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Use of Intelligent Transport System (Its) Measures at Pune

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ABSTRACT:
Streets are the arteries of urban communities. They are the ones which provide mobility for men and material. They are also used for water, sewerage, telecom, electricity distribution among other things. They also to a large extent determine the character of the city. Well-designed and well-maintained streets can make a perceptible difference to the quality of life. In this paper, we deal with streets in the urban and semi-urban context. Streets and roads are used interchangeably to mean the same thing. Our focus is going to be geometric design aspect. The geometric design of streets can make a huge difference how efficiently it carries out its functions, and its safety. Hence, the main consideration deal with the geometric design of the road, that is the plan and section view, the width of the pavement, and cycle tracks, the intersections, and other such details along with what improvements need to be employed in order to make it a safer, and increase it efficiency in a way such that it would benefit every user of the road. At the point, the solution is not to widen roads or build flyovers, it is to encourage the use of public transport, cycles by increasing safety and discourage use of personal motorized vehicle in every way possible. This being said, this paper deals with the geometric and safety aspects of one such road in Pune whose traffic problems just do not seem to end-from Shankar-Mat to Swargate. This is one of the busiest streets, that is utilized by all kinds of users, with a minor part being personal motorized vehicle users as compared to the whole.
Key words: well-designed, geometric design, vehicle,

INTRODUCTION:

Roads are a vital part of any transport system. They are like the intrinsic nerves that connect anything to everything. The efficiency of a road network in any city is crucial as it maximizes social and economic benefits. They play a significant role in achieving national development and contributing to the overall performance and social functioning of the community. Roads allow the movement of men and materials along with utilities such as water, electrical wires and phone cables, among others.

Road design, hence, is a pivotal aspect of every urban community; it being needless to say that it should be safe, comfortable and attractive for all the users-the cars drivers as well as others which encompass pedestrians, cyclists, and those using the public transport. It should include requirements of people of all ages and abilities and equally relevant to residents along with visitors.

Pune follows the global trend towards increased urbanization; hence, there is an immediate need to ensure our city is pleasant, safe and a healthy place to live in. Any form of movement within densely populated space entrails risk, especially for the pedestrians and cyclists, and so, all possible measures must be taken to ensure their safety.

Pune, along with the rest of India, originally followed the European model of transport about 20 to 30 years ago, where majority of the population used to walk, rode cycles or preferred public transport; but with the change in

the policies, the country switched to the American model, with increased number of the personal vehicles, which lead to severe traffic problems. America, having realized the constraints of their systems, has started following the European model with the implementation of cycle tracks on Manhattan Street, one of the most crowded streets of New York. The USA have realized the hiccups of their system, and its time India too, takes an initiative to change its ways, before it's too late to reverse the effects.

With the increasing numbers of the vehicles registered every year, traffic obviously worsens. One of the roads in Pune that has increasing traffic issues is the Katraj-Swargate rod. In this paper, the patch from Shankar-mat to Swargate is analyzed – the problems faced while traveling on this road by its various users, the safety measures that could be enforced, and how the efficiency can be increased.

OBJECTIVES OF ANY ROAD:
The general expectations from a street are listed below. In other words, these are the objectives on which street design should be based.

1. Safety: This is the primary concern. A road should be safe for all users, including and specially pedestrians, cyclists, the elderly and the handicapped. In the absence of good designs and enforcement, might is right rules, traffic can be chaotic and unsafe.

2. Ease of navigation: Situations are frequently faced when a parked car is abutting a road, or pedestrians standing in the middle of the road causing the vehicle driver to swerve, or at U-turn with cars piled up obstructing the straight moving traffic. All this results in the driver always on the edge, and can never relax. This makes the whole driving experience a stressful one. Similar is the case with pedestrians. With no clear cut footpath or pedestrian crossings at intersections, it can be a very stressful experience just crossing a road, or even walking on the footpath this need not be the case.

Ease of navigation can always be achieved, as against spped of navigation. Speed depends on the road available and traffic. However, navigation, irrespective of traffic density, both ofpedestrians and vehicles can be made easier and stress free by better designs of roads and intersections.

3. Quick and smooth movement: Design should ensure quick and smooth movement of vehicles. This does not mean that vehicles should go with high speed, rather that they can maintain a deciend average speed over their drive.

4. Aesthetics: Any road should look appealing to its users; in short, it should be pretty, neat, clean and green. Neat refers to clearly marked anes, straight footpath edges, no protrusions, are all required of the road, which add to the appearance of the city. Cleanliness should be built in, that is, it should be easy to clean and maintain. Roads present a wonderful opportunity to add to the green cover of the city. Trees & other greenery along the roads can make it a very pleasant experience.

