USE OF TRANSPORT MODELS FOR MASS TRANSIT STUDIES

By

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ABSTRACT
The need for traffic planning of big cities is increasing world over and several planners and engineers have developed matrices and models to represent and understand the urban scenes. Karachi, Lahore, Rawalpindi and Islamabad are the big cities of Pakistan. Almost all the major roads of these cities have crossed their capacities and traffic congestions have risen to such an alarming position that if scientific / engineering solutions are not sought, it will harm the beauty and economic growth of these. In Pakistan still agencies and city governments think traffic modeling a futile effort and consider it wastage of time and money. In this paper the author highlighted benefits of traffic model studies and its impact on future year planning. Traffic Modeling involves preparation of a road network model for whole of the city and a transportation model of the city for trip generation, trip attraction, trip distribution and trip assignment. Different Options / Scenarios are studied. Three Model Studies recently conducted for Mass Transit in Lahore, Rawalpindi / Islamabad and Karachi are presented in this paper and are analyzed for their benefits to city governments.

It is concluded in the end that with the traffic model study agencies and city governments got a treasure of socio economic data, transport plans, private/public transport trips detail and different traffic scenarios for city planners and builders.

1. INTRODUCTION

1.1 GENERAL

Increasing traffic volumes, in urban areas of Pakistan are calling for integrated transport planning and road network. Growth in population and vehicle ownership together with shifting of population from rural areas to urban areas are posing serious challenges to traffic planners. People’s preferences in terms of time, money, comfort, and convenience prescribed for future transport system. Study of transport economics, land-use, and vehicle for human characteristics, traffic flow characteristics and geometrics are means of determining urban area traffic problems in a transport system.

The need for traffic planning of big cities is increasing world over. “In 1850 there were four cities in the world with more than 1-million people and in 1950 there were about a hundred cities of this size. At present, there are about 400 cities of this magnitude” (C. Jotin and B. Kent Lall, 2002).

Several planners and engineers have developed matrices and frameworks to represent and understand the urban scenes. During the last 30 years a great mass of information has been collected and scores of papers and books have been written on urban area traffic planning (C. Jotin and B. Kent Lall, 2002). Urban transportation planning leads to decisions on transportation policies and programs which promote travel and land development patterns that are in keeping with community goals and objectives.

Recently Pakistan has witnessed an exponential growth in car sales. This increase has occurred mainly due to the declining interest rates and the stronger local currency which bodes well for overall financial health. A statistics compiled by the Pakistan Automotive Manufacturers reveals an increase of 23 percent in car sales, 23 percent in motorcycles, 92 percent in trucks, 28 percent in LCVs and bus sales grew by 48 percent. (Pakistan Automotive Manufacturers, 2007) Securities leasing companies and

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Banks are playing an important role in boosting automobiles demand. About 40 percent of the new car sales are now financed by these entities. Due to reduced interest rates, leasing and financing options are becoming increasingly attractive to buyers and perhaps more importantly to loan-providers. Another important development in automobile financing is increasing interest-free car financing schemes based on Islamic financing mode of Ijarah or Islamic leasing, which should positively impact demand from interest-averse individuals.

Recently Pakistan Environment Protection Agency (PEPA) has raised severe concerns on increasing deterioration of environment in Islamabad due to the construction of new roads and avenues by Capital Development Authority (CDA). They have urged CDA to undertake environment study before embarking on any such project as a number of trees and green areas are being affected due to such projects.

Hence these trends require more advanced road network planning and development. Transportation analysis has become necessary in the design of shopping mall, a large apartment building and a super market. Traffic study is also necessitated by the increasing level of congestion in growing areas, particularly those which are located within the boundaries of a large urban area. In an attempt to control unplanned growth and unplanned loads of traffic, traffic study has become a requirement whether the road network under new scenarios will be able to handle the additional traffic while offering acceptable level of service. The trends of today will extend into the future. More stringent requirements for road quality, safety and environmental performance will be introduced. Congestion, noise and pollution will be worsened. Such Studies provide answers to following questions

- What are the existing traffic conditions on the network surrounding the study area?
- How much additional traffic will be generated in future?
- How will additional traffic affect the existing conditions?
- What roadway improvement or change in the study area would be necessary to minimize the growing traffic impact?

