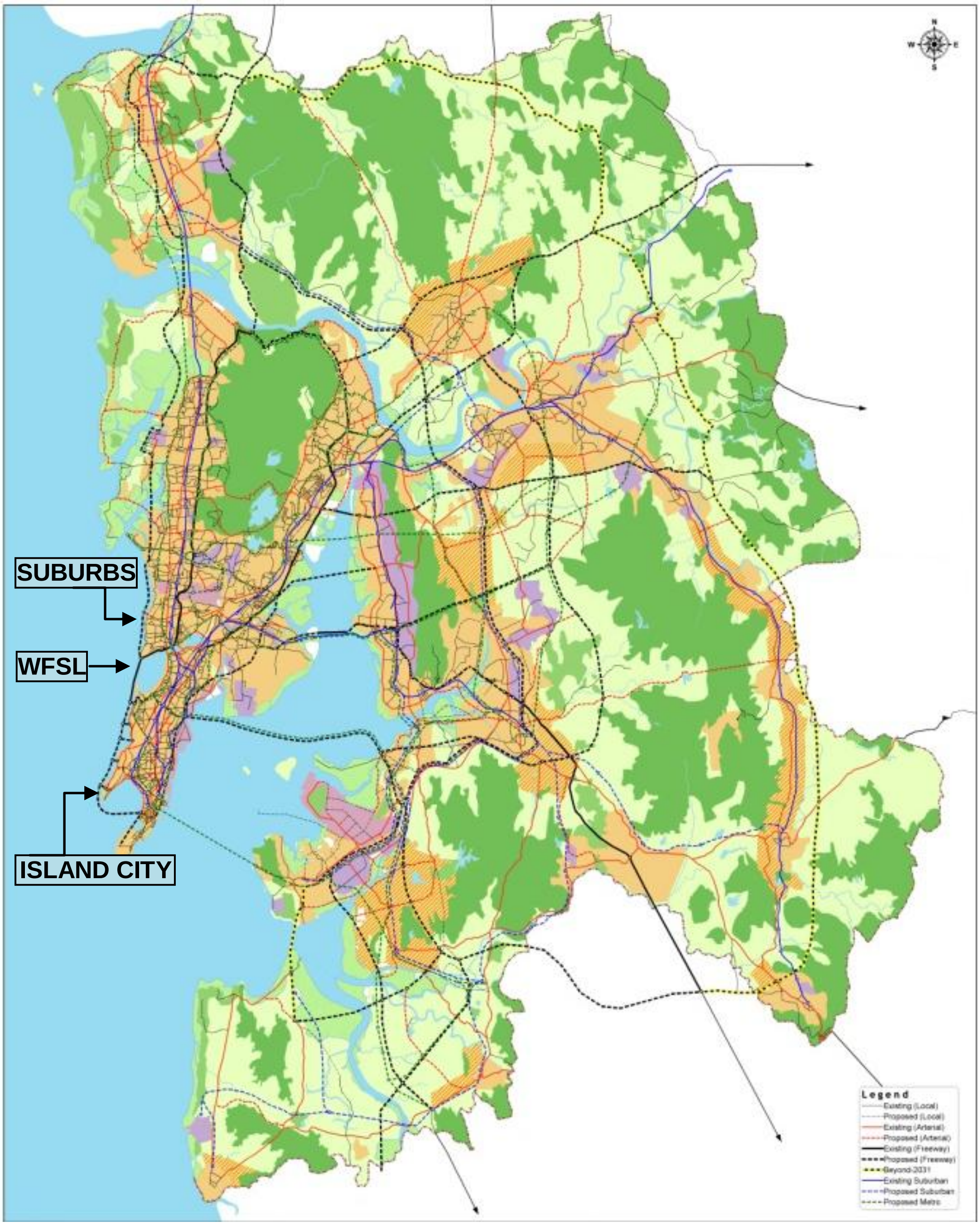

Figure 1 – Study Area (MMR)

Zoning system

Any transportation model requires the study area to be divided into the zones i.e. Traffic Analysis Zones (TAZ). As per TRANSFORM, 2005 the MMR has been divided into 1037 zones and the same zoning system is adopted for the present study. In all there are 1030 internal zones within MMR and 7 external zones which are within Maharashtra state but outside of MMR.