5. Optimal space utilization: To achieve all the above, it must keep in mind that space is at a premium in the urban cities. All the above must be achieved within the given or reasonable width of road. To do this one must design innovative and efficiently. Thus the roads must be comprehensively designed to make efficient use of available space, taking into account all its uses. Examples of some functions are street furniture such as but stops, street lighting utility lines such as electrical, water and draining, cables etc. This being established, it can be judged as to what are the requirements, and the various uses of any street can now be considered.

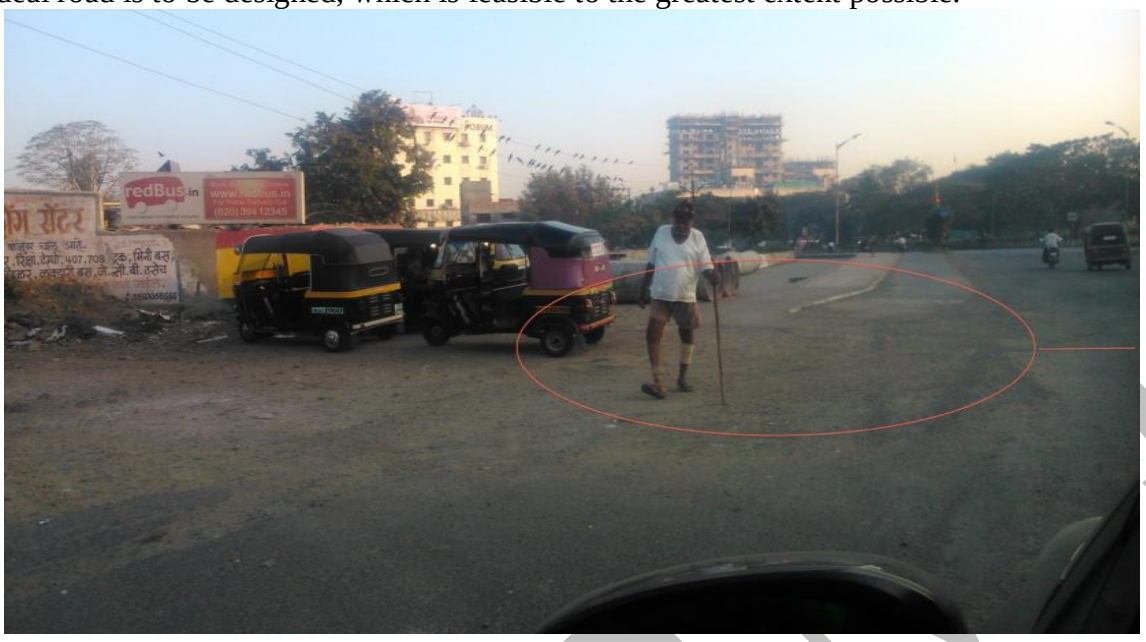
USES OF STREETS

There is more to a street than movement of vehicles. IT also needs to be safe, usable and appealing for pedestrians, cyclists and handicapped. It is also used for parking, turns, used by hawkers, etc. For better understanding it can be classified as follows :

- People movement
  - Thoroughfare for motorized vehicles 2, 3 & 4 wheelers–light commercial vehicles and greater than 4 wheelers–heavy commercial vehicles.
  - Thoroughfare for non-motorized vehicles, pedestrians, cyclists
  - Street intersections, turns and pedestrian crossings
- Static uses
  - Parking
    - Wheeler parking
    - Wheeler parking
    - Wheeler, taxi and para-transit parking

- Heavy vehicles parking
- Hawkers
- Bus stops and transit facilities
- Streetlights
- Hoardings banners
- Environmental functions
  - Trees
  - Garbage bins
  - Rainwater run off
- Utility uses
  - Electricity
  - Water
  - Sewerage
  - Telephone cables
  - Internet cables
  - Cable TV
  - Others

With a clear understanding regarding of what needs to be provided on any road, the road chosen-Shankar Math to Swargate can now be designed with the above points in mind. The main considerations deal with the geometric design of the road, that is the plan and section view, the width of the pavement, and cycle tracks, the intersections, and other such details and what improvements need to be employed in order to make it a safer, more attractive and vibrant road that would benefit everyone by generating and sustaining communities with wide ranging economic, social and environmental consequences.
There is great importance given to the pedestrian safety, use of various intelligent transport systems that can be employed and their feasibility, along with designing a road in a way that is convenient for all and provides the least possible travel time. A major aspect includes the consideration of the Rapid Bus Transit system and at what intervals should these be provided depending upon the timing – whether it is a peak hour or otherwise. Hence, an ideal road is to be designed, which is feasible to the greatest extent possible.



REVIEW OF LITERATURE:
Jepson & Ferreira (1999) recognize that the increasing costs of traffic congestion needs to be addressed through an integrated multi-modal transport system. The saving to the community in facilitating a shift to public transport can be significant, particularly in urban peak congested conditions.

