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TRAVEL DEMAND FORECASTING FOR AN URBAN FREEWAYCORRIDOR: A CASE STUDY OF VERSOVA BANDRA SEA LINK

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ABSTRACT

Transport demand is growing drastically in Indian cities due to increase in urbanization and migration from rural areas and smaller towns. Increase in household income, increase in commercial and industrial activities has further added to transport demand in metropolitan regions like Mumbai Metro Politian Region (MMR). Hence India is concentrating more on the urban infrastructure like construction of many expressways, freeways, BRTS etc. to accommodate the rapidly growing urbanization and also to get relieved from congestion. Many a times the geographical constraints also limit the opportunities for creating the infrastructure and force the government to build the transport infrastructure with very high investment through various PPR (Public Private Partnership) model. Hence the feasibility of having any kind of that infrastructure is highly necessary with the more accurate estimation of travel demand in the future. Versova-Bandra Sea Link (VBSL) which is a pert of western free corridor in MMR is one of those kinds of urban freeway infrastructures in which is also taken as case study in the present study. It has been observed that the estimated ridership on the Bandra-Worli Sea Link (BWSL) freeway corridor which is already open to traffic is highly overestimate because of bias towards new alternative in stated preference behavioural discrete choice modelling due to the hypothetical opinions of respondents. Hence the attempt has been made in this paper to eliminate the bias by integrating the revealed preference behavioural analysis of existing BWSL corridor with the Stated Preference analysis of proposed VBSL corridor. Speed & delay surveys have been conducted for getting the realistic travel time, travel time savings due to existing BWSL. Also, the speed delay surveys have been conducted on various corridors parallel to Versova to Bandra to know the need of the VBSL. Later, the study focuses towards the analysis of Revealed Preference (RP) survey conducted for BWSL and estimates the actual subjective value of time perceived by the existing users of BWSL. Stated Preference survey (SP) is conducted for VBSL to estimate more realistic Subjective Value of Time (SVOT) than that obtained directly from SP analysis with the help of corrected subjective value of time for BWSL from RP analysis. With the corrected VOT, after validating the existing ridership on BWSL, the ridership has been forecasted on VBSL for various horizon years under the respective toll and SVOT for BWSL and VBSL from validated travel demand model for entire MMR in CUBE Voyager software platform.

Keywords: Urban Freeway Bias, Stated Preference, Revealed Preference, Subjective Value of Time, Ridership, Travel Demand Model

INTRODUCTION

Mobility of any person or good is very essential for the fulfilment of any activity in the society. Statistics indicate that traffic accidents are a primary cause of accidental deaths in Indian cities. Environment is also severely being affected due to very high emissions because existing congested urban corridors. A high level of pollution is another undesirable feature of overloaded streets of a city. The main reasons for these problems are the prevailing imbalance in modal split, inadequate transport infrastructure, and its suboptimal use. Because of the many problems faced by the existing urban transportation system, urban infrastructure has to be developed in a structured manner. Hence the planning and checking the feasibility of that infrastructure like freeways with highly accurate demand estimates is very important w.r.t. infrastructure investment perspective. Versova-Bandra Sea Link (VBSL) freeway corridor which is proposed in Mumbai Metropolitan (MMR) is taken as study for forecasting of the travel demand. It has been clearly reflected in Bandra Worli Seal Link (BWSL) project that, the forecasted traffic in the planning stage is not really using the freeway when it is opened for the traffic. Hence there is a need to study the actual behaviour of the traveller who is using the facility compare with the modelled behaviour in the past and use same corrections in the ridership estimations of future freeway infrastructure. Then it can be possible to eliminate the bias in modelled behaviour of hypothetical stated preference analysis.

STUDY OBJECTIVES AND SCOPE

The main aim of this study is to forecast the traffic volume that would be on VERSOVA-BANDRA Sea link (VBSL) under the prescribed toll rates. Towards this aim, the objectives were set for these studies are as given below

- Evaluate the realistic travel time by a speed delay survey on existing corridors and finding actual Value of Time on BWSL corridor from RP survey.
- Verifying the subjective value of time (SVOT) which has been obtained in the past from Stated Preference model (SP) of Bandra- Worli freeway Sea link (BWSL), by Revealed Preference survey (RP).
- Conducting the Stated Preference survey for VBSL freeway corridor which is proposed and estimating the realistic SVOT after the application of model bias correction.
- Validating the ridership on BWSL for the base year 2011 and forecast the traffic loading on the corridors BWSL and VBSL for the future years 2021 and 2031under prescribed toll rates and transport network scenarios considering the committed projects by that year.

LITERATURE REVIEW

The development of travel demand modelling history starts with the use of analytical and statistical techniques in 1960s, taken over by probabilistic approaches in 1970s and early 1980s, and further superseded by disaggregate models in 1980s. The 1990s have seen the dominant use of RP and SP approaches and behavioural theories in transportation planning and modelling.

(**Hutchinson, 1974**), During the early days the aggregate behaviour models attempt to predict the travel characteristics such as model split over an aggregate population. Then the disaggregate models which predict the travel behaviour at individual decisions level have been introduced.