1.2 PROBLEM STATEMENT

Different transportation planning studies are conducted in big cities to evaluate traffic problems and to give solutions to reduce traffic congestion, jams, noise and pollution on major roads and intersections. The solution lies in planning the city as a whole not as a segment. This implies study of traffic which includes study of traffic pattern, its origin and destination, its growth, land use, human behavior, traffic flow characteristics and impact of future development on road network. The geometric design of roads and intersections shall then be conducted which will cater traffic volumes.

Karachi, Lahore, Rawalpindi and Islamabad are the big cities of Pakistan. Almost all the major roads of these cities have crossed their capacities and traffic congestions have risen to such an alarming position that if scientific / engineering solutions are not sought, it will harm the beauty and economic growth of these cities.

Uptill now most of the solutions are sought based on merely traffic volumes and no study of traffic pattern vis-a-vis traffic modeling, future years traffic impact, socio-economic growth and impact of future years development as envisaged in the master plan of the cities are considered. Design based merely on traffic volumes does not suit for big metropolitan cities. Scientific and engineering approach is now sought throughout the developed world for planning the cities. State of the art technique of traffic modeling is being adopted throughout the world to study the overall traffic movement of the city. Based on the traffic model results, best geometric/transport solutions are sought. In this research paper, focus was made on components of city planning i.e. trip-generation, trip-distribution, model-split and traffic assignment and outcome of Mass Transit Studies conducted recently in Karachi Master Plan by JICA, Lahore Urban Transport Plan by JICA and Rawalpindi / Islamabad Traffic Model Study by NESPAK.

1.3 OBJECTIVES

This research study was carried-out to achieve the following objectives:

- What are the best planning techniques for city transport planning authorities?
- What data city authorities shall acquire and maintain which is necessary to conduct transport model studies and planning?
- Whether outcome of Transport Model Studies is Beneficial or Useless?
- Whether to go for Mass Transit Routes or stick to road widening and grade separations?

1.4 SCOPE OF RESEARCH

The author divided the research work to achieve the objectives as follows:

- Three traffic models recently developed for Mass Transit Studies are.
    - Karachi Transport Improvement (Master Plan) Model Study 2012 by JICA.
    - Lahore Urban Transport Master Plan Model Study 2011 by JICA.
    - Rawalpindi / Islamabad Model Study for Mass Transit System 2014 NESPAK were studied.
- Data used in these models were investigated.
- The outcome of these studies and projects were investigated.

2. TRANSPORT PLANNING TECHNIQUES

2.1 INTRODUCTION

A lot of work has been done in Pakistan on road geometrics and almost all the roads are being designed as per international standards and by using state of the art software by Pakistani Engineers but very little research has been carried-out on traffic planning and analysis. Due to the absence of any government body which formulates transport policy and network and transport research institutions, majority of the traffic and transport studies have been carried-out by international agencies. This section presents concepts and guidelines related to traffic modeling and give brief overview on Karachi, Lahore and Rawalpindi / Islamabad traffic Models mentioned earlier.

2.2 OVERVIEW OF TRAFFIC MODEL PROCESS

The traditional four-step process has been developing over the past 25 years for forecast of urban travel. The four step traffic modeling is: (C.S. Papacostas and P.D. Prevedouros, 2002)

- Trip generation: Forecast the number of trips that will be made.
- Trip distribution: Determines where the trips will go.
- Mode usage: Predicts how the trips will be divided among the available modes of travel.
- Trip assignment: predicts the routes that the trip will take, resulting in traffic forecasts for the highway system and rider ship forecasts for the transit system.

Urban activity forecasts provide estimates of where people will live and where business will be located in future. These forecasts also include the intensity of activity, such as number of households and the number of employees in businesses. Zones are of great help in organizing information and forecasting. Several additional factors, such as car ownership, residential density, and amount of vacant land, may also be known.

These forecasts are done for small parcels of land called zones. Zones vary in size, with the smallest about the size of a block in the central area, whereas the largest on the urban fringe may be several square miles in area. An area with a million people could have 700 to 800 zones. Zonal urban activity forecast are based on the following: (C. Jotin and B. Kent Lall, 2002)

- Total urban area population and employment estimates.
- Location behavior of people and businesses.
- Local policies regarding land development, transportation, zoning, roads, and so on.

Once the study area has been divided into appropriate analysis units, such as zone and sectors, information about activities in these areas can be gathered and aggregated. The results of a typical activity analysis provide the planner with present levels of activities in zones to help in predicting future levels. These activity forecasts are direct inputs to the next stage of the process, trip-generation analysis.

