International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391

Integrated Traffic Planning of BRTS "A case Study - Mr-10 road Indore"

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ABSTRACT:Indore is a fast growing industrial city of Madhya Pradesh. To meet the large demand and improve the capacity and productivity of buses, ICTSL has proposed to plan, to develop and operate Bus Rapid Transit System (BRTS) in Indore. Bus Rapid Transit System is a new form of public transportation which is an emerging approach of using buses as an improved high-speed transit system. Bus Rapid Transit involves coordinated improvements in a transit system's infrastructure, equipment, operations, and technology that give preferential treatment to buses on urban roadways. We are selecting MR-10 Road corridor for our case study of integrated planning of BRTS. Now a day's MR-10 area of Indore is developing rapidly. To provide faster and effective transit services, schedule is made for transit units going to be run on that route. The schedule is made for 14 hours in a day (7:00 AM To 09 PM) from Radisson Square to Aurobindo Square and vice versa. For finding out schedule of transit units, traffic data are collected at different road sections along the route. The traffic data is then analyzed and traffic flow and passenger flow along the route is taken out. Transit units are provided on the basis of passenger flow at different sections and at different time within a day. Reduction in air and noise pollution is calculated after planning of BRTS.

Keywords: BRTS, Scheduling, MR-10 Road,Traffic Data, Transit units.

1. Introduction

Transportation is the backbone to the development of urban areas. It enables functioning of urban areas efficiently by providing access and mobility. Passenger transport has an overriding influence on the functioning of the city. With growth, the mobility needs increases. People's personal choices and freedom get expressed in increased ownership and use of personalized vehicles. The public agencies operating public transport systems often fail to restructure service types to meet with the changing demand pattern. As a result public transport becomes financially less viable, speeds reduce, and congestion levels increase and the transportation becomes a source of environmental problem. Vehicles are major sources of urban air pollution and greenhouse gas emissions. There are economic consequences as well.

Considering all these facts, Govt. of India has also emphasized in the National Urban Transport Policy on development of efficient Mass Transport system in urban area. The objective of this policy is to ensure safe, affordable, quick, comfortable, reliable and sustainable access for the growing number of city residents to jobs, education, recreation and such other needs within our cities. It is sought to be achievedby:.

- Encouraging integrated land use and transport planning in all cities so that travel distances are minimized and access to livelihoods, education, and other social needs, especially for the marginal segments of the urban population is improved.
- Bringing about a more equitable allocation of road space with people, rather than vehicles, as its main focus.
- Encourage greater use of public transport.
- Enabling the establishment of quality focused multi-modal public transport systems that are well integrated, providing seamless travel across modes.
- Establishing institutional mechanisms for enhanced coordination in the planning and management of transport systems.
- Introducing Intelligent Transport Systems for traffic management.
- Addressing concerns of road safety and trauma response.
- Reducing pollution levels through changes in traveling practices, better enforcement, stricter norms, technological improvements, etc.

2. Objectives

1) To observe the existing traffic and travel characteristics of the study area and to increase the accessibility in the city by providing the BRTS.
2) To determine the peak and off peak hours along the route and no. of transit unit.
3) To increase the speed of transportation by providing the flyover from Radisson Square to Sayaji Square and width of MR-10 road is increased.
4) To reduce the traffic congestion by providing the extra buses in the peak hours.
5) To improve the traffic management in the city by proper scheduling.
6) To calculate the CO_2 emission and noise pollution reduction.
7) To calculate the time saving and accident cost.

3. Methodology

Traffic data, traffic composition, hourly traffic volume, hourly variation of traffic flow, and hourly variation of passenger flow on BRTS etc. are shown on tables, charts and graphs of the different section of MR-10 road corridor of BRTS. One of them is shown below

4. Traffic Survey and Data Collection

Table 1: Traffic flow from Radisson Square to Vijay Nagar Square (No. of vehicles)

Type of vehicle	08 to 09 AM	09 to 10AM	10 to 11AM	01 to 02 PM	02 to 03PM	05 to 06PM	06 to 07PM	07 to 08PM	Total
2 Wheeler	430	450	378	325	301	370	510	475	3239
3 Wheeler	42	72	50	35	30	35	60	55	379
Bus (city)	14	18	25	10	12	15	20	16	130
Bus	21	25	26	15	13	25	25	20	170
Truck	28	32	40	25	22	15	15	17	194
Magic	14	25	35	16	25	30	45	40	230
Cycle	18	30	45	25	15	20	19	25	197
Car	240	325	312	175	125	250	356	300	2083
Tractor	29	35	30	15	7	20	20	15	171
Total	836	1012	941	641	550	780	1070	963	6793
Total good transportation	78	92	96	55	42	60	60	52	535
Total public transportation	758	920	845	586	508	720	1010	911	6258