Discrete choice analysis is an essential component of studying individual choice behaviour. The model can be used to estimate the total number of people who change their behaviour in response to an action. In general, discrete choice models postulate that "The probability of individuals choosing a given option is a function of their socioeconomic characteristics and the relative attractiveness of the option." In SP survey the respondents express preferences in hypothetical situations. In contrast, RP data are based on actual choices made in observable situations. The advantage from the disaggregate modelling is that, we can have number of travellers as distinct observations and obtain the utilities for each alternative infrastructure or mode of transport based on which the traveller is assumed to chose the alternative with maximum utility. Each individual or traveller faces a situation to make a choice according to his/her perception of relevant attributes among different alternatives.

(**Sanko, 2001**), In the RP Survey the respondent is asked to reveal his choice and corresponding travel and socio economic attributes, hence the utility models formed with the RP data are more reliable. However it is difficult to model the behaviour with respect new policies, projects or modes by using the RP data. In that case, SP analysis is the next appropriate option for dominating those limitations. In the SP survey, the respondents are examined to know how they would respond to a hypothetical situation of some fixed set of attributes. Hence the attributes need to be very clear and understandable to the respondent to compare those with his/her present attributes.

(**King, 1983**), A willingness to pay to diminish travel time by one unit is usually calculated from discrete travel choice models, as the ratio between the travel time coefficient and the coefficient of travel cost (if travel utility is linear). This represents the rate of substitution between cost and time for a given level of utility, and is also called the subjective value of travel time (SVOT). Utility functions are normally of the following form

$$U_j = \ldots\ldots + a_t \times TIME + a_c \times COST \qquad \text{----------} \quad \text{Eq. (1)}$$

Thus the value of travel time is equal to (a_t / a_c) in terms of cost units. The concept of VOT is associated with individual decisions or alternatives. The each individual may weighs the time differently, when choosing among different travel options. Hence, the estimation of appropriate VOT is of critical importance in transport planning process in terms of mode choice of the travellers and in the economic or financial analysis of transport infrastructure investments. In urban transportation scenarios, time savings is the significant indicator of performance of the transport system.

(**Prato, 2009),** Route choice model maps travel demand (often defined by an origin-destination (OD) trip table) into a link flow pattern, which is also known as a traffic assignment. In the late 1990s, many discrete choice models were adapted to route choice situation. These models are modifications of the Multi Nominal Logit (MNL) model. The Multi Nominal Logit (MNL) model can be consistently estimated on a subset of alternatives.

STUDY AREA AND METHODOLOGY

The proposed Versova-Bandra sea link (VBSL) will essentially serve as a Freeway corridor for total MMR because it will connect to Western free way Sea Link (WFSL) which is connecting from Bandra to Nariman point. Hence MMR is taken as the study area for the present study. Mumbai is well known as the financial capital of India which is one of the most thickly populated cities in the world. The Mumbai Metropolitan Region (MMR) as defined by the Mumbai Metropolitan Region Development Authority Act 1974 covers full Districts of Mumbai City and Mumbai Suburbs and part of the Districts of Thane and Raigad. **Figure 1** is showing map of MMR. It is a highly urbanized area with 13 Municipal Councils, 7 Municipal Corporations and a few non-municipal towns. In addition, there are more than 900 villages in this region. Considerable changes in the growth and distribution of population and employment are observed in the Region over the last couple of decades. It is further seen that population of MMR has increased from 7.79 million in 1971 to 20.75 million in the year 2011(**Table 1** and **2** are showing basic statistics of MMR). This is predicted to reach 34 million in the year 2031.

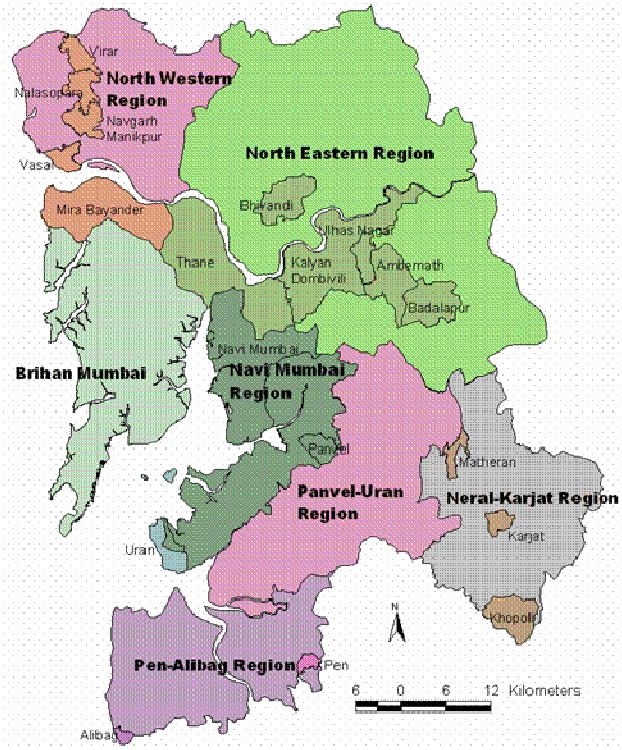

Figure 1 – Geographical area of Mumbai Metropolitan Region (TRANSFORM, 2005)

Due to geographically constraint on one side, and With such a huge population and the streaming of the traffic only in one particular (North-South) direction in the morning hours and vice-versa in the evenings has created a lot of traffic problem in the city of MMR and the

peak hour congestion on roads has thus reached to extreme levels. The average speed of these vehicles has been falling down to 5 to 15 KMPH in the peak time .In the congested network is already overloaded and the rapid growth in population, employment and vehicle ownership in the city demands better transport infrastructure like free way corridors i.e. Western Free way sea link (WFSL), Passenger Water transport (PWT), Mumbai - Pune Express way etc. for decongest the existing roads.