The authors suggest that the bus lanes can be dividing in two distinct categories namely: those that share part of the arterial road space with general traffic; and stress/malls that are designated exclusively for buses. There has been a variety of bus priority systems used for at least 25 years in various areas throughout the world. European countries, particularly England, have pioneered many of the bus priority systems on arterial streets. Bus lanes and traffic signal priority are the most common forms of bus priority and these systems provide significant travel timesaving in congested arterial roads. It is acknowledged however, when assessing the need for bus priority treatments, a detailed investigation of each route needs to be undertaken. The selection of these treatments must be consistent with the traffic management strategy for a route.

Bus Stop Relocation: The location of bus stops can be critical to the efficiency of the bus system. Factors such as traffic volumes, passenger demand, adjacent land use and road geometric conditions must be considered in sitting a bus stop. The location of the bus stop becomes an even more important in areas where there are bus priority systems.

Bus Stop Spacing : They discuss a program to rationalize bus stops in San Francisco, where the bus stop spacing was increased from between 120 m – 250 m to 250 m – 300 m. These changes resulted in a 40 per cent reduction in bus stops and an increase in overall bus travel speeds of between 4 and 14 per cent The spacing of bus stops requires a balance between bus travel efficiency and passenger convenience in accessing bus stops. The relationship between convenience and efficiency may be modeled to determine the appropriate spacing of bus stops. It is generally expected that bus stops should be locatedbetween 200 meters and 500 meters apart. The minimum spacing of 200 meters was calculated based on Australian conditions, using typical acceleration, deceleration and stop times for a bus.

Table 1 : Strategies for active bus priority at traffic signals

Bus Arrival Period	**Bus Phase**	**Bus Phase Queue Jump**	**Absolute Bus Priority**	**Selective Bus Priority**
Bus arrives during green phase of intersection	No change in phasing	No change in phasing	No change in phasing	No change in phasing
Bus arrives 0 to 13 seconds from the end of the green phase	Phasing is modified to provide a green light for bus	Bus receives a 5s green phase prior to start of next green	Extend green phase to accommodate the bus	Extend green phase to accommodate the bus
Bus arrives between 13 seconds from the end of the green phase and 13 seconds from the start of the next green phase	Phasing is modified to provide a green light for bus	Bus receives a 5s green phase prior to start of next green	Cut off opposing green phase and return the green phase for the approach with the bus arriving. The modifications to the opposing phases must be made with a minimum green time of 6 second	Cut off opposing green phase and return the green phase for the approach with the bus arriving 13 seconds early. A bus that arrives during the red phase will have to wait until the start of the next green phase.
Bus arrives 0 to 13 seconds from the start of the green phase for the approach the bus is traveling	Phasing is modified to provide a green light for bus	Bus receives a 5 s green phase prior to start of next green	Cut-off the green phase for opposing approaches and start the green phase for the bus approach early by the required time to allow the bus to receive a green light	Cut-off the green phase for opposing approaches and start the green phase for the bus approach early by the required time to allow the bus to receive a green light.

Krishna & Reddy (2002) are focusing on public transport and transportation measures to provide a safer environment. As the public transport plays a vital role in transport system by providing economies of scale, congestion. So, PMC and PCMT operate a fleet of buses, auto rickshaws and other models. As day-by-day the vehicles are growing faster and faster. The high growth of two-wheeler indicates lock or inefficiency of P.T. system. By that the less importance is given to public transport and for this the problems arises like high consumption, emission by vehicles, congestion, no rules and regulation for deriving. At traffic signal points, all

vehicles get choked up to go first and fast, this keeps vehicles emitting more pollutants by consuming more fuel. By providing proper and punctual PTS traffic congestion be reduced that will directly reduce use of personal vehicle.

The following points are given by the author for safer environment and proper transport system are given below :

- Separate lanes for different kinds of vehicles
- Separate slow and fast moving vehicles
- Phasing out old and heavily polluting vehicles
- Restricted areas for IPT modes
- Licensing policy
- Strict checking on road vehicles

These following measures will give proper and coordinate PTS, along with minimizing the fuel consumption and reducing congestion levels.

Mittal & Sarin (2005) emphasize that the only alternative to increasing the road capacity is to maximize the existing available infrastructure and to get optimum returns from new investments on highway building. Intelligent transport systems provide opportunities to achieve this. In order to achieve better safety and decrease the number of accidents, injuries and fatalities, new approaches to highway safety are required. ITS technologies can be applies to reduce traffic exposure, reducing the probability of crash occurrence, and minimizing the consequences of a crash. There is great potential in India for these technologies. IT is a new traffic concept that links people, roads and vehicles in info-oriented multimedia society. It is a movement of information for the movement of people and goods. ITS is an application of modern computer, communications and vehicle sensing technologies to productivity and information.