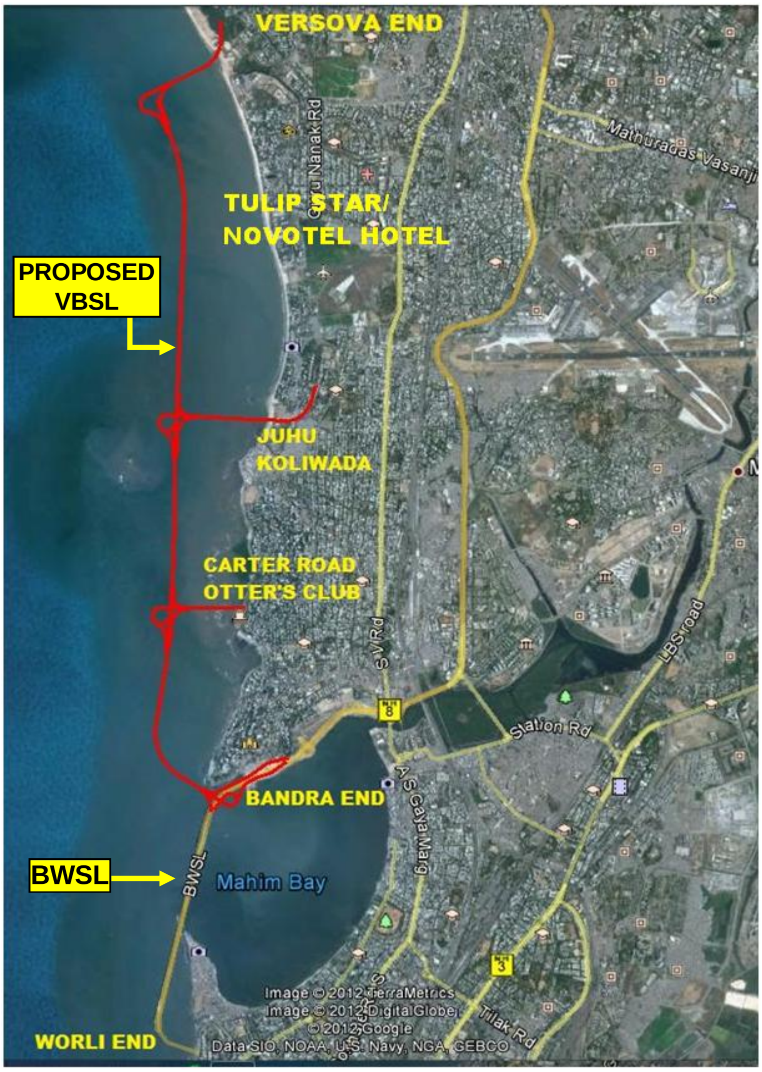

Figure 2 – Proposed VBSL Location and Alignment

Planning Variables

The variables that describe the travel demand traditionally have been the population, employment and vehicle ownership. Population, employment and vehicle ownership in greater Mumbai and their projection into the future has been taken from the TRANSFORM study (2005). The zonal planning parameters considered from the Transform study for Travel demand modeling are:

- Population (POP)
- Resident Worker – Office (RWF)
- Resident Worker - Industry category (RWI)
- Resident Worker – Other (RWO)
- Resident Student (RS)
- Office Jobs/Employment (OJ)
- Industry Jobs/Employment (IJ)
- Other Jobs/Employment (OTJ)

The planning variables for the years 2011, 2016, 2021 and 2031 and the aggregate total population and employment are taken from TRANSFORM Study.

Population

The forecasted population for the total MMR is shown in Figure 3.