The Salient Features of VBSL Project are,

- Distance between Bandra to Versova – 10.1 km. (approximately)
- Proposed Number of Lanes – 6 lane divided (and 4 lane for the connectors)
- Cost of the Project – ` 1900 - 3000 Crores (Depending on the alternative alignments)

Figure 2 is showing the proposed location of VBSL and existing BWSL on the map.

Table 1 Basic Statistics on Study Area – MMR

Parameter	Year 1991	Year 2011
Population	14.53 Million	20.75 Million
Private Vehicle Ownership	0.718 Million	1.356 Million

STUDY METHODOLOGY

The methodology followed for achieving the above mentioned objectives is detailed here with the help of the flow chart in the Figure 3.

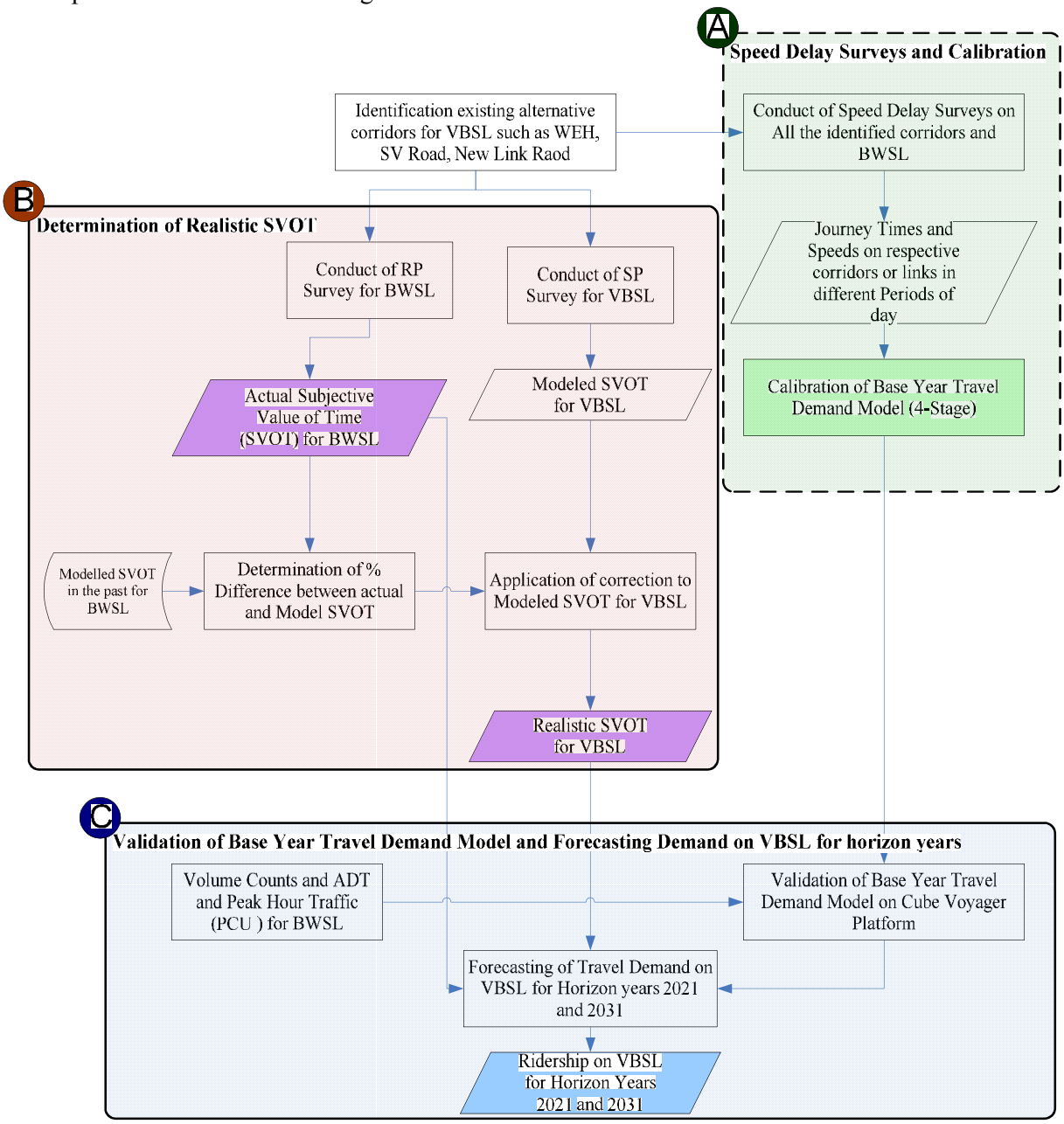

Figure 2 – Proposed Methodology for Carrying out the Ridership Estimation on Urban Freeway Corridor (VBSL)