MR-10 road corridor has thirteen intersections between Radisson square to Aurobindo square. The traffic growth on this road is increasing rapidly day by day because of development of new colony and township along corridor. With direct connectivity of MR-10 road with Super corridor and Ujjain-Sanwer Road thetraffic is expected to increase more. In future with the growth of Information Technology sector in the city i.e. Multinational companies like TCS & Infosys will start their centre near super corridor and hence the traffic growth will increase enormously in the city at this section.

4.1 Detailed information of road.

Name of road: MR-10 Road Corridor
Total length of road: 8.4km
No. of signalized intersections: 13 no.
No. of Rotary intersections: 03
No. of lane on Road: 02
Type of traffic: Mixes Traffic

4.2 Traffic Flow Study

Traffic flow study is carried out to understand the efficiency level of the traffic system and to correlate with the proposed capacity. Here traffic flow study was carried out at 13 mid sections, located between all the major intersections of the corridor. The surveys were conducted during morning; noon, evening hours between 09:00AM to 10:00AM, 01:00PM to 03:00PM and 05:00PM to 08:00PM and finally the numbers in peak hours are represented.

Vehicles are found on the corridor are cars, taxis, two wheelers, auto rickshaws, bus, minibus, trucks, cycle etc. Analysis is carried out for the traffic flow characteristics, vehicular traffic composition of all modes types, peak hour and off-peak hours' traffic, PCUs, etc.

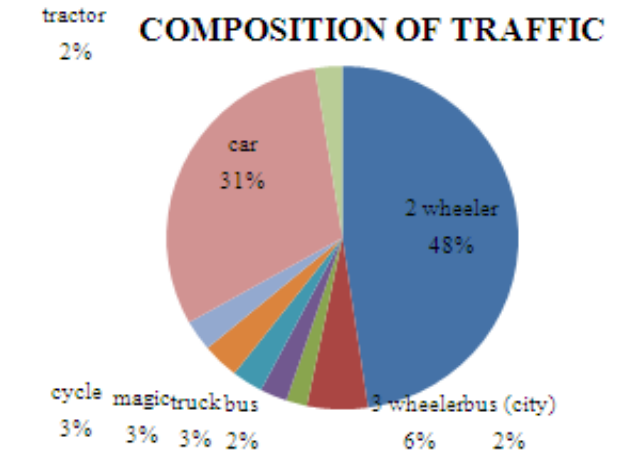

Figure 1: Showing Traffic Composition

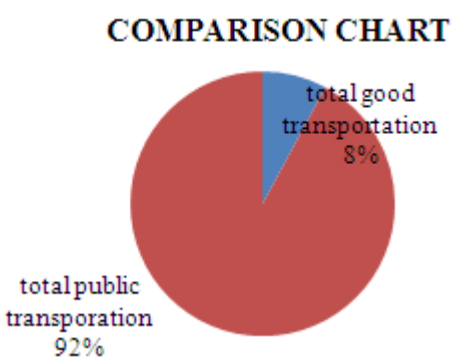

Figure 2: Comparison Chart

Table 2: Traffic flow from Radisson Square to Vijay Nagar Square (No. of vehicles) For BRTS

Type of vehicle Provision for public transportation	08 to 09 AM	09 to 10AM	10 to 11AM	01 to 02 PM	02 to 03PM	05 to 06PM	06 to 07PM	07 to 08PM
Required flow (60%) for BRTS	455	552	507	352	305	432	606	547
Remaining traffic flow	303	368	338	234	203	288	404	364

