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# Analyzing the traffic conditions and efficiency of current Toll system for Design of Vashi Toll Plaza

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**Abstract**

*For the construction of highways the essential part is collection of funds. These funds are collected directly or indirectly. Indirect revenues are collected in the form of petrol tax, rubber tax etc.Direct revenues are collected directly from road users in the form of Toll collections. But due to Toll collections, it effects on free flow which results queuing are formed The efficiency is depends on the service rate of toll boothThis paper focus on the current traffic conditions at Vashi Toll Plaza by collecting 7 days hourly basis traffic data. This paper reviews the forecasted traffic and requirements of future Manual Toll Lanes and ETC Toll Lanes at Vashi Toll Plaza.*

***Keywords:-Traffic, efficiency, Toll Plaza, Toll Lanes***

## 1. INTRODUCTION

India has second largest road network in the world. At 1.70 km of roads per square kilometer of land, the quantitative length road network is higher than that of Japan (0.91), United States (0.67), Brazil (0.18) or Russia (0.08).The length of national highways in India increased from 70,934 in 2010-11 to 101,011 km in 2015-16

Maharashtra State Road Development Corporation (MSRDC) has undertaken the development of roads and allied infrastructure mainly through private participation. Most of the projects undertaken by MSRDC are on 'Build, Operate and Transfer' (BOT) basis and deal with road projects, flyover projects, toll collection rights etc. Since inception DC has completed 18 projects with estimated cost of 7,187 crore incurring actual expenditure of 6,822 crore. Collection of these revenues is takes place through Toll Plaza. As the traffic increases the Toll Plaza lanes also required to be increases. This paper reviews forecasted tollable traffic and the requirements of up gradation of lanes.

## 2. Research Framework and Evaluation

Seven days both directions Traffic data is collected at Vashi Toll plaza in which one direction of Toll Plaza is towards Mumbai and another is towards Vashi.

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| Day | Two wheeler | Car/Jeep | LCV | Truck/Bus | M-Axle | Others | Total |
|---|---|---|---|---|---|---|---|
| **Sunday** | 8822 | 40424 | 3918 | 4524 | 2554 | 0 | **60242** |
| **Monday** | 8879 | 41377 | 4798 | 4823 | 2711 | 1 | 62589 |
| **Tuesday** | 9400 | 43728 | 4999 | 4813 | 2931 | 1 | 65872 |
| **Wednesday** | 9835 | 45000 | 5276 | 5021 | 3139 | 2 | 68273 |
| **Thursday** | 10078 | 45671 | 5306 | 5249 | 3377 | 0 | 69681 |
| **Friday** | 9556 | 43795 | 5745 | 6146 | 3013 | 1 | 68256 |
| **Saturday** | 9937 | 43753 | 5805 | 4954 | 3416 | 3 | **70390** |
| **Average** | **9501** | **43753** | **5151** | **5076** | **3020** | **1** | **66742** |

**Table No.2.1 Seven Days Daily Traffic towards Mumbai**

**Table No.2.2. Seven Days Daily Traffic towards Vashi**

| Day | Two wheeler | Car/Jeep | LCV | Truck/Bus | M-Axle | Others | Total |
|---|---|---|---|---|---|---|---|
| **Sunday** | 7956 | 50082 | 8066 | 2973 | 3009 | 1 | 72076 |
| **Monday** | 7833 | 49697 | 8179 | 3980 | 3369 | 0 | 73073 |
| **Tuesday** | 7467 | 42294 | 7492 | 3591 | 3731 | 0 | **64559** |
| **Wednesday** | 7735 | 43656 | 7745 | 3732 | 3666 | 2 | 66548 |
| **Thursday** | 8335 | 47468 | 8301 | 3943 | 3950 | 1 | 72005 |
| **Friday** | 7588 | 46028 | 8156 | 4111 | 3506 | 0 | 69384 |
| **Saturday** | 8242 | 49168 | 8591 | 3879 | 3924 | 0 | **73802** |
| **Average** | **7879** | **46913** | **8076** | **3743** | **3594** | **1** | **70207** |