ITS embraces many fields including overll fleet management, vehicle management, incident management, traveler information, electronic payment and vehicle control. Certain ITS measures used include speed limiting inside vehicles, photo radars for speed checking and red speed camera for checking any violations. The following are two tables that were given:

Table-2 : Safety Dimension – ITS Technologies offered

Dimension of road safety	Infrastructure Based	Vehicle Based	Cooperative Based
❖ To control and influence traffic exposure	❖ Access control like ramp metering ❖ Electronic road pricing	❖ Electronic driver license check ❖ Intoxicated driver check ❖ Electronic coupling of heavy vehicles	❖ Travel planning ❖ Route guidance
❖ To reduce probability and prevention of crashes	❖ Weather information ❖ Lane keeping ❖ Speed cameras ❖ Incident detection system ❖ Roadside traveler info system ❖ Intersection traffic management	❖ Collision avoidance systems ❖ Vision enhancement systems ❖ Seat belt reminder ❖ Vehicle speed alerting system	❖ Intelligence speed control ❖ Driver info systems on in vehicle instruments and traffic and weather ❖ Highway roil intersection systems ❖ Lane enforcement
❖ To reduce consequences of crashes	❖ Emergency phone systems ❖ Closed circuit television ❖ Highway traffic and management systems	❖ Automated collision notification systems	❖ Emergency source assistance system ❖ Emergency response systems

Supekar (2008) observed his views on traffic conditions and transport options. How the people are facing complicated problems in this regards :

- Maximizing road used per capita : this means carry more people with less vehicles or operating mass transit system.
- Strengthening and giving priority to public transport : reliable, adequate, efficient and safe to attract road users.
- Avoiding use of 2 wheelers, cars, auto rickshaws and taxies to release the congestion.

Nesamani & Subramanian (2009) are emphasizing on the importance of factors influencing speed of urban arterial in designing better roadways. Speed of vehicles depends on number of factors such as vertical grades, median type and horizontal curves with or without transition, sight distance and super elevation. Urban arterial are for through traffic on a continuous route. Mobility is its primary function with controlled access parking. Traffic on Indian roads is of heterogeneous in nature. In recent study the speed of vehicles decreased in the range of 5 5o 8.5% when the shoulder condition changes from bad to worse in highway links. The speed should be varying always if this not it creates a problem of congestion, accidents, emission of rays, it is divided into peak period and off-peak period. Peak period represents the congested traffic conditions and off-peak period represents the relatively free flow conditions in off-peak period, speed was mostly ranging between 20 & 40 km/h and average speed was similar to that during peak period and average accelerating and declaration were high during peak period. This might be due to lesser headway between vehicles, compared to the off-peak period. In is mentioned that in mornings, peak-period traffic tends to move in the same direction and during the same time period of the day. In the evening peak-period, thee is a relative flexibility and a traffic gets distributed and staggered across time period. However, during both peak and off-peak period, the v/c ratio is more than the 1 in majority links.

Oxley (2010) suggests that pedestrians are considered vulnerable road users largely due to their lack of protection and limited biomechanical tolerance to violent forces of hits by a vehicle. In a collision with a vehicle, pedestrians are always the weakest party and are at a greater risk of injury or death compared with most other road users. In Western Australia there were in total 104 pedestrian death and over 950 serious injuries between 2004 and 2008, representing approximately 10% of all road deaths and approximately 9% of all serious injuries. The Safe Systems approach to road safety emphasizes safe drivers in safe vehicles traveling on safe roads at safe speeds. This basic premise aims to eliminate fatal crashes and reduce serious injury crashes through the provision of a safe, crashworthy system that is forgiving of human error and accommodates vulnerability to serious injury. Pedestrian safety has long posed a major challenge to road safety authorities. However means to improve the safety of pedestrians include : constructing traffic calming to protect pedestrians ; providing additional shared paths ; reducing speed limits in areas of high pedestrian activity such as strip shopping precincts ; educating the community on the rights and responsibilities of all road users ; including shared paths and upgraded pedestrian facilities in major infrastructure projects ; nominating pedestrian and cycling infrastructure ; and promoting the manufacture and purchase of more pedestrian-friendly vehicles.

Gupta R. K. (2012) paper identifies the deficiencies in the existing signal systems and describes how MaDSS can overcome them. With the ever-increasing vehicular population, the demand too has increased tremendously. This has brought about a reduction in the efficiency of traffic signal systems. Traffic signal have gone from being traffic controllers to queue generators. Signals are now being blamed for the long queen formations and pollution at intersections. Queues are not only formed but also lengthened at signalized intersections, resulting in accumulation of traffic. This accumulated traffic stays in the queue longer that it ideally should. The reason being, the number of vehicles leaving the queue is far less than those joining.