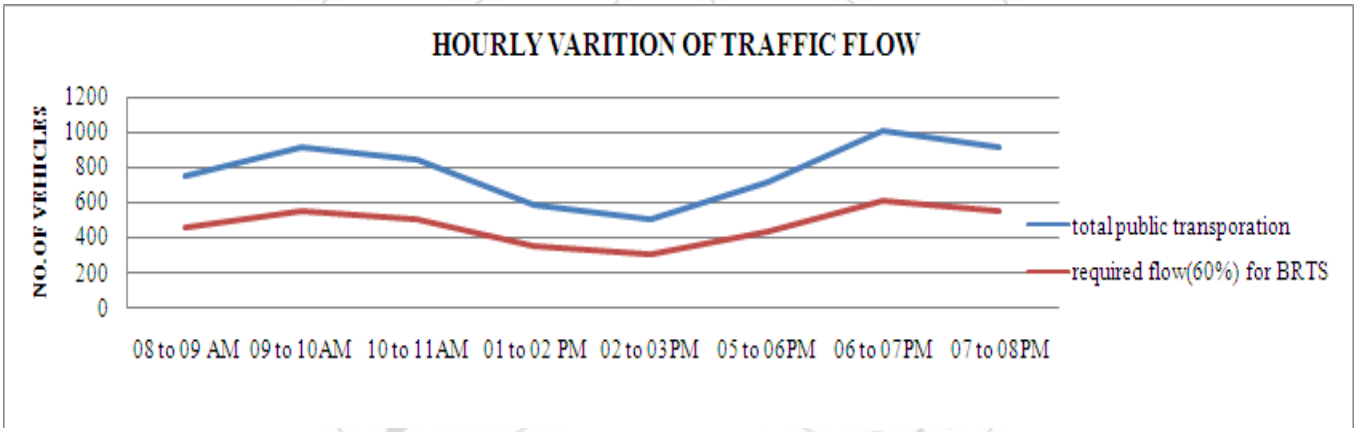

Figure 3 Showing Hourly Variation of Traffic Flow

Table No.4 Showing passenger flow from Radisson Square to Vijay Nagar Square

Passenger flow									
Type of vehicle	08 to 09 AM	09 to 10AM	10 to 11AM	01 to 02 PM	02 to 03PM	05 to 06PM	06 to 07PM	07 to 08PM	Total
2 wheeler	1342	1404	1179	1014	939	1154	1591	1482	10106
3 wheeler	129	221	153	107	92	107	184	169	1162
bus (city)	140	180	250	100	120	150	200	160	1300
magic	72	129	180	82	129	154	231	206	1183
cycle	90	150	225	125	75	100	95	125	985
car	698	946	908	509	364	728	1036	873	6062
Total	2471	3029	2896	1938	1718	2394	3338	3014	
Required flow(60%) for BRTS	1482	1817	1737	1163	1031	1436	2003	1809	12478

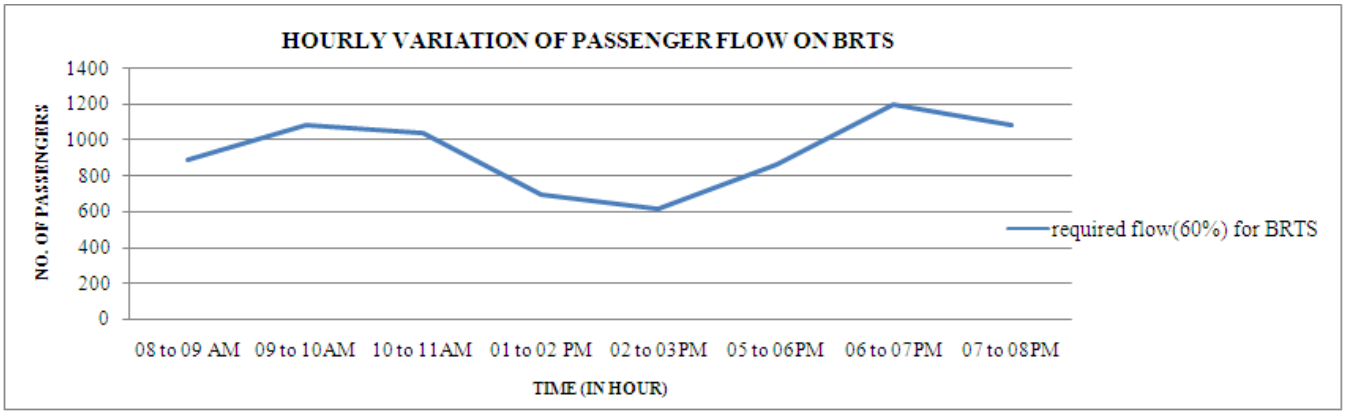

Figure 4 Showing Hourly Variation of Passenger Flow on BRTS

The above traffic data, traffic composition, hourly traffic volume, hourly variation of traffic flow, traffic comparison chart, and hourly variation of passenger flow on BRTS etc shown on tables, charts and graphs of the different road section of MR-10 road corridor of BRTS gives us the peak hour passenger flow at different intersections which is required by us for deciding the number of buses to be run at different time on the MR-10 road corridor of BRTS.