From the above traffic study it concludes that,

- Saturday is the Peak Day at Both directions.
- Tuesday is the off Peak Day towards Mumbai and Sunday is the off Peak Hour towards Vashi

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## 2.1. Pie chart diagram (Traffic composition)

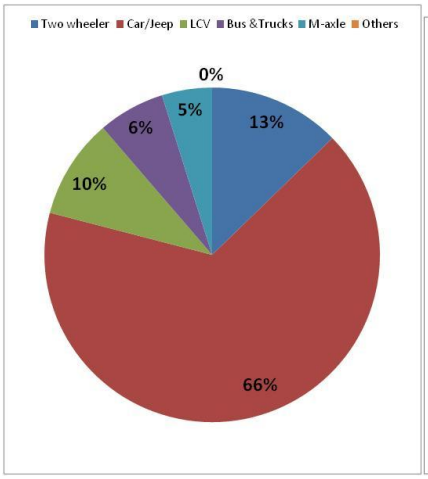


**Fig 2.1.1 Towards Mumbai**

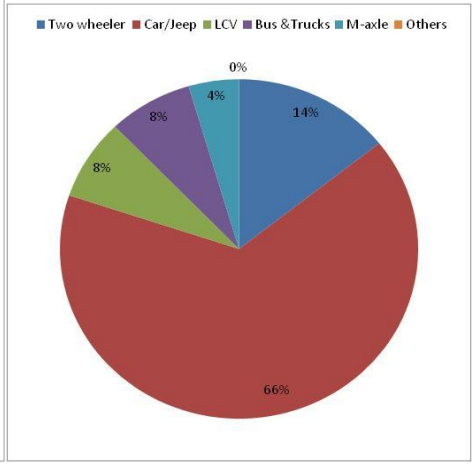


**Figure 2.1..2 Towards Vashi**

## 2.4. Average Annual Daily Traffic:

The factors are generally established from past traffic survey data or from the petrol/ diesel sales data at existing petrol pumps or traffic data at Existing Toll Plazas along the project corridor. In present study the traffic data is collected 6 months to calculate the seasonal correction factor

**Table 2.4.1 Seasonal correction factor**

| Sr.No. | LMV | LCV | Truck/Bus | MAV | Total | ADT | SCF |
|---|---|---|---|---|---|---|---|
| 1 | 1606708 | 341398 | 246990 | 146432 | 2341438 | 78048 | 0.986842 |
| 2 | 1682342 | 365720 | 220836 | 164133 | 2433029 | 81101 | 0.949692 |
| 3 | 1685281 | 335115 | 225000 | 146008 | 2391318 | 79711 | 0.966258 |
| 4 | 1555501 | 351543 | 173220 | 163836 | 2244540 | 74818 | 1.029444 |
| 5 | 1433731 | 344342 | 185538 | 175928 | 2139753 | 71325 | 1.079858 |
| 6 | 1630050 | 327965 | 186100 | 169571 | 2313696 | 77123 | 0.998674 |
| **Average** | **1598953** | **344406** | **206284** | **160986** | **2310629** | **77021** | **1.019** |

We get Annual average daily traffic (AADT) by multiplication of Average Daily Traffic (ADT) to SCF.