Saxena, R. K (2013) concluded that final product of this research, the Texas Guide for Retrofit and Planned Bicycle Facility Design, allows the user to input basic roadway and traffic data into a Microsoft Excel workbook and generate two measures to identify the operational performance of an on-street bicycle facility. The first measure provides a rating from 1 to 6 of a cyclist's comfort level on a given roadways segment, as well as a descriptive label of the comfort rating. The second measure developed from this research project allows users to predict the physical location of both cyclists and motorists during passing events.

RESULT & DISCUSSION:

The traffic details of a recent survey done by S. N. Bhobe, from the survey

Mode	**% of Vehicles during peak hour**	**No. of vehicle during peak hour**	**No. of users per vehicle**	**Total No. of users**	**% users by vehicle**	**Equi. Factor**	**PCU**
2W	50.50	4121	1	4121	41.43	0.5	2061
3W	11.00	898	1.2	1078	10.83	1	898
4W	12.51	1021	1.2	1225	12.32	1	1021
MINI BUS	0.72	59	12	708	7.12	3	177
STD. BUS	0.59	48	50	2400	24.13	3	144
LCV/TEMPOS	1.94	158	2	316	3.18	1	158
3-AXLE	0.04	3	3	9	0.09	3	9
TRACTOR	0.00	0	1	0	0.00	3	0
BICYCLE	1.09	89	1	89	0.89	0.5	45
TOTAL		**6397**		**9946**			**4513**

Table-2 : Showing the expected values of PCU/hrs for the upcoming years

S. No.	**Years**	**PCU/hr**
1	2014-2015	5130
2	2015-2016	5489
3	2016-2017	5873
4	2017-2018	6284
5	2018-2019	6724
6	2019-2020	7195
7	2020-2021	7698
8	2021-2022	8237
9	2022-2023	8814
10	2023-2024	9431
11	2024-2025	10091
12	2025-2026	10797
13	2026-2027	11553
14	2027-2028	12361
15	2028-2029	13227
16	2029-2030	14153