With the help of this graph we get the traffic composition at different sections hourly variation of traffic flow at road section in between the different intersections, at different time period of time. From the above data we get the hourly variation of traffic flow and passenger flow in between the sections of different nodes on the BRTS corridor.

The peak hour and off-peak hour passenger flow on graph shows the flow of passenger at the particular intersection at the specified time and at the specified time interval within a day. With the help of this we can find out number of buses required for the transportation on the BRTS corridor.

Peak hour passenger flow

- Between 09:00 AM – 11:00AM
- Between 05:00 PM - 07:00PM

Off - Peak hour passenger flow

- Between 02:00 PM – 03:00PM

4.3. Scheduling

Scheduling is the process of deciding how to commit resources between a varieties of possible tasks. Scheduling a set of processes consists of sequencing them on one or more processor such that the utilization of resources optimizes some scheduling criterion. In operation research scheduling is traditionally performed statically, off line, while in an operating system, the information from which scheduling decisions should be made dynamically.

Transit system run on specified routes and schedule. A schedule is a statement of times at which transit unit arrives at particular stop over a period of time. It is also the statement of time at which a single transit unit of a given route arrives at different stops on its route. The later information can always be derived once the schedule of arrivals and departures of all the stops are known.

4.4 The Transit Scheduling

Another optimization problem related to the transit system design is the scheduling of transit units (say buses). The problem here is that given a set of route, one need to develop schedules for bus arrivals and departures at all the stops of the network. A good or efficient schedule is one which minimize the waiting time of passengers while operating within a set of resource and service related constraints.

The total waiting time of passenger have two components:

(i) The total initial waiting time (IWT) of passenger, this is the sum of the waiting times of all the passengers at their point of origin.

(ii) The total transfer time (TT), this is the sum of the transfer times of all the transferring Passengers.

Schedule determination is based on speed of BRTS bus. Table No.5 gives the schedule of the chosen section

After this Schedule is prepared from Radisson to Aurobindo Square and vice Versa for 14 hours in a day (7a.m. to 9 p.m.) Table No.6 shows one of the Schedule of the Bus running from Radisson Square to Aurobindo Square (7 a.m. to 9 a.m.)

Table 5: Schedule determination of MR-10 road corridor for BRTS

Sr.No.	Name of stop	Distance(km)	Dwell time (Minute)	Travel time required
1.	Radisson Square	-	2	
2.	Vijay Nagar Square	900	3	1 min 40sec
3.	Sayaji Square	500	3	0 min 50sec
4.	Meghdoot Square	1100	2	0 min 40 sec
5.	Talwalkar's Square	100	3	0 min 45 sec
6.	Bapat Square	600	3	0 min 50 sec
7.	Heera Nagar Square	300	2	0min 45sec
8.	Auto Stand Square	300	2	0 min 50sec
9.	Temple Square	200	2	0 min 50sec
10.	CG Mourya Square	1800	3	1 min 0 sec
11.	Idea Square	600	2	3 min 40sec
12.	Lavkush Square	1500	2	1 min 50sec
13.	Aurobindo Square	500	3	1 min 40sec

5. Future Forecasting of Traffic Data

On the basis of past record of traffic data growth rate factor is calculated for different kind of vehicles for the determination of future traffic.

Table No.7

GROWTH RATE FACTOR(GRF)[11]	
Type Of Vehicle	GRF%
2 Wheeler	10.79
3 Wheeler	3.84
Car	7.26
Bus	8.22
Tractor	5.34

On the basis of above GRF following future traffic data is calculated

Table No.8

Present PCU/day	2020 PCU/day	2025 PCU/day
8925	14106	26119

Onthe basis of above traffic data it is analyzed that to accommodate this traffic on present existing lane is very difficult. So to accommodate this traffic design of flyover is done from Radisson square to Sayaji square and width of MR-10 Road Bridge is increased

Table 6: Schedule from 07 AM to 09 AM(Radisson to Aurobindo Square)