2.3 TRIP GENERATION

Trip generation is the process by which measures of urban activity are converted into numbers of trips. For example, the number of trips that are generated by a shopping center is quite different from the number of trips generated by an industrial complex that takes up about the same amount of space. In trip generation, the planner attempts to quantify the relationship between urban activity and travel.

The land use data provide the analyst an input for trip-generation analysis. Surveys of travelers in the study area show the numbers and types made, by relating these trips to land-use patterns, the analyst is able to forecast the number of trips that will be made in the future, given forecasts of population and other urban activity. Here's a simplified example. A small city's survey data shows that zone-11 has an employment of 900 people and attracts 4511 trips. Dividing the trips by employees, we find that about five trips are attracted per employee. This rate can then be used to predict attractions for future employment levels. The output of trip-generation analysis is a table of trip ends i.e. the number of trips produced and the number of trips that are attracted.

After trip-generation analysis, the planner knows how many trips are produced by each zone and how many are attracted by each zone. In addition, the planner knows the purpose of the trips. Trips are put into several categories, like trips from home to work, or home to shop, or home to school. This categorization is necessary because each trips purpose reflects the behavior of the trip maker. For example, school trips and work trips are pretty regular, shopping and recreation trips are less so. There are basically two tools for trip-generation analysis, multiple linear regression and cross-classification. These methods are explained in the following sections.

- *Multiple Linear Regression Technique.*
- *Trip-Rate Analysis Technique.*
- *Category Analysis or Cross-Classification Analysis.*

Multiple Linear Regression technique is used for all three models because of big size of cities owing to its large data handling.

2.4 TRIP DISTRIBUTION

After the trip-generation stage, the analyst knows the number of trip production and trip attractions that each zone will have. But where do the attractions in one zone say zone-1 come from and where do the productions go? What are the zone-to-zone travel volumes?

Trip-distribution procedures determine where the trips produced in each zone will go and how they will be divided among all other zones in the study area. The output is a set of tables that show the travel flow between each pair of zones. In a hypothetical five-zone city, zone-1 may produce 2000 trips, and zones-1, 2, 3, 4 and 5 may attract 300, 600, 200, 800, and 100 trips, respectively. The decision on where the trips go is represented by comparing the relative attractiveness and accessibility of all zones in the area.

There are several methods of trip distribution analysis : the Fratar Method, The intervening Opportunity Model, and The Gravity Model. The Fratar method and the gravity model are the most widely used.

- *The Fratar Method.*

- *The Gravity Model.*

Gravity model is used for all of above three city models.

2.5 MODE USAGE

In this phase of travel-demand forecasting, the planners analyze people’s decisions regarding mode of travel, auto, bus, train, and so on. In the flowchart of the travel demand forecasting process, mode usage comes after trip distribution. However, mode usage analysis can be done at various points in the forecasting process. Mode usage analysis is also commonly done within trip-generation analysis. The most common point is after trip distribution, because the information on where trips are going allows the mode usage relationship to compare the alternative transportation services competing for users.

Before planner can predict how travel will be split among the modes available to the travelers, he must analyze the factors that affect the choices that people make. Three broad categories of factors are considered in mode usage:

- The characteristics of the trip maker (e.g., family income, number of autos available, family size, residential density).

- The characteristics of the trip (e.g., trip distance, time of day).

- The characteristics of the transportation system (e.g., riding time, excess time).

The planner looks at how these characteristics interact to affect the trip maker’s choice of mode. When the relationships have been discovered, the planner can predict how the population of the future will choose from among the modes that will be available.

Generally, at this point in the forecasting process, some consideration is given to predicting the number of occupants in autos for those choosing that mode. This consideration of auto occupancy either can be included in the mode usage relationship with each level of occupancy being considered a separate mode, or a separate relationship might be developed. In this respect two models are widely used

- *Direct-Generation usage Modes Models.*

- *Trips-Interchange Mode Usage Models.*

Trip interchange technique is used for Lahore and Rawalpindi / Islamabad Model.

2.6 TRIP ASSIGNMENT

Trip assignment is the procedure by which the planner predicts the paths the trips will take. For example, if a trip goes from an outer city area to inner city area, the model predicts the specific streets or transit routes to be used. The trip-assignment process begins by constructing a map representing the vehicle and transit networks in the study area. The network maps show the possible paths that trips can take.