## 2.5 PCU

In view of variety of vehicles, a number is assigned to a vehicle based on its speed, space and characteristics, in comparison to Car termed as equivalent Passenger Car Unit (PCU)

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**Table No.2.5.1.Passenger Car Unit**

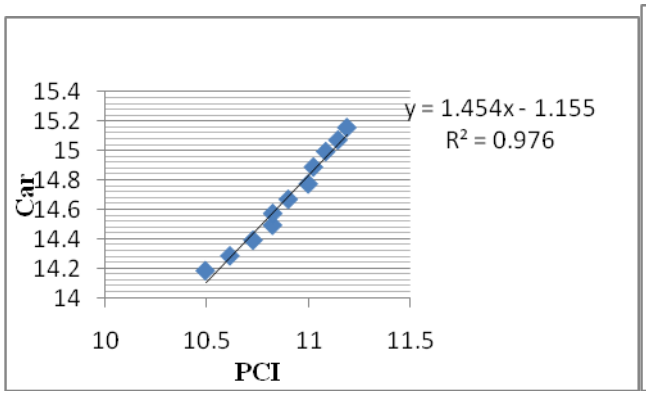
| Type | T/W | Car | LCV | Truck | Mav | Total |
|---|---|---|---|---|---|---|
| Factor | **0.5** | **1** | **1.5** | **3** | **4.5** | |
| PCU (Mumbai) | 3947 | 47006 | 12138 | 11253 | 16209 | 90547 |
| PCU (Vashi) | 4760 | 43841 | 7741.5 | 15258 | 13621.5 | 85122 |

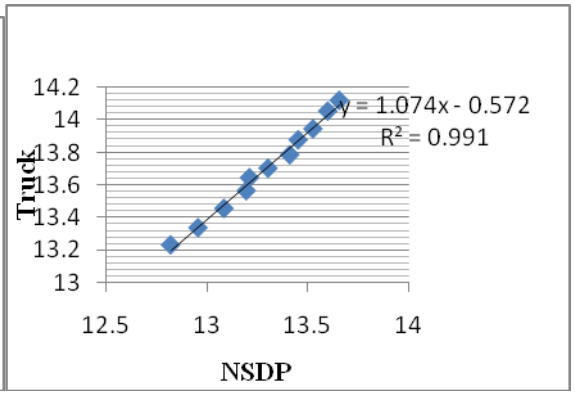
## 3. TRAFFIC ANALYSIS AND FORECAST

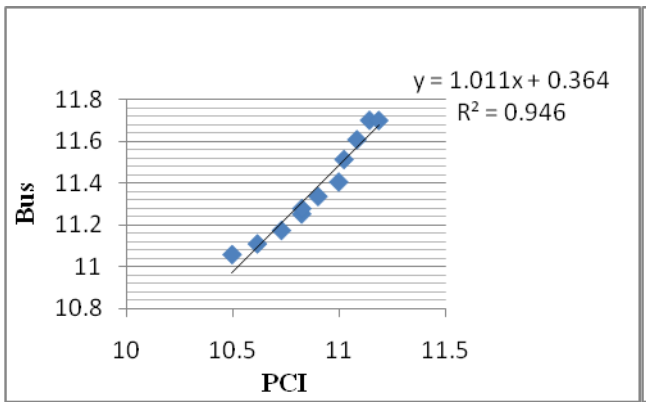
### 3.1 Secondary Data

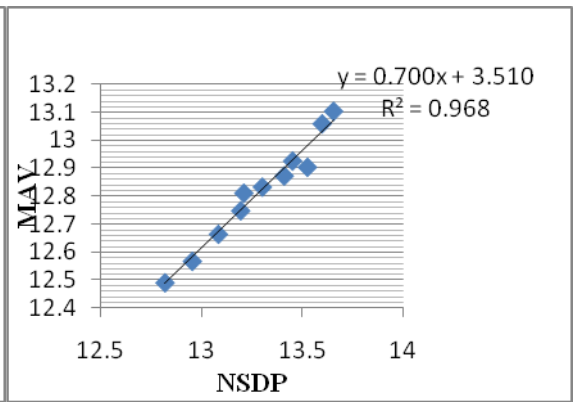
Besides primary surveys, the following data was collected from various sources:

- Population data
- Vehicle Registration data
- NSDP, GDP and Per-capita income data



### 3.3 Future Growth:

Based on the present NSDP growth of Maharashtra and future policies of the government, the projected NSDP, Population and PCI growth rates calculated.