Sr. No	1	2	3	4	5	6	7	8	9	10	11	12	13
Time required		00:01:40	00:00:50	00:00:40	00:00:45	00:00:50	00:00:45	00:00:50	00:00:50	00:01:00	00:03:40	00:01:50	00:01:40
Dwell Time		00:03:00	00:03:00	00:03:00	00:02:00	00:03:00	00:03:00	00:02:00	00:02:00	00:03:00	00:02:00	00:02:00	00:03:00
Bus No 1	07:00:00	07:04:40	07:08:30	07:12:10	07:14:55	07:18:45	07:22:30	07:25:20	07:28:10	07:32:10	07:37:50	07:41:40	07:46:20
Bus No 2	07:06:00	07:10:40	07:14:30	07:18:10	07:20:55	07:24:45	07:28:30	07:31:20	07:34:10	07:38:10	07:43:50	07:47:40	07:52:20
Bus No. 3	07:12:00	07:16:40	07:20:30	07:24:10	07:26:55	07:30:45	07:34:30	07:37:20	07:40:10	07:44:10	07:49:50	07:53:40	07:58:20
Bus No. 4	07:18:00	07:22:40	07:26:30	07:30:10	07:32:55	07:36:45	07:40:30	07:43:20	07:46:10	07:50:10	07:55:50	07:59:40	08:04:20
Bus No. 5	07:24:00	07:28:40	07:32:30	07:36:10	07:38:55	07:42:45	07:46:30	07:49:20	07:52:10	07:56:10	08:01:50	08:05:40	08:10:20
Bus No. 6	07:30:00	07:34:40	07:38:30	07:42:10	07:44:55	07:48:45	07:52:30	07:55:20	07:58:10	08:02:10	08:07:50	08:11:40	08:16:20
Bus No. 7	07:36:00	07:40:40	07:44:30	07:48:10	07:50:55	07:54:45	07:58:30	08:01:20	08:04:10	08:08:10	08:13:50	08:17:40	08:22:20
Bus No. 8	07:42:00	07:46:40	07:50:30	07:54:10	07:56:55	08:00:45	08:04:30	08:07:20	08:10:10	08:14:10	08:19:50	08:23:40	08:28:20
Bus No.9	07:48:00	07:52:40	07:56:30	08:00:10	08:02:55	08:06:45	08:10:30	08:13:20	08:16:10	08:20:10	08:25:50	08:29:40	08:34:20
Bus No.10	07:54:00	07:58:40	08:02:30	08:06:10	08:08:55	08:12:45	08:16:30	08:19:20	08:22:10	08:26:10	08:31:50	08:35:40	08:40:20
Bus No.11	08:00:00	08:04:40	08:08:30	08:12:10	08:14:55	08:18:45	08:22:30	08:25:20	08:28:10	08:32:10	08:37:50	08:41:40	08:46:20
Bus No.12	08:06:00	08:10:40	08:14:30	08:18:10	08:20:55	08:24:45	08:28:30	08:31:20	08:34:10	08:38:10	08:43:50	08:47:40	08:52:20
Bus No.13	08:12:00	08:16:40	08:20:30	08:24:10	08:26:55	08:30:45	08:34:30	08:37:20	08:40:10	08:44:10	08:49:50	08:53:40	08:58:20
Bus No.14	08:18:00	08:22:40	08:26:30	08:30:10	08:32:55	08:36:45	08:40:30	08:43:20	08:46:10	08:50:10	08:55:50	08:59:40	09:04:20
Bus No.15	08:24:00	08:28:40	08:32:30	08:36:10	08:38:55	08:42:45	08:46:30	08:49:20	08:52:10	08:56:10	09:01:50	09:05:40	09:10:20
Bus No.16	08:30:00	08:34:40	08:38:30	08:42:10	08:44:55	08:48:45	08:52:30	08:55:20	08:58:10	09:02:10	09:07:50	09:11:40	09:16:20
Bus No.1	08:36:00	08:40:40	08:44:30	08:48:10	08:50:55	08:54:45	08:58:30	09:01:20	09:04:10	09:08:10	09:13:50	09:17:40	09:22:20
Bus No.2	08:42:00	08:46:40	08:50:30	08:54:10	08:56:55	09:00:45	09:04:30	09:07:20	09:10:10	09:14:10	09:19:50	09:23:40	09:28:20
Bus No.3	08:48:00	08:52:40	08:56:30	09:00:10	09:02:55	09:06:45	09:10:30	09:13:20	09:16:10	09:20:10	09:25:50	09:29:40	09:34:20
Bus No.4	08:54:00	08:58:40	09:02:30	09:06:10	09:08:55	09:12:45	09:16:30	09:19:20	09:22:10	09:26:10	09:31:50	09:35:40	09:40:20
Bus No.5	09:00:00	09:04:40	09:08:30	09:12:10	09:14:55	09:18:45	09:22:30	09:25:20	09:28:10	09:32:10	09:37:50	09:41:40	09:46:20