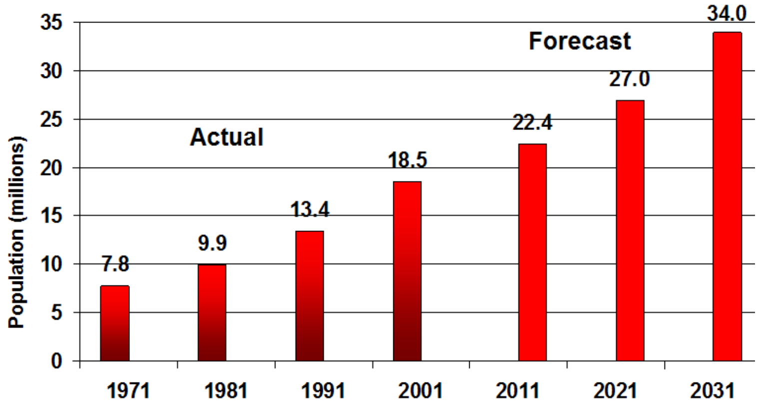

Figure 3 – Forecasted Population of MMR from 1971 to 2031 (TRANSFORM, 2005)

Employment

The projected employment (in million) in MMR is shown in the Table 1.

Table 1 - Projected Employment (in million) of MMR (TRANSFORM, 2005)

Factor	2011	2016	2021	2031
Employment	9.40	10.80	12.25	15.3

Plan Period

For the present study, 2005 is taken as the prior base year since TRANSFORM was carried out in this year. 2011 is taken as the base year. Since, the VBSL is likely to be in operation by 2016, the horizon year is taken as 2031 with two intermediate forecasts for 2016 and 2021.

STATED PREFERENCE EXPERIMENT

Stated Preference Survey

Stated preference is a statement by an individual of his/her liking (or disliking) for one alternative over another. The SP survey which was carried out (before the construction of BWSL) by IIT Bombay itself in the year 2008, to estimate the commuter preference and willingness to shift to the recently constructed toll road BWSL is made use of for the present study. The survey was conducted at workplaces in the island city and suburbs (Bandra, Worli, Haji Ali and Nariman Point) covering the catchment areas of the proposed BWSL corridor.

Methodology for calculating VOT from SP survey

One of the advantages of SP survey is that they are based on consumer economic theory, and specifically in the random utility theory already analysed by McFadden (1974). However, there might be errors due to the practical difficulty of conducting the experiment. An individual must choose between different alternatives characterised by a number of variables. Thus, the degree of utility perceived by a decision maker when selecting a given option may be represented as follows:

$$U_{in} = V_{in}\left(X_{in}, S_n, A_n\right) + \varepsilon_{in}$$

where i indicates one option from group $i = 1,.....J$, and n the decision maker, U_{in} is the total utility provided by option i to decision maker n, V_{in} the perceived utility provided by option i to decision maker n, explained by the following variables: X_{in} the variables associated to type of route, journey etc., S_n the socioeconomic variables, A_n the other variables and ε_{in} the random utility factor. Decision maker n will choose option i only if $U_{in} > U_{jn}$,
that is, if $V_{in} + \varepsilon_{in} > V_{jn} + \varepsilon_{jn}$, For all $i \neq j$. Note this is the case when: $V_{in} - V_{jn} > \varepsilon_{jn} - \varepsilon_{in}$

It follows that, since $(\varepsilon_{jn} - \varepsilon_{in})$ cannot be observed, we cannot accurately establish when $(V_{in} - V_{jn}) > (\varepsilon_{jn} - \varepsilon_{in})$. All we can do is calculate the probability that the above equation may become true, as follows: $P_{in} = P\,[(\varepsilon_{jn} - \varepsilon_{in}) < (V_{in} - V_{jn})]$

In order to set up our model we must therefore assume the random factor to be distributed in a certain way. The usual assumption is that these unobserved influences occur independently and identically throughout the sample. The multinomial logit model described below complies with the above assumption and has been widely used in related literature:

$$P_{in} = \frac{e^{V_{in}}}{\sum_{j=1}^{j} e^{V_{jn}}}$$

The perceived utility component will thus depend on the individual's choice of option 1 or 2:

$V1 = \alpha_T T_1 + \alpha_c C_1$,
$V2 = \alpha_T T_2 + \alpha_c C_2$,

where T_i represents the respective travel times and C_i the respective prices. Parameters α_T and α_c indicate the marginal utility of each variable. Note that the value of travel time is easily calculated using the following equation:

$$VOT = \frac{\partial V_i / \partial T_i}{\partial V_i / \partial C_i} = \frac{\alpha_T}{\alpha_C}$$

Where *VOT* is the value of time. Individuals whose *VOT* is higher than that calculated using the above equation will use the more expensive, faster means of transport. Individuals whose

VOT is lower than that calculated using the above equation will travel by the cheaper slower means of transport. An option is selected according to a subjective assessment of each individual's time and, therefore, value of time decides the effect of time savings on that individual's utility. In other words, value of time represents each individual's willingness to pay for a certain degree of time saving.

SP Experiment Design

In the design of SP experiment, travel time, travel cost, discomfort and toll were chosen as the attributes. The experiment was designed as a choice experiment by constructing several options with different attribute levels. The typical format of stated preference experiment and the different levels of attributes used are shown in Table 2 and Table 3 respectively.

Table 2 – Typical Stated Preference Experiment Design

<table>
<tr><th colspan="2">Existing Trip</th><th colspan="3">Proposed BWSL</th></tr>
<tr><td>Travel Time</td><td>Stated</td><td colspan="2">Travel Time</td><td>3 levels</td></tr>
<tr><td>Travel Cost</td><td>Stated</td><td colspan="2">Travel Cost</td><td>2 levels</td></tr>
<tr><td>Discomfort</td><td>Stated</td><td colspan="2">Discomfort</td><td>2 levels</td></tr>
<tr><td>Toll</td><td>Nil</td><td colspan="2">Toll</td><td>3 levels</td></tr>
<tr><th colspan="5">Choice Scale</th></tr>
<tr><td>Definitely Existing = 1</td><td>Probably Existing = 2</td><td>Can't Say = 3</td><td>Probably BWSL = 4</td><td>Definitely BWSL = 5</td></tr>
</table>

Table 3 –Levels of Attributes in SP Experiment

Attribute	No. of Levels	Values	Units
Travel Time	3 levels	0.25, 0.5, 0.75 times Existing Trip	Minutes
Travel Cost	2 levels	1, 0.8 times Existing Trip	Indian Rupees
Discomfort	2 levels	2, 3	On a scale of 1-5
Toll	3 levels	30, 45, 60	Indian Rupees

A typical SP option floated is shown in Table 4.

Table 4 Typical SP Experiment

Existing Trip		**Proposed BWSL**		
Travel Time	90 Minutes	Travel Time		45 Minutes
Travel Cost	Rs. 150	Travel Cost		Rs. 120
Discomfort	4	Discomfort		2
Toll	Nil	Toll		Rs. 45
Choice Scale				
Definitely Existing = 1	Probably Existing = 2	Can't Say = 3	Probably BWSL = 4	Definitely BWSL = 5

Calibrated Parameters form SP Survey Data

The parameters of the logit model which were calibrated by employing maximum likelihood estimation technique are shown in the Table 5. Also, the subjective values of time and driving discomfort obtained from the model are shown in Table 6.

Table 5 –Calibrated parameters of BWSL SP survey

Attribute	Estimate/Co-efficient	t-statistic
Travel Time	-0.016	-2.1
Travel Cost	-0.010	-1.5
Discomfort	-0.210	-1.5
Rho-squared statistic	0.301	

Table 6 –Subjective values of time and discomfort for car users

Attribute	Subjective Value
Travel Time	Rs. 96 / hr / person i.e., Rs. 210 / hr / PCU*
Driving Discomfort	Rs. 21 per unit shift

*Taking an average car occupancy of 2.18

TRAVEL DEMAND MODEL

General

The models calibrated during TRANSFORM (2005) which includes trip end models (productions and attractions), gravity distribution models and mode choice models are adopted for the present study. The calibrated models are applied for the forecasted future year (2011, 2016, 2021 and 2031) planning parameters to estimate the traffic on proposed VBSL for future years.