Speed delay surveys were conducted on the existing Mahim- Nariman point corridor, existing Mahim – Haji Ali junction through BWSL corridor and existing road stretches between

Versova- Bandra for getting the current speed & travel time in the peak traffic conditions and to know the need of the project. This information is used to adjust the parameters of the speed various road links. RP survey (The data sheet of RP survey is shown in Annexure) is conducted to get the actual travel attribute characteristics like travel time, travel cost including with toll and also the socioeconomic characteristics like Vehicle ownership, Income, origin–destination from commuters who are using the BWSL and also the non-users of BWSL. The difference in travel time between users and non users of BWSL for the same O-D should be equal to the travel time saved due to BWSL as obtained from Speed-Delay surveys. As it is verified we can trust the RP data. Then this data is used for developing utility equation by using ALOGIT Software and for calculating present subjective value of travel time (SVOT) of BWSL. SVOT is used for getting the generalized cost for trip assignment. By incorporating respective tolls and SVOT into the travel demand model which has been developed in CUBE Voyager software, the traffic ridership is estimated on the BWSL for the base year 2011 which is again validated with the actual traffic counts on BWSL on a typical weekday.

Actual SVOT obtained from RP data is copared with the past SVOT of BWSL which was obtained from SP survey and the percentage difference between modelled and actual SVOT is determined. Here this percentage difference is termed as correction factor. Then SP survey has been conducted for VBSL from the respondents at their work places. By using this data, the utility equations are developed and SVOT for VBSL is estimated. Then this SVOT is corrected for having the realistic SVOT so as to eliminate bias of over estimation of value of time by reducing the modelled SVOT by the amount of correction factor calculated based on RP analysis for BWSL. Travel demand forecasting has been performed with the corrected SVOT for VBSL and actual SVOT for BWSL on CUBE Voyager Software platform and ridership is estimated for the horizon years 2021 and 2031.

SPEED DELAY SURVEYS AND CALIBRATION

Speed and delay studies used for the purpose of calibrating regional transportation planning models and for finding the level of service The main purpose of this survey is to get the present journey times and delays.

In order to get accurate data on travel times, delays and their locations a handheld GPS (Global Positioning System) palmtop is used in a vehicle moving with the traffic. Components of the GPS receiver are shown in the Fig4.1. GPS receiver logs data continuously at time interval of one second. The GPS data provides both spatial and time/distance based data from which various traffic parameters can be derived, including travel time, stopped time, travel speeds (instantaneous and average), and various congestion indices.

For the present study the following corridors are selected to conduct the Speed Delay Surveys

i) Mahim -Nariman Point Corridor
ii) Mahim – Haji Ali Junction through BWSL corridor
iii) Western Express way (WEH) between road stretches of Bandra to Versova
iv) Swami Vivekananda (SV) road between road stretches of Bandra to Versova

v) New Link Road between road stretches of Bandra to Versova

Speed Delay Survey for BWSL corridor

The Speed delay survey was conducted on both the selected corridors (i, ii in the above list), in which the following data were collected for each observation at the segment level.

- Travel time
- Direction (peak and off-peak)
- Segment length
- Speed

Data collected by using GPS on the Mahim – Haji Ali I/s and Mahim – Haji Ali through BWSL corridors for each of the segments in southbound direction and northbound direction during morning and evening peak time . The figure 3 presents the average speeds on two corridors.

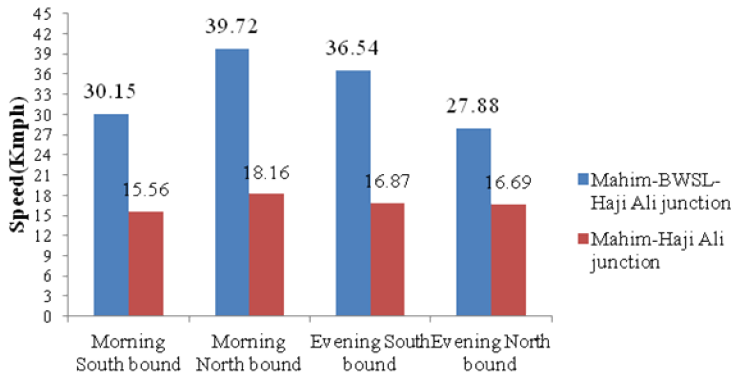

Figure 3- comparison of speed between two corridors w.r.t different peak time and direction

From Figur3 we can observe that more speed was achieved due to BWSL from Mahim to Haji Ali junction. This will give the benefits from the WFSL in terms of Vehicle Operating Cost (VOC). The below Figure 4 is showing the value of travel time saving between present Mahim – Haji Ali junction local road and Mahim to Haji Ali via BWSL w.r.t. different peak time and direction.