The intersections (called nodes) on the network map are identified, so that the sections between them (called links) can be identified. After the links are identified by nodes, the length, type of facility, location in the area, number of lanes, speed, and travel time are identified for each link. If transit is available, additional information, which identifies fares, headways (time between vehicles), and route descriptions, is included on a separate network. This information allows the computer to determine the paths that the travel might take between any two points on the network and to assign trips between zones to these paths. The output of trips-assignment analysis shows the paths that all trips will take, and, therefore, the number of cars on each roadway and the number of passengers on each transit route.

Several techniques are available to determine the paths on a network where assigned trips between zones will go. Two techniques are: minimum path and minimum path with capacity restraint are widely used.

- *Minimum-Path Techniques.*
- *Minimum Path with Capacity Restraints.*

Minimum path with capacity restraint technique is used for all three models i.e. Karachi, Lahore and Rawalpindi / Islamabad.

3. DATA NECESSARY FOR CITY AUTHORITIES TO ACQUIRE AND MAINTAIN

After going through these studies and the time required conducting these studies it was found that if socio-economic data was readily available with city authorities half the time could have been saved. The important data which shall be readily available with transport authorities before conducting transport studies are.

- Population data of each Transport Analysis Zone.
- Transport Analysis Zone’s Boundaries data.
- Existing Road network in GIS format.
- Existing Public Transport routes data.
- Traffic count data on major roads and intersections.
- Zone wise Land use data, i.e. Residential area, Commercial area, Offices and School / College / Universities data.
- Legally binding Master Plan of the city.

As all the above data is available in electronic format with different government agencies and department, the only thing a transport planning agency needed is to get the data from these agencies , make a data base and update it regularly.

4. TRAFFIC MODEL RESULTS BENEFICIAL OR USELESS

4.1 INTRODUCTION

This section presents output of traffic models developed for Karachi, Lahore, Rawalpindi and Islamabad cities and whether these results are beneficial or useless

4.2 Karachi Model Outputs

Table 3-1-1 Estimation of Population in Karachi City

Year	Population	Average Annual Increase Rate
1998	11,335,000	4.68%
2005	15,120,000	4.20%
2010	18,529,000	4.15%

Source: KSDP-2020

Table 3-3-2 Arterial Road Lengths

Expressway	Highway	Principal Arterial	Minor Arterial	Total
25.6 km	173.2 km	157.2 km	527.9 km	883.9 km

Source: JICA Study Team

Table 2-4-3 Trip Rate by Working Status

Unit: No. of trips per day per person

Worker	Jobless	Retired	Housewife	Student	Others	Average
2.52	0.61	0.93	0.28	2.06	1.79	1.51

Source: HIS in KTIP

Table 5-2-2 Estimated Trip Generation

Trip Purpose	Trip Rate	No. of Trips (1,000)		
		2010	2020	2030
To work	0.31	4,894	7,121	8,167
To school	0.21	3,232	4,702	5,393
Business	0.02	281	409	469
Private	0.10	1,613	2,348	2,693
To home	0.63	9,924	14,439	16,561
Total	1.27	19,944	29,018	33,283
Increase		1.00	1.45	1.67

Source: Prepared by the JICA Study Team

Table 2-4-5 Percentage of Trip Purpose by Travel Mode (%)