Trip Generation

The trip generation model estimates the number of trips produced and attracted to each of the TAZ. The trips produced are estimated from the household socio-economic and trip making characteristics. The trip attractions are estimated from type of employment categorized in each zone.
Trip end models are classified by six purposes namely,

- Home Based Work-Office (HBWF)
- Home Based Work-Industries (HBWI)
- Home Based Work-Other (HBWO)
- Home Based Education (HBE)
- Home Based Other (HBO)
- Non Home Based (NHB)

Trip End Model excluding walk trips captures the intra study area trips (i.e.) internal to internal (I-I) made by the residents of the study area for morning peak i.e. 6 a.m to 11 a.m. Multiple Regression technique was adopted to develop these models.

Trip Distribution

Once the trip productions and attractions for each zone are computed, the trips are distributed among the zones using Trip Distribution Models in the form of Origin destination matrices. A doubly constrained gravity trip distribution model is used for distributing passenger trips. A Gravity Trip Distribution model of the following form is used for distributing the total internal passenger trips.

$$T_{ij} = A_i O_i B_j D_j F_{ij}$$

Where,

$$A_i = \frac{1}{\sum_j B_j D_j F_{ij}} \qquad B_j = \frac{1}{\sum_i A_i O_i F_{ij}}$$

F_{ij} /f_{ij} = the deterrence function
t_{ij}= Highway travel time from i to j = Friction factor
T_{ij} = Number of trips between zones i and j.
α = Calibration parameter – power function
β = Calibration parameter – exponential function

Modal Split

The total trips from the distribution step are divided into captive riders (70% - Public Transport) and choice riders (30%) first for each purpose. The multinomial logit (MNL) model applied for the choice riders is shown in the Figure 4. Then the modal split equations are applied for those choice riders separately for Island city and non-Island city.

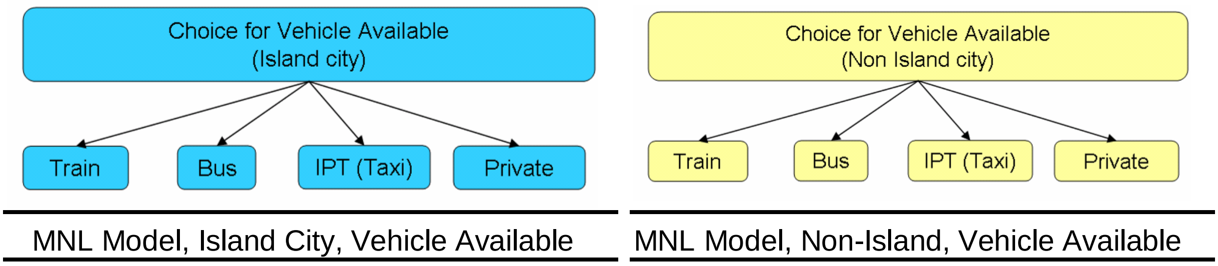

Figure 4 – Summary of Mode Choice Model Structures: Without Walk (TRANSFORM,2005)

Then the PT users from the choice riders are accumulated and added to the captive riders. Hence the whole trips are here being divided into Public Transport (PT) and Private Vehicle (PV) trips.

Trip Assignment

The peak hour PT and PV trips are obtained from the modal split stage. The Trip Assignment process is then carried out consisting of sequential two steps:

- Public Transport Assignment
- Highway Assignment

Public Transport Assignment

The public transport assignment is done based on Generalized Time (GT) units of each mode. The stochastic user equilibrium algorithm is utilized for the public transport assignment.