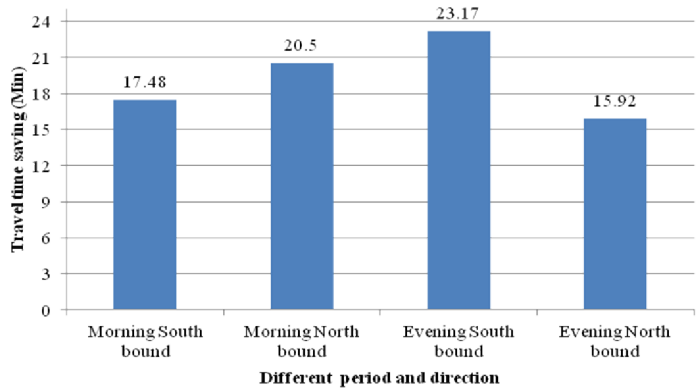

Figure 4 - Showing travel time saving variation in different peak time period and direction due to BWSL corridor

By using this results of speed – delay survey the travel time skims are validated. Then the adjusted skims are used in the generation of utility equations in the route choice modelling.

Speed Delay Survey for Versova – Bandra Sea Link (VBSL)

The speed delay surveys have been conducted for selected 3 corridors which are also mentioned below along proposed VBSL corridors as shown in the figure 4. These three corridors are the main arterial roads of the western suburbs feeding traffic to the CBD.

i) Western Express way (WEH) between road stretches of Bandra to Versova
ii) Swami Vivekananda (SV) road between road stretches of Bandra to Versova
iii) New Link Road between road stretches of Bandra to Versova

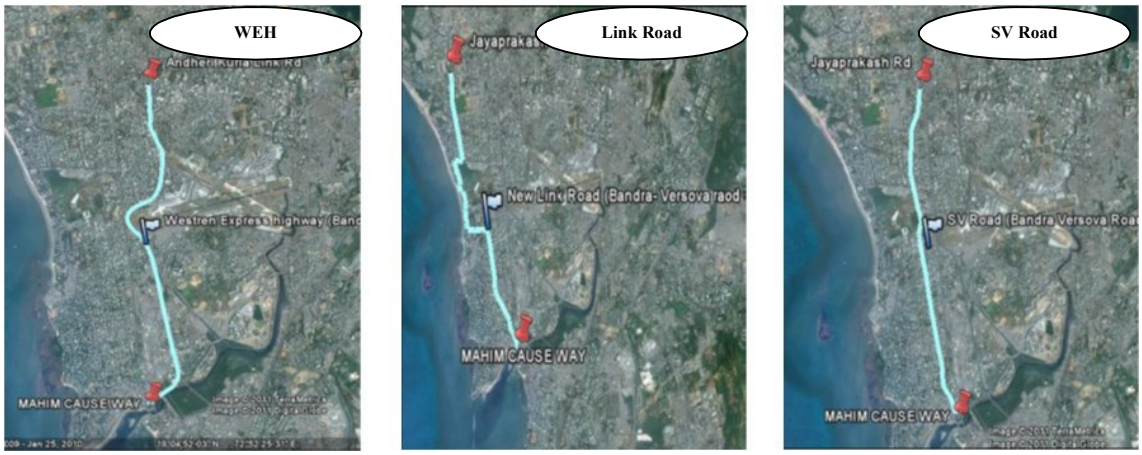

Figure 5 - Existing WEH corridor, new link corridor and SV Road corridor between Bandra to Versova (source: Google Earth)

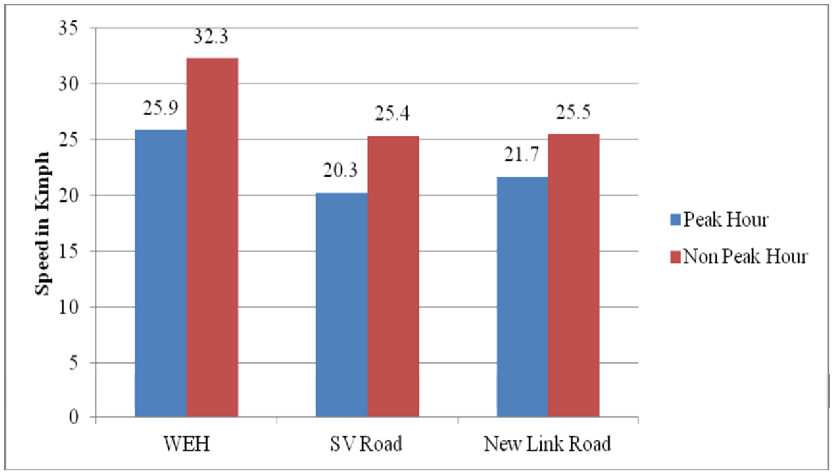

Figure 6 - Showing the Journey Speed comparison on three corridors during peak and non peak hours in north bound direction