As per IRC: 108-2015, "Guidelines for traffic prediction on Rural Highway" growth rates are generated.

**Table 3.3.1Projected Future growth rates in percentages**

| Sr.No. | Vehicle Type | 2015-18 | 2018-23 | 2023-28 |
|---|---|---|---|---|
| **1** | **Cars** | 6 | 5 | 4 |
| **2** | **Bus** | 5 | 4 | 3.5 |
| **3** | **Truck** | 5 | 4 | 3 |
| **4** | **Mav** | 3 | 3 | 2 |
| **5** | **Two wheeler** | 7 | 5 | 4 |

### 3.4 Forecasted Traffic

**Table 3.4.1 Projected Traffic towards Mumbai**

| Year | T/W | Car/Jeep | LCV | Bus | M-axle | Total |
|---|---|---|---|---|---|---|
| **2018** | 7894 | 47005 | 8093 | 3752 | 3601 | 70345 |
| **2019** | 8288 | 49355 | 8415 | 3902 | 3711 | 73671 |
| **2020** | 8704 | 51825 | 8753 | 4058 | 3822 | 77162 |
| **2021** | 9137 | 54414 | 9101 | 4217 | 3937 | 80806 |
| **2022** | 9596 | 57135 | 9467 | 4386 | 4055 | 84639 |
| **2023** | 10076 | 59994 | 9846 | 4563 | 4177 | 88656 |
| **2024** | 10477 | 62392 | 10142 | 4724 | 4257 | 91992 |
| **2025** | 10898 | 64887 | 10446 | 4888 | 4345 | 95464 |
| **2026** | 11334 | 67482 | 10757 | 5061 | 4432 | 99066 |
| **2027** | 11787 | 70184 | 11080 | 5236 | 4521 | 102808 |

**Table 3.4.2 Projected Traffic towards Vashi**

| Year | T/W | Car/Jeep | LCV | Bus | M-axle | Total |
|---|---|---|---|---|---|---|
| **2018** | 9521 | 43840 | 5161 | 5085 | 3028 | 66636 |
| **2019** | 9997 | 46032 | 5368 | 5288 | 3119 | 69804 |
| **2020** | 10497 | 48334 | 5583 | 5500 | 3212 | 73126 |
| **2021** | 11022 | 50750 | 5806 | 5720 | 3309 | 76607 |
| **2022** | 11573 | 53288 | 6039 | 5949 | 3408 | 80257 |
| **2023** | 12151 | 55952 | 6280 | 6187 | 3510 | 84080 |
| **2024** | 12637 | 58191 | 6531 | 6404 | 3580 | 87342 |
| **2025** | 13143 | 60518 | 6727 | 6628 | 3652 | 90668 |
| **2026** | 13668 | 62939 | 6929 | 6860 | 3725 | 94121 |
| **2027** | 14215 | 65457 | 7137 | 7100 | 3799 | 97708 |

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### 4. Toll Service time

The service time required for vehicles are collected at Vashi Toll Plaza on both direction.