5.1 Geometric design of flyover

Table 9

Length of Flyover	1400m
Width of Lane	17m
No. of lane	4
Width of footpath	1.5m on each side
No. of station	3

Existing width of MR-10 road – 10m
Width increased by - 8m
Total width - 18m

5.2 Cost of flyover and increased width of MR-10 Road Bridge

Cost of flyover- 93, 111, 3400/- (665081/m length)[10]

Cost of increased width of MR-10 Road Bridge –36, 948, 9444/-

6. Environmental Factor

Aswe know vehicles are the major source of air and noise pollution and day by day travel demand is increasing which result in increasing air and noise pollution. Air pollution is not only unhealthy for human being but it also seriously affects our vegetation. So it is very important to design an integrated traffic system which reduce the pollution. After planning the integrated traffic system following reduction takes place on MR-10 Road Indore.

6.1 Air Pollution

Table 10

Type of veh.	CO2 emission in grams /veh Km [12]	Total CO2 emission in grams / veh Km	CO2 emission in grams / veh Km(mixed traffic lane)	Total CO2 emission in grams / veh Kms(mixed lane+BRTS)	% Reduction
2 wheeler	94	637414	254966		
3 wheeler	172	65188	26075		
Bus (city)	750	38250	15300		
Bus	963	58743	58743		
Truck	1100	152900	152900		
Magic	189	21168	8467		
Cycle	0	0	0		
car(petrol)	293	335778	134311		
Diesel	172	197112	78845		
Tractor	1100	144100	144100		
		1650653	**873707**	**896819**	**45.66**

6.2 Noise Pollution

The noise from whatever source it comes from is undoubtedly, physiologically as well as psychologically harmful. Invading environment in dangerous proportions, it is an invisible but insidious form of pollutant Noise as a potentially harmful pollutant is being recognized as a great nuisance these days affecting the quality of life, particularly, in urban areas

The noises from individual vehicles includes
1) Noise from engine, transmission.
2) Exhaust noise.
3) Noise due to slamming of car doors.
4) Use of horns

Type of veh.	Intensity of sound (dB) [14]	Total intensity (dB)	Mixed traffic sound intensity (dB)	Total sound intensity after BRTS (dB)	% Reduction
2 Wheeler	94	637414	254966		
3 Wheeler	90	34110	13644		
Bus (City)	98	4998	1999		
Bus	98	5978	2391		
Truck	102	14178	5671		
Magic	84	9408	3763		
Cycle	0	0	0		
Car	79	181147	72459		
Tractor	102	13362	5345		
		900595	**360238**	**362350**	**42.765**

6.3 Time saving cost

Type of veh.	Time saving cost/veh.[13]	Total time saving cost	Mixed traffic rate	Total	% reduction
2 wheeler	32	216992	86797		
bus (city)	62.5	3188	1275		
Car	39.5	90574	36229		
		310753	**124301**	**125345**	**39.66**

6.4 Accident cost:-

Type of vehicles	Accident cost per veh. [13]	Total accident	Mixed traffic	Accident cost in mixed traffic	Total	% Reduction
2 Wheeler	6650	45093650	2712	18037460		
3 Wheeler	7600	2880400	152	1152160		
Bus(City)	76050	3878550	20	1551420		
Bus	76050	4639050	24	1855620		
Truck	8600	1195400	56	478160		
Magic	7600	851200	45	340480		
Car	26150	59961950	917	23984780		
		118500200		**47400080**	**49225280**	**48.459**

7. Conclusions

1) Route is analyzed and transit unit are provided on the basis of passenger traffic flow along the sections on the route.
2) 16 transit units are required to run along the route, continuously throughout the day.
3) 60% of passenger traffic is travelling through BRTS
4) Additional 20 transit units are required to accommodate the peak hour traffic at some specified sections of the route.
5) Well managed traffic system has been designed on Excel along the route by proper scheduling
6) On the basis of traffic forecasting width of MR-10 Bridge is to be increased by 8m (3.5m plus 0.5m footpath on each lane)
7) To reduce the congestion, flyover is designed from Radisson Square to Sayaji Square.
8) CO_2 emission and noise pollution is reduced by 45.66% and 42.76% respectively.
9) Time saving and Accident cost is reduced by 39.6% and 48.5% respectively.

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