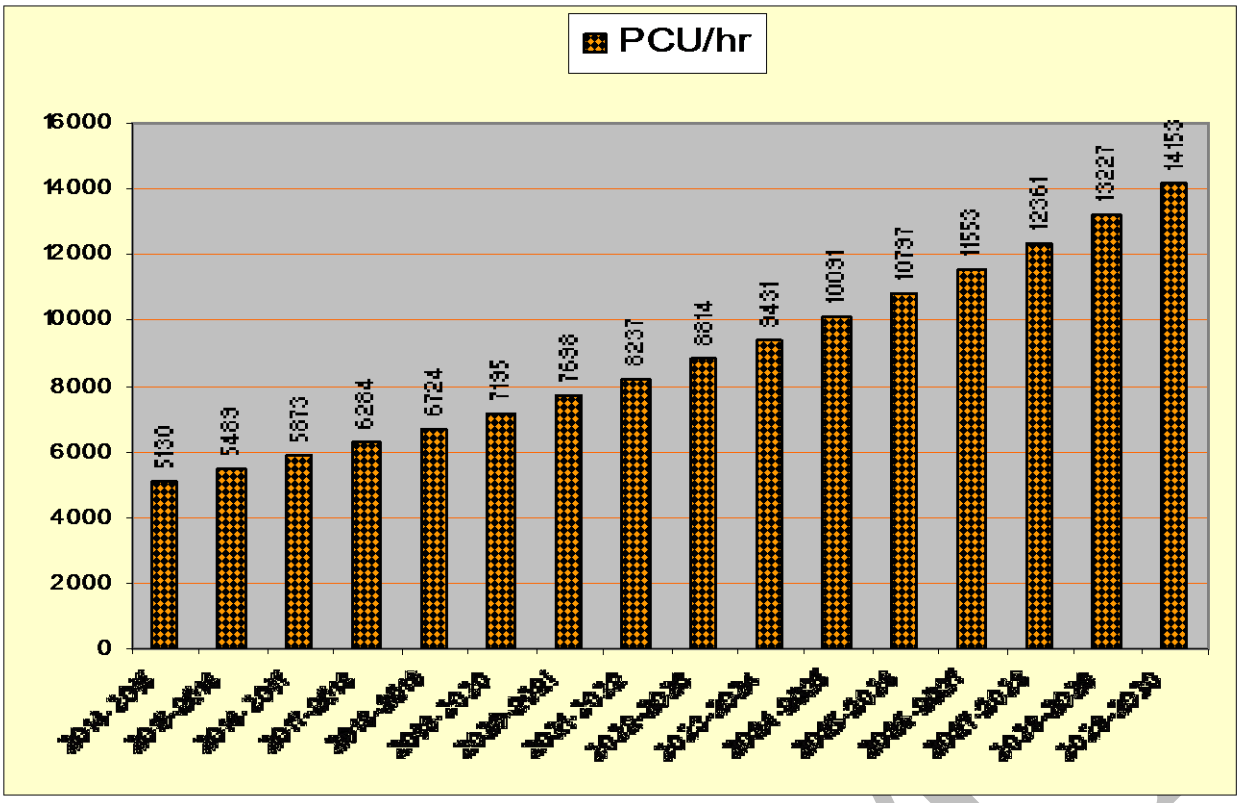
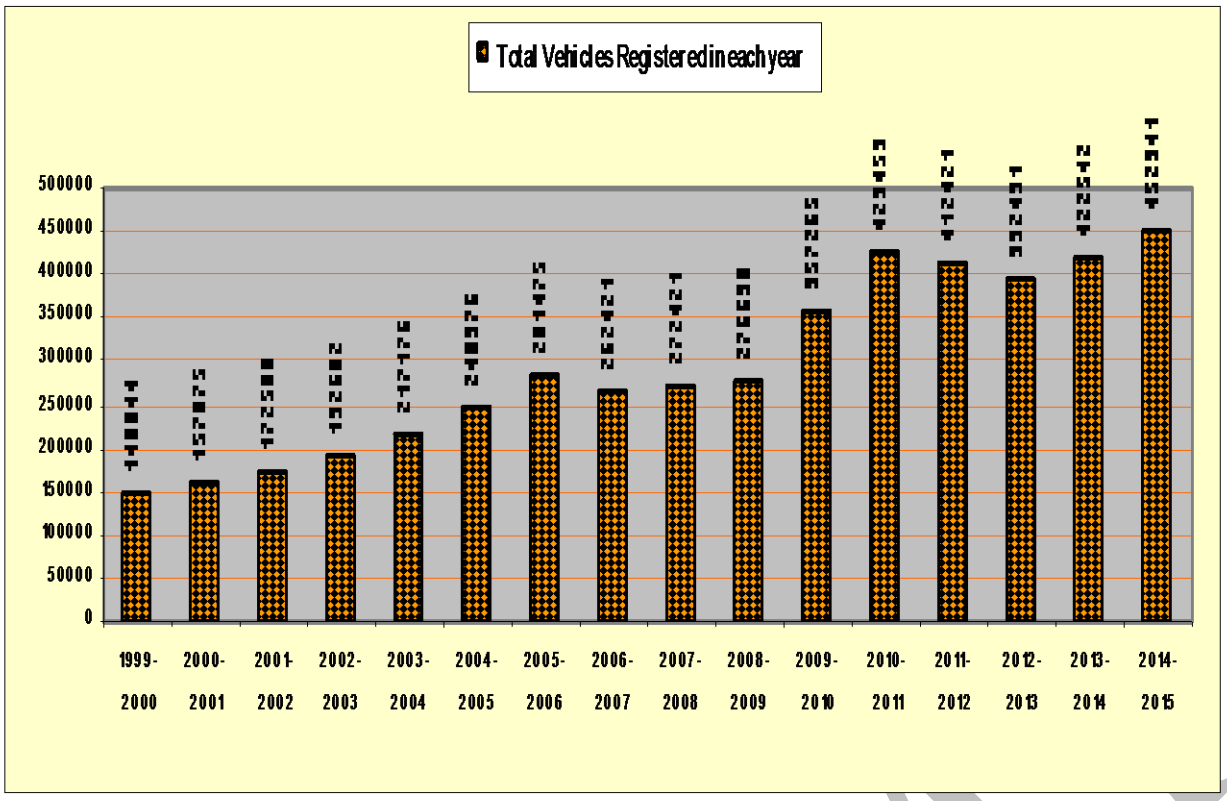


Table-3 : Showing the total number of vehicle registered each year

S. No.	Years	Total Vehicles Registered in each year
1	1999-2000	148844
2	2000-2001	157875
3	2001-2002	172500
4	2002-2003	192682
5	2003-2004	217176
6	2004-2005	248376
7	2005-2006	281475
8	2006-2007	262421
9	2007-2008	272421
10	2008-2009	276698
11	2009-2010	357265
12	2010-2011	423453
13	2011-2012	412421
14	2012-2013	392431
15	2013-2014	422542
16	2014-2015	452341