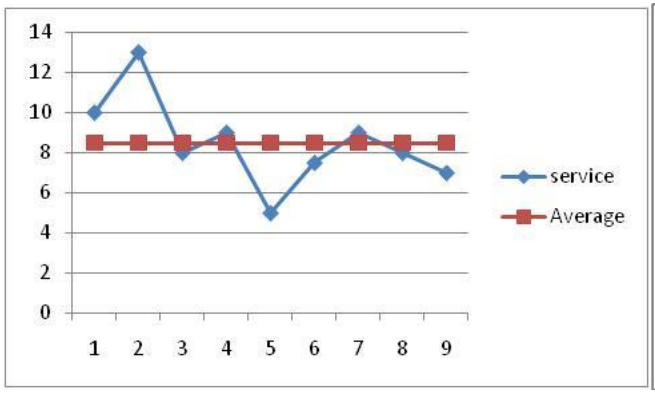


**Fig.4.1.Service Rate towards Mumbai**

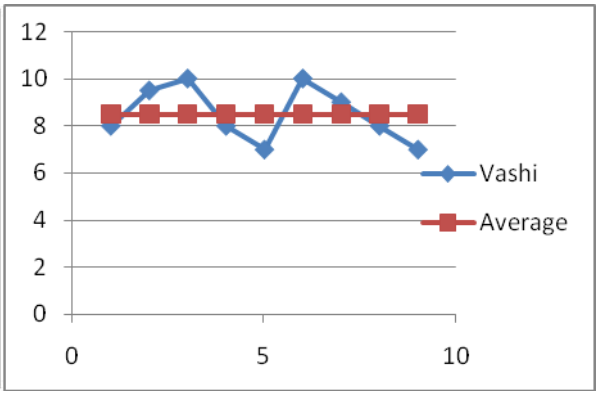


**Fig. 4.2. Service Rate towards Vashi**

**Sample calculation (Towards Vashi)**

Number of Tollable vehicles, Nmin=λ/μ

Therefore, service rate is 8.5 sec/vehicle and Arrival rate is 4559 PCU/Hr

Number of lanes required is 4559/424 i.e. 11 lanes are required

Similar calculations are adapted for Manual lane requirement.

| Year | Vashi Toll Plaza | | Total |
|---|---|---|---|
| | Towards Mumbai | Towards Vashi | |
| 2018-19 | 11 | 12 | 23 |
| 2019-20 | 12 | 13 | 25 |
| 2020-21 | 13 | 13 | 26 |
| 2021-22 | 14 | 14 | 28 |
| 2022-23 | 14 | 14 | 28 |
| 2023-24 | 15 | 15 | 30 |
| 2024-25 | 15 | 15 | 30 |
| 2025-26 | 15 | 16 | 31 |
| 2026-27 | 16 | 16 | 32 |
| 2027-28 | 17 | 17 | 34 |

By considering 70% Vehicles as ETC Vehicles, the lane numbers are calculated which have service time 900VPH.

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| Year | Vashi Toll Plaza | | | | Total |
|---|---|---|---|---|---|
| | Towards Mumbai | | Towards Vashi | | Total lanes required |
| | ETC | Manual | ETC | Manual | |
| **2018-19** | 4 | 4 | 4 | 4 | 16 |
| **2019-20** | 4 | 4 | 4 | 4 | 16 |
| **2020-21** | 4 | 4 | 4 | 4 | 16 |
| **2021-22** | 4 | 4 | 4 | 4 | 16 |
| **2022-23** | 5 | 4 | 5 | 4 | 18 |
| **2023-24** | 5 | 4 | 5 | 4 | 18 |
| **2024-25** | 5 | 4 | 5 | 5 | 19 |
| **2025-26** | 5 | 5 | 5 | 5 | 20 |
| **2026-27** | 5 | 5 | 5 | 5 | 20 |
| **2027-28** | 5 | 5 | 6 | 5 | 21 |



**Fig.4.3.Vashi Toll Plaza Photographs.**

## 5.Conclusion

1) Total 7 days average traffic towards Mumbai is 66742 and towards Vashi is70207.
2) Service rate required at Toll Plaza is 8.5 sec/vehicle and Arrival rate at each Toll Lane is 4559 PCU/Hr
3) Forecasted Traffic towards Mumbai is 102807 and Vashi is 97707 on year 2027-28.
4) Total Manual Lanes required on 2018-19 are 23 and 2027-28 are 34.
5) If 70% Vehicles are ETC users then, Total Manual Lanes required on 2018-19 are 8 and ETC lanes are 8. On year 2027-28, Total Manual Lanes required are 10 and ETC lanes required are 11.Due to higher service rate of ETC Lanes, it requires less Toll lanes which results less area requires for construction Toll Plaza.

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