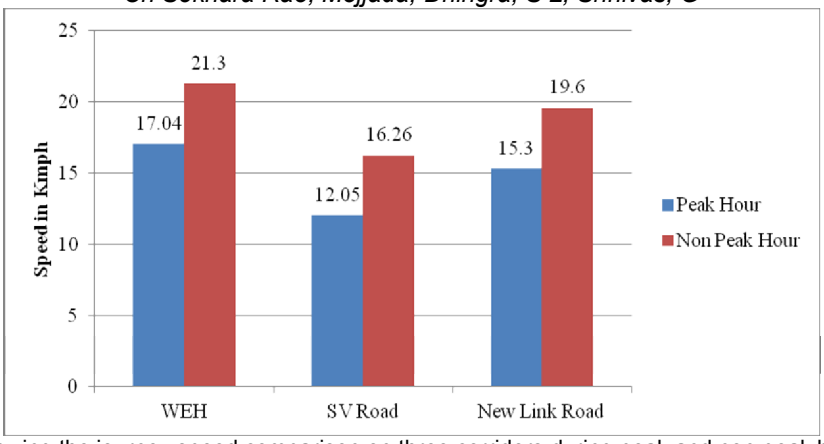

Figure 7 - Showing the journey speed comparison on three corridors during peak and non peak hours in south bound direction

Speed and Delay survey results for all 3 corridors shows a drastic reduction in Journey Speed(s) and Running Speed(s) of traffic flow during the peak hours of the day. The reason behind the cause may be because of enormous developments taking place along the side of corridors in terms of Residential, Recreational and Commercial activities. Development of road infrastructure like Grade separators (flyovers), Foot over bridges for pedestrian crossings etc. This might be challenging because of limited right of way available along the SV road and Link Road.

RP AND SP SURVEYS

Administration of RP and SP Surveys

The experiment has been carried in association with a team of about 5 enumerators (M. Tech students of Transportation Systems Engineering, IIT Bombay) in the workplaces in the Western Suburbs (Bandra, Versova, Borivali, Juhu and Andheri) and island city (Worli, Hajiali and Nariman Point) covering the catchment areas of the BWSL and proposed VBSL corridor. The face-to-face work based pilot survey was conducted before taking up main survey in order to arrive at a suitable survey instrument design for this study. Based on the experience gained in pilot survey a few modifications were made to different parts of the questionnaire instrument for increasing the efficiency of survey. The main survey was done in the month of April, 2011 for 14 days. In majority of the cases the interviews were conducted by taking prior appointments from the concerned authorities. About 120 numbers of samples for RP Survey and 75 numbers of samples for SP survey are obtained due less response rate.

Analysis of RP Survey for BWSL

Revealed preference is a statement consists of personal information like origin, destination, income, household size, sex, vehicle ownership etc. and travel information like mode of travel choices, travel time and travel cost and level discomfort etc. of user who is using a transportation system to his/her activities.

The survey has been conducted by asking the commuters who are using Bandra –Worli Sea link. Travel Time (TT), Travel Cost (TC) as generic variables and Income as an alternative specific variable.

Utility Equations for calculating the Subjective value of Time (SVOT) from ALOGIT is as follows

$$U_{BWSL}=\alpha\ TT+\beta\ TC+CONST \qquad \text{Eq. (2)}$$

$$U_{Existing}=\alpha\ TT+\beta\ TC+\gamma\ income \qquad \text{Eq. (3)}$$

Here are α, β, γ are coefficients of parameters to be estimated using RP data by ALOGIT. Table 2 is showing the Calibrated Parameters of utility equation for BWSL.

Table 2 - Calibrated Parameters of Utility of BWSL RP Survey

Parameter	**Estimated value of Coefficient**
Travel Time (TT)	-0.3504
Travel Cost (TC)	-0.2930
ρ2-statistic	0.182
SVOT	(-0.3504/-0.2930)*60 = ` 71/Hr

Sign of the estimated values of coefficients is logically good. But ρ2-statistic value that we got is reasonably acceptable. It has been observed from past studies that, the modelled SVOT for BWSL from past SP Survey is about Modelled SVOT of BWSL as per SP survey is Rs.96 / Hr based on which the ridership estimates were done. Hence the correction need to be applied to eliminate the bias using the correction factor calculated as below,

$$\text{Correction Factor for SVOT in \%} = [(\text{Modelled - Actual})/\text{Actual}] * 100 \qquad \text{Eq. (4)}$$

$$= [(96-71)/71]*100$$

$$= 35.21\%$$

Analysis of SP Survey

Stated preference is a statement by an individual of his/her liking (or disliking) for one alternative over another. The stated preference technique is used to determine the commuter behaviour with respect to the improved transportation system. This SP study determined the commuter preference and willingness to pay for the proposed VBSL (Versova- Bandra Sea Link) corridor in Mumbai. SP survey of commuters is required to model the generalized cost of travel as perceived by them along with their willingness to opt for VBSL. Without any doubt, the proposed VBSL will provide better quality of service in terms of substantial reduction in travel time, more comfort and reliability.

In the present context, attributes of VBSL like travel cost, travel time, toll, comfort, would play major role in attracting the commuters from the existing alternate links to VBSL. The present SP experiment is designed as a ranking experiment by constructing several options with different attribute levels.

The attribute travel time for private mode on VBSL is considered at three levels. The present travel time is known from each respondent at the time of interview. The attribute levels used for travel time are 0.25, 0.5 and 0.75 times of the present travel time. The attribute travel cost is considered at two levels. The present travel cost is known from each respondent at the time of interview and knowing the origin and destination of respondent's trip. The attribute levels for travel cost considered are 1 time and 0.8 times the present travel cost. Driving discomfort attribute is considered at two levels i.e. level 2 and 3 (**WFSL report, 2008**).**Table 3** showing the different levels in driving discomfort.