Total Vehicles Registered in each year
500000
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
1999-2000
2000-2001
2001-2002
2002-2003
2003-2004
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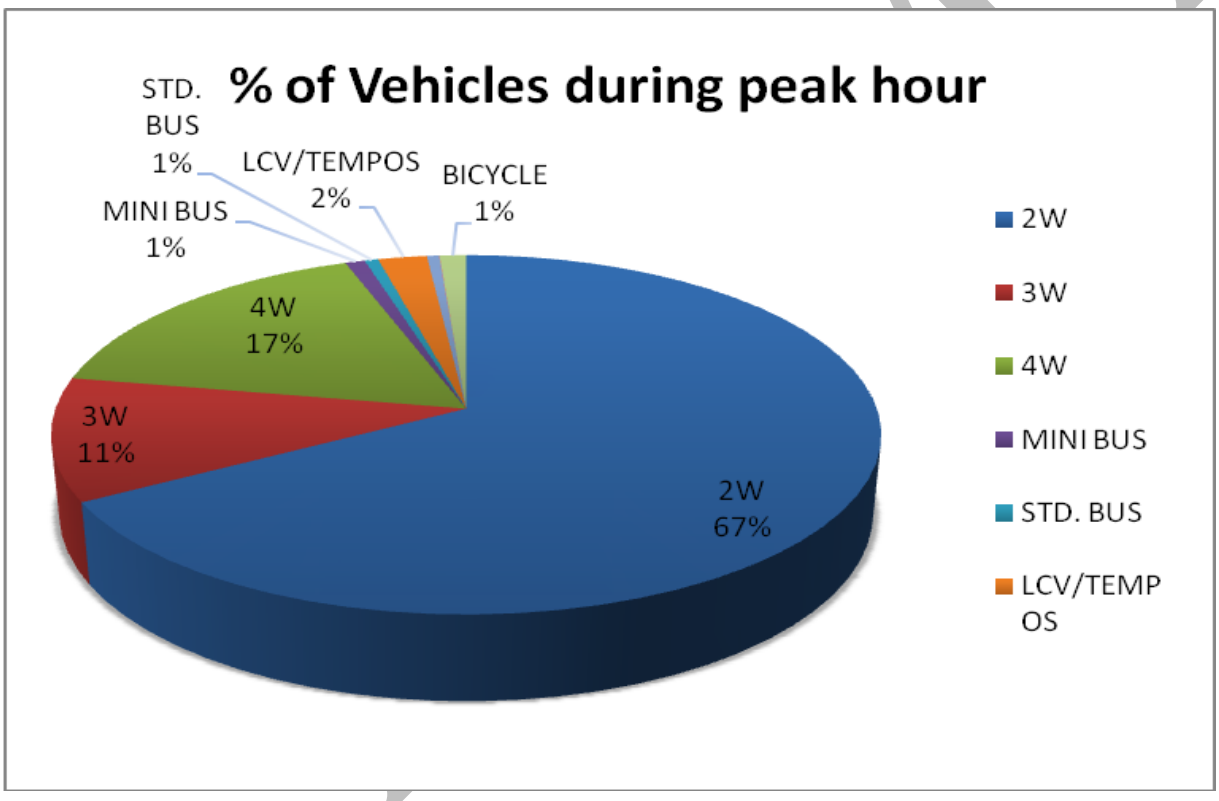
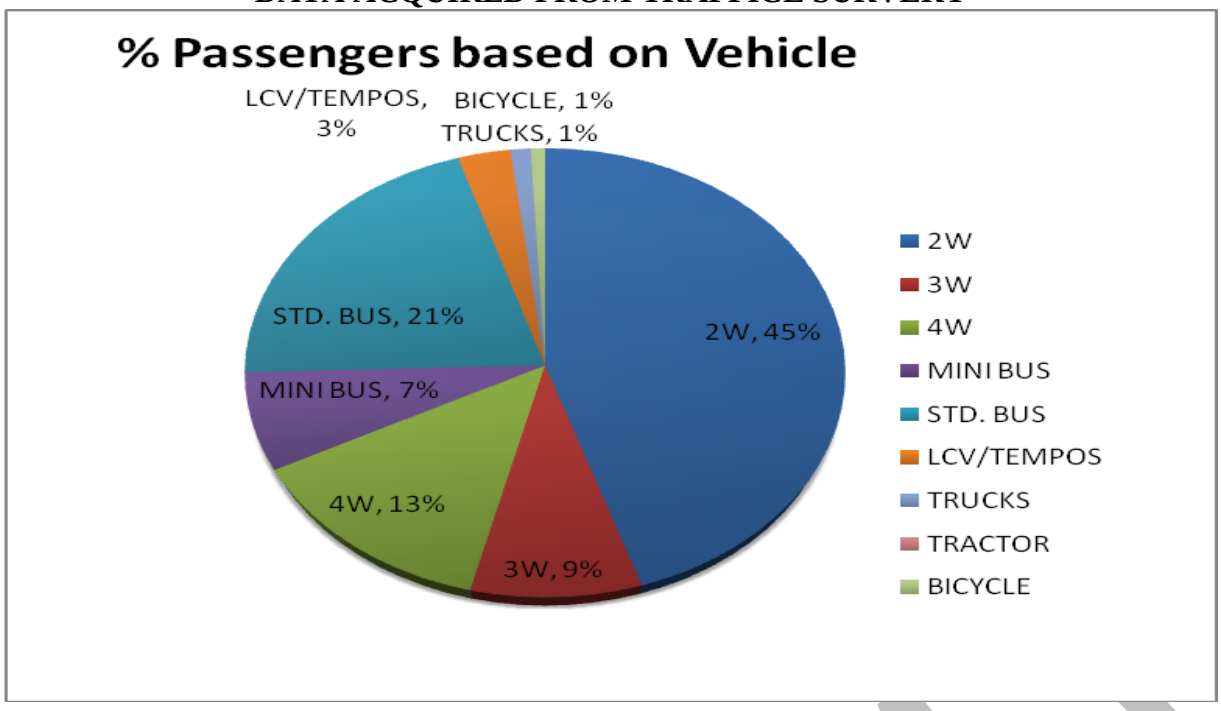
2011-2012
2012-2013
2013-2014
2014-2015