GT = IVTT + WTFAC*WT +TRFAC*NTR + WKTFAC*WKT + FARE / VOT + DF

Where,

IVTT	- In-vehicle travel time	FARE / VOT	- Fare / Value of time
WT	- Waiting time	NTR	- Number of Transfers
WKT	- Walk time	DF	- Discomfort
FAC	- Factor	TR	- Transfer

Highway Assignment

The Highway Assignment is done based on the Generalized Cost (GC) approach. The highway assignment is carried out by assigning the PV and Commercial Vehicle (CV) trips. The congested highway skims and link volumes are obtained as outputs from the highway Assignment. External travel of private vehicles is considered for highway assignment. Also, the delays at the intersections have been considered to represent the realistic flow patterns.

Highway Assignment is done by building paths based upon link costs (impedances) and assigning trips to those paths for each origin zone. After all the origin zones have been processed, link costs are updated based upon the level of congestion on each link. Then the entire path and assignment process is repeated. This process continues until the tolerance value is reached. The volumes from each iteration are combined to form a weighted assignment.

PT and Highway Assignment Interaction

In the trip assignment stage, initially the public transport assignment is done and then the link capacities are reduced accordingly for further highway assignment. This facilitates the interaction between public transport and highway assignments. Once the highway assignment is done, the congested link travel times are used as inputs back to public transport assignment in the next iteration. The whole process is repeated until the link costs are stabilized which can be given as input to the modal split step in next iteration. At the end of each iteration, network cleaning process is carried out.

RECALIBRATION OF VALUE OF TIME

After the trip assignment stage, the travel demand model is validated from the available ground counts. The link volumes obtained from the model on the Mahim Causeway (Figure 5) which was the only major road connecting island city and suburbs before the construction of BWSL were more or less matching with the ground counts. When the post scenario after construction of BWSL (toll road) was considered, the link volumes differed considerably. The obtained link volumes from the model on BWSL was about 8,200 PCUs in peak hour (accounting to 98,400 Daily PCUs considering the 8% of daily traffic as peak hour traffic) as against the present day realised traffic of 4,500 PCUs in peak hour.

The link volumes were on a much higher side and it was mainly due to the high value of time (Rs. 210 / hr / PCU) considered which was calibrated from the SP survey data. High VOT may be attributed to various reasons such as a poor understanding of the exercise, tiredness or failure to take the questionnaire seriously, all of which are peculiar to each polled individual. These existing error risk or bias (both random and system) had a considerable effect on both estimations and results. This constituted the need for recalibration of value of time to represent the realistic situation.

A capacity restraint procedure based on Generalized Cost (GC) is used in highway assignment. The GC used in the highway assignment is of the form:

$$GC = VOT*TT + VOC*Distance + Toll$$

Where,

GC = Generalized Cost (in Rs.)
VOT = Value of Time (in Rs./min)
VOC = Vehicle Operating Cost (in Rs./km)
TT = Travel time (in min)
TC = Travel cost (in Rs.)

The VOT in the above generalised cost equation has been varied till the present day realised traffic volume is obtained on the BWSL. Once the VOT is recalibrated as explained above, the model is revalidated for the screen line and cordon ground counts. Now, the parameters of generalized cost used in the present study are as below,
VOT = Rs. 140/hr and VOC = Rs.5.6 /Km

After this exercise, the validated model is used to estimate the flow on the proposed Versova Bandra Sea Link (VBSL) (Figure 2) for forecast years 2016, 2021 and 2031 for different toll rates such as free, Rs.5, Rs.7, and Rs.10. Also, the toll revenue generated is calculated and the same has been shown in the following section.

Figure 5 – Location of Mahim Causeway and BWSL

Toll Revenue on Proposed VBSL

The transport network considered for future years is given in Table 7.