Table 3 - Driving Discomfort levels considered for travel in SP experiment

Level of Driving Discomfort	**Speed**
1	>=80
2	70-80
3	50
4	20-30
5	10-20

The driving comfort levels of 1 and 2 are only possible on urban freeways like VBSL. The driving discomfort levels 4 and 5 are generally observed on the existing urban streets of Mumbai. Urban streets may provide driving discomfort level of 3 only when the traffic volume levels are very low. The attribute toll was considered at three levels, namely, low, medium and high. For the commuters travelling from Versova to Bandra, toll levels considered are Rs. 75, Rs. 90 and Rs. 100.

By taking the all four attributes and their respective levels the complete factorial (Full factorial design) involves 36 combinations, out of these we have taken 10 combinations by using the fractional factorial design while keeping main effects to design the SP experiment.

The following are the different 10 number of options selected for SP experiment.

Existing Trip

Travel Time(Min)	Travel Cost(Rs)	Discomfort Level	Toll(Rs)

TT	Travel Cost	Discomfort	Toll(Rs)	option	Choice	Rating
0.25	1	2	90	1		
TT	Travel Cost	Discomfort	Toll(Rs)	option	Choice	Rating
0.25	1	2	100	2		
TT	Travel Cost	Discomfort	Toll(Rs)	option	Choice	Rating
0.5	0.8	2	90	3		
TT	Travel Cost	Discomfort	Toll(Rs)	option	Choice	Rating
0.5	0.8	3	75	4		
TT	Travel Cost	Discomfort	Toll(Rs)	option	Choice	Rating
0.5	1	2	75	5		
TT	Travel Cost	Discomfort	Toll(Rs)	option	Choice	Rating
0.5	0.8	2	100	6		
TT	Travel Cost	Discomfort	Toll(Rs)	option	Choice	Rating
0.75	0.8	2	75	7		
TT	Travel Cost	Discomfort	Toll(Rs)	option	Choice	Rating
0.75	0.8	3	75	8		
TT	Travel Cost	Discomfort	Toll(Rs)	option	Choice	Rating
0.75	1	2	90	9		
TT	Travel Cost	Discomfort	Toll(Rs)	option	Choice	Rating
0.75	1	3	75	10		

Travel Time (TT), Travel Cost (TC) as generic variables and Income as an alternative specific variable.

The formulated Utility equations are,

$$U_{vbsl} = \beta\ TTVBSL + \gamma\ TCVBSL + \varphi\ DCVBSL + CONST \qquad \text{Eq. (5)}$$

$$U_{em} = \beta\ TTEM + \gamma\ TCEM + \varphi\ DCEM + \gamma\ INCOME \qquad \text{Eq. (6)}$$

Where,

U_{vbsl} = deterministic component of utility of VBSL,
U_{em} = deterministic component of utility of Existing Mode,
TT = travel time,
TC = sum of travel cost and toll,
DC = driving discomfort,
β, γ, φ =parameters to be estimated using SP data and
CONST = constant that explains the unobserved effects.

The coefficients of parameters of the utility equations were calibrated by using ALOGIT.

Table 4 - Calibrated Parameters of VBSL SP Survey

Parameter	**Estimated value of Coefficient**
Travel Time	-0.03917
Travel Cost	-0.03573
Discomfort	-0.9300
ρ2-statistic	0.1484
SVOT from Model	(-0.03917/-0.03573)*60 = ` 65.8 /Hr

The signs of all the parameters are found to be logical. All the variables entered the model are found to be statistically significant. Although, a ρ^2-statistic (a robust goodness-of-fit statistic that varies between 0 and 1) can be found to be reasonably good if it is more than 0.3, in the present case it is found to be 0.1484 which is reasonably acceptable.

As there will be some bias in the estimated SVOT through SP analysis it needs to be corrected. Hence,

Corrected realistic SVOT for VBSL = Modelled SVOT – Modelled SVOT *Correction Factor

= 65.8 – 65.8 * (35.21%)

= ` 42.63 /Hr

SVOT obtained from the RP analysis for BWSL and corrected SVOT from the SP for VBSL are used for travel demand model in the trip assignment step.

TRAVEL DEMAND FORECASTING ON FREEWAY CORRIDORS

Cube Voyager software platform is employed for the forecasting of traffic along the selected corridors. The travel demand model is developed for entire MMR in order to capture the long movements from southern part to northern. The four stage traditional travel demand modelling process which includes the sequential steps Trip Generation, Trip Distribution, Modal Split and Trip Assignment is followed in the present study. The travel demand model is implemented for entire MMR in CUBE for the land use scenario selected for the MMR in the transportation study for MMR and the snap shot of model structure in the software platform is shown the **Figure 8**. As the part of demand modelling process the GIS based network has been developed for entire MMR considering all the existing and future network of proposed transport infrastructure and public mass transport systems. However the all the calibrated and validated trip end models, gravity models, and speed flow relation ships have been adopted from the Transform Study which was conducted in the year 2005 and the model is not discussed greatly in this paper as it is used as a tool for estimating the demand.