% of Vehicles during peak hour
STD. BUS 1%
LCV/TEMPOS 2%
BICYCLE 1%
MINI BUS 1%
4W 17%
3W 11%
2W 67%
2W
3W
4W
MINI BUS
STD. BUS
LCV/TEMPOS

DATA ACQUIRED FROM TRAFFICE SURVERY



The other thing to note is that the PCU/hr value for 2013 was 4368, and that of 2014 is 4794.

FUTURE SCOPE:

A big concern on top of urban transportation planner's mind is how to speed up the traffic : putting more buses on the road will jam the roads even worse and deteriorate the air; building more subway is costly and time consuming. Well, here is an cheaper, greener and fast alternative to lighten their mind up a bit : the straddling bus, first exhibited on the 13th Beijing International High-tech Expo in May this year. In the near future, the model is to be put into pilt use in Beijing's Mentougou District.

Proposed by Shenzhen Hashi Future Parking Equipment Co., LOtd., the model looks like a subway or light rail train bestriding the road. It is 4-4.5 m high with two levels: passengers board on the upper level while other vehicles lower than 2 cm can go through under. Powered by electricity and solar energy, the bus can speed up to 60 km/h carrying 1200-1400 passengers at a time without blocking other vehicles' way. Also it costs about6 500 million yuan, about 477 crore Rupes to build the bus and a 40 km-long path for it, only 10% of building equivalent subway. IT is said that the bus can reduce traffic jams by 20-30%.

The straddling bus combines the advantages of BRT; it is also a substitution for BRT and subway in the future. As you all know, the majority of vehicles on the road is car, and the shortest, also the ar. Normally the overpass is 4.5-5.5 m high. The highlight innovation of straddling bus is that it runs above car and under overpass. Its biggest strength is saving road spaces, efficient and high in capacity. It can reduce up to 25-30% traffic jams on main routes; running at an average 40 km/h, it can take 1200 people at a time, which means 300 passengers per cart.

Nowadays many big cities have remodeled their traffic signaling system, to prioritize public buses, that is to say when a bus reaches a crossing, red light on the other side of the fork will turn on automatically to give buses the right of way. The straddling bus can learn from this BRT method. The car can make the turn with the bus if that is the direction it wants to go too; if not, the red light will be on to stop the cars beneath while the bus take the turn.

The bus is 6m in width and 4-4.5 m high. How will people get off the bus if an accident happens to such a huge bus? Here the most advanced escaping system in the world is introduced. In the case of fire or other emergencies, the escaping door will open automatically, similar to an aircraft; planes are equipped with inflated ladder so people can slide down on it in emergency. It is the fastest way to escape.
The bus can save up to 860 ton of fuel per year, reducing 2640 ton of carbon emission. Beijing's Mentougou District is carrying out a eco-community project, it has already planned out 186 km for our straddling bus. Construction has begun in 2011.

CONCLUSION:

Pune is one of the boomtowns of India, and it will continue to be a boomtown for many years to come. One of the attributes that come with being a boomtown in this era is amorphous, amoeba-like growth. Change happens relatively fast, and our infrastructure needs to be as flexible as possible.
With the improvement in the automobile technologies, we have better, faster, more comfortable vehicles ; but does a city like Pune possess the type of infrastructure and roads desired for such a thrilling experience ? The traffic is escalating at uncontrollable rates ; RTO, the Regional Transport Office, registered a record of 44+ thousand new vehicles within the short period of three months; these been added to the already existent, enormous vehicle population of the city. Not only adding to the traffic problems, but also augmenting the concentrations of poisonous exhaust gases, noise levels, the parking problems accompanied with the deteriorating quality of life.

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