Table 7 – Transport Network adopted for future years

Year	Transport Network
2016	• Base year network (with BWSL) • Proposed VBSL • WFSL (Worli – Haji Ali) • Metro Routes (Lines – I ,II, III) • (Line I Versova - Andheri – Ghatkopar • Line II Charkop – Bandra - Mankhurd • Line III Colaba - SEEPZ)
2021 & 2031	• Base year network (with BWSL) • Proposed VBSL • Proposed Suburban rail Routes • Metro Routes (All lines) • Monorail Route • Proposed Expressways • (WFSL, MTHL, etc.)

From Figure 6, Figure 7, Figure 8 and Figure 9, it is clear that Daily Toll revenue will be maximum if Rs 7/Km/PCU is charged. Estimated traffic is reduced to almost half for toll of Rs 10/ Km/PCU.

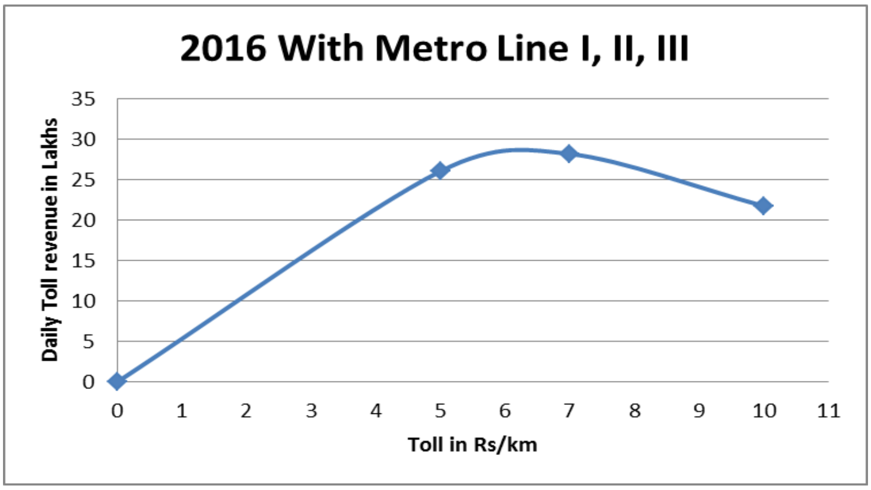

Figure 6 – Toll Revenue for 2016 with Metro Line I, II, III

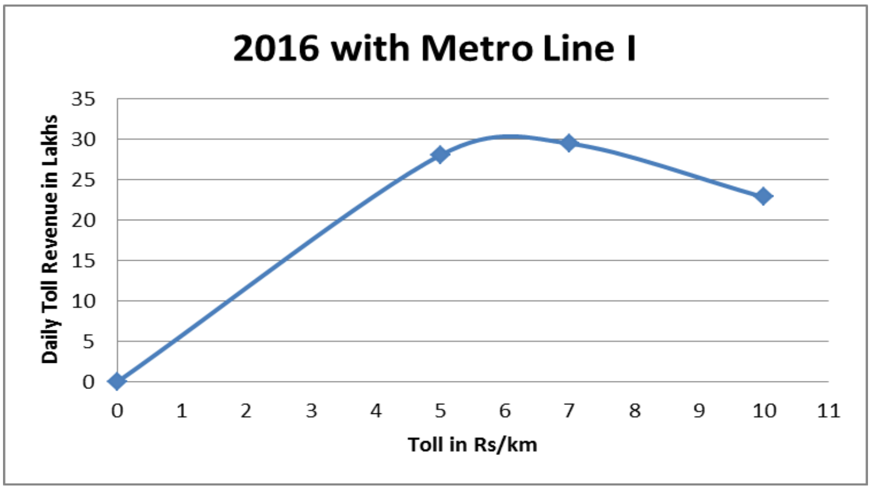

Figure 7 – Toll Revenue for 2016 with Metro Line I

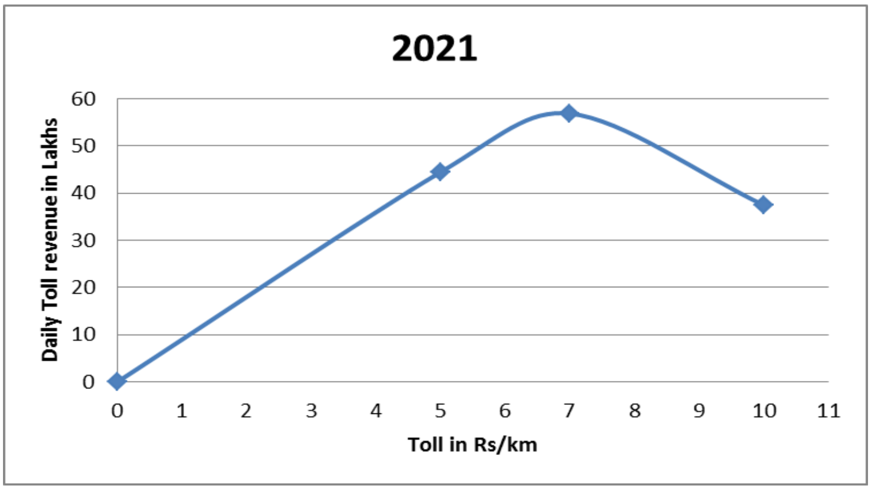

Figure 8 – Toll Revenue for 2021

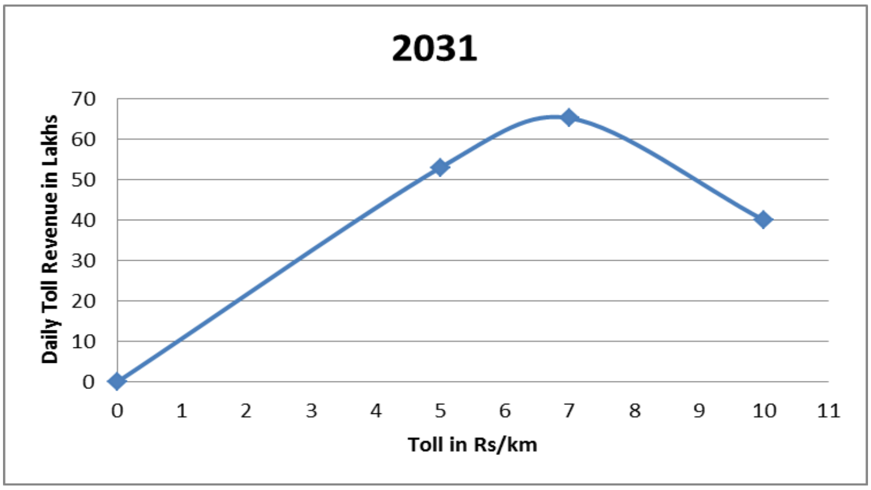

Figure 9 – Toll Revenue for 2031

CONCLUSIONS

Time savings generally represent a majority of the benefits generated by transport infrastructure investments. Hence, it is crucial that projects of this nature be assessed as accurately and realistically as possible. Recent literature has insisted on the need for adopting a value of time figure which suits the peculiarities of each context under analysis, abandoning—wherever possible—the usual practice of using the same criteria for any project or situation being assessed.

This paper has applied a recalibration technique which replicates the realistic situation for estimating demand on a proposed toll road in an urban area. Results indicate that, for passenger traffic, value of time obtained from the SP survey data is Rs. 210 / hr / PCU which is about 50% more than the realistic value of time i.e., Rs. 140 / hr / PCU.

The estimation of demand on the toll road (BWSL) in the present study has illustrated the relevance of the value of time factor in transport policy decision-making. Thus, in the context where the above value of time figures were obtained (a toll motorway i.e, BWSL competing with a trunk road I.E, Mahim Causeway) pricing policy is an essential tool for optimum traffic distribution minimising user travel time and hence congestion time.

The availability of traffic volumes on a toll road before and after construction may sometimes be a limitation for the proposed recalibration technique.

Finally, a second exercise of estimating the demand on the proposed VBSL has been carried out. The model with the recalibrated value of time is used for this purpose and the toll revenue estimated for different toll rates is discussed in the earlier sections.

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