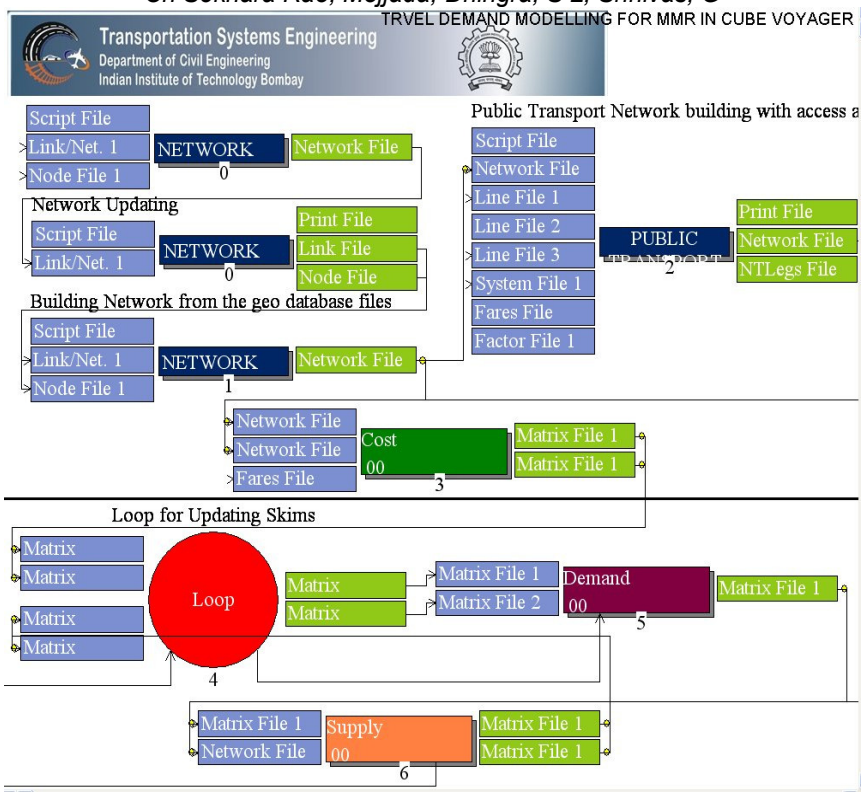

Figure 8 – Travel Demand Model structure implemented in CUBE Voyager software

Travel Demand Model Validation for Base Year traffic on BWSL

The traffic coming onto the BWSL is estimated for the base year 2011 by using current toll i.e. Rs.50 and actual subjective value of time i.e. Rs.71/hr which is calculated from RP data. Daily traffic (vehicles) coming on BWSL for the year 2011 as per actual data collection taken at toll plaza on BWSL corridor is 34494 in both the directions. Comparison of actual traffic and estimated traffic taking both the model SVOT of past and current actual SVOT from RP data is tabulated below in **Table 5**. It can be clearly found that the estimated traffic with the actual value of time is closer the original traffic. By employing the proposed technique bias been reduced from 178.1% to 36.55% which is very significant. As the 36.55% difference in traffic demand may be acceptable the model is validated and can used for forecasting.

Table 5 - Daily traffic coming on BWSL in both directions for the year 2011 in PCU

Case	Traffic in PCU	% Difference between original traffic
As per traffic data collected at toll plaza for the month January, 2011	35,169	0%
As per RP survey model with toll Rs.50 and SVOT of Rs.71/hr	48,026	+36.55%
As per Past SP survey model with toll Rs.57 and SVOT of Rs.96/hr	97,891	178.3%

Travel Demand Forecasting on VBSL freeway corridor for Horizon Years

After validating the travel demand model for the base year of 2011, traffic coming onto the VBSL for the for the horizon years 2021 and 2031 is forecasted by using toll Rs.75 for VBSL and subjective value of time (corrected) i.e. Rs.42.63/Hr for VBSL by using the developed travel demand model for MMR on CUBE Voyager software platform. Future year toll has calculated by using the whole sale price index of 5.5% for every 3years. The expected or forecasted traffic for VBSL in both the directions for horizon years is shown in the **Table 6**.

Table 6 – Expected Daily volume in PCU on VBSL

Year	Average Daily Traffic (ADT)
2021	72,109
2031	91,143

CONCLUSIONS

The study results has shown clearly that the subjective value of time computed from SP survey directly over estimates the traffic very heavily in the range of 178% which can not be acceptable. It is usual that the SP analysis over estimated the value of time as the respondents are asked to give opinion with respect a hypothetical situation which need to be corrected in a logical approach. Hence the actual value of time is calculated from RP survey based on the present (Base year-2011) experience of BWSL users and non users. The estimates with the actual SVOT obtained from RP are validated against the original traffic counts which have shown about the difference of 36% which may be acceptable. Hence correction factor is calculated based on the SVOT of BWSL from past SP survey and SVOT obtained from RP survey of BWSL. The same correction factor is applied on the over estimated SVOT of VBSL obtained from SP survey to relax it. The corrected SVOT is used for forecasting traffic on VBSL with more confidence as it was corrected for the expected bias. The travel demands are estimated on VBSL using a four stage travel demand model implemented on CUBE Voyager software platform for the horizon years 2021 and 2031.

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