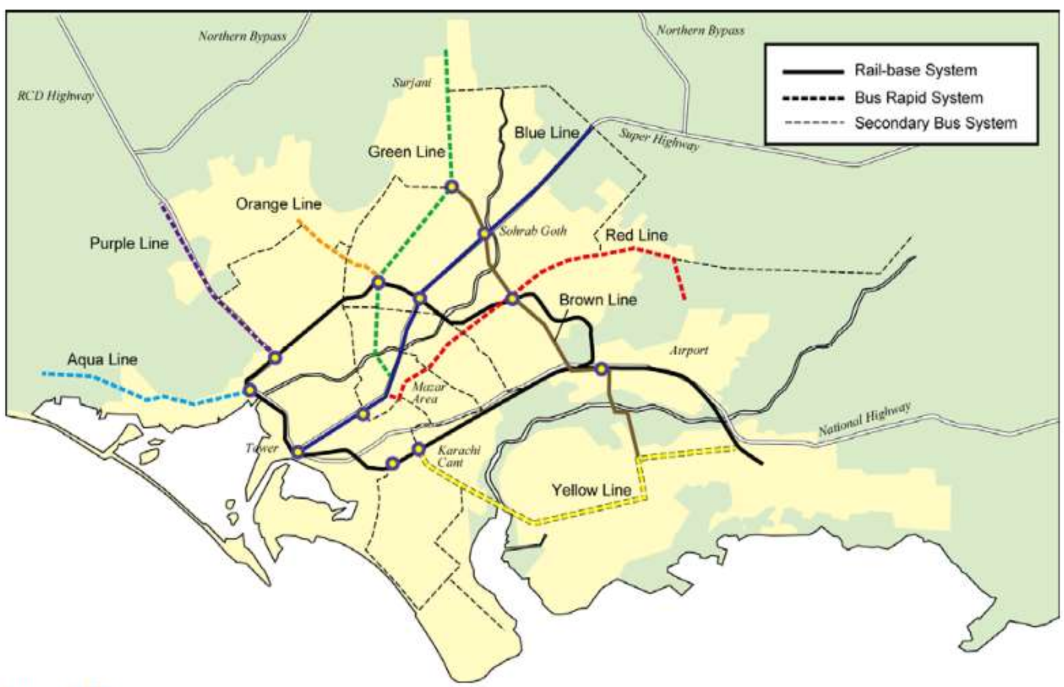
	Walk	Motorcycle	Car	Para Transit	Bus	Others	Total
To Home	49.3	47.3	45.5	49.6	49.1	46.0	48.6
To Work	18.6	34.7	24.7	19.4	32.4	40.0	24.2
To School	20.8	4.9	5.7	20.0	8.7	3.1	14.6
Business	0.8	2.5	5.2	1.2	1.3	4.0	1.6
Private	10.5	10.6	19.0	9.7	8.5	6.9	10.9
Total	100	100	100	100	100	100	100

Source: JICA Study Team (Household Interview Survey, 2010-11)

Table 5-2-3 Number of Trips by Mode

Mode	2010		2020		2030	
	(1,000)	(%)	(1,000)	(%)	(1,000)	(%)
Walk	8,057	40.4	11,331	39.0	12,648	38.0
Motorcycle	2,194	11.0	2,966	10.2	3,349	10.1
Car	4,088	20.5	6,221	21.4	7,001	21.0
Bus	5,598	28.1	8,499	29.3	10,284	30.9
Total	19,937	100.0	29,017	100.0	33,283	100.0

Note (1) : This is the model of Full Network Case (see P5-28).
Note (2) : "Bus" includes other types of public transport systems.
Source : Prepared by the JICA Study Team.



Source: KTIP

Figure 6-4-11 Master Plan Network

Table 6-4-4 Passenger Volume of Mass Transit in 2030

Code Name	Maximum section per direction		Boarding ('000 per day)	Passenger-kms (million per day)
	Day	Peak Hour		
KCR	290,000	21,700	505	16.3
KCR Extension	412,000	30,900	487	8.7
Blue Line	357,000	27,000	661	10.9
Brown Line	286,000	21,500	736	8.8
Yellow Line	235,000	17,600	653	6.0
Green Line	244,000	18,300	432	4.9
Red Line	144,000	10,800	355	4.0
Orange Line	247,000	18,500	397	2.2
Purple Line	53,000	4,000	83	0.6
Aqua Line	330,000	24.700	449	2.2
Total	–	–	4.758	64.6

Note : No. of transfer passengers are not included.
Source : KTIP

Financial Internal Rate of Return (FIRR)

Financial Internal Rate of Return (FIRR) is compared to market interest rate to evaluate the profitability of the project. It has been calculated for the five lines as shown in Table 9-2-5. The result shows that all the projects are not profitable with very low FIRR. This means that these projects cannot be implemented in commercial base. Note that in KCR SAPROF (2008, JICA), FRR of KCR was calculated at 2.3%.

Table 9-2-6 FIRR of MRT lines (unit: Billion)

	Green Line	Blue Line	Red Line	Brown Line	Yellow Line
Revenue (in 2010)	4.11	6.19	2.00	5.43	4.76
FIRR	0.13%	0.73%	0.75%	2.33%	1.46%

Source: Estimation in KTIP

4.3. Lahore Model Outputs

Table 2.3.7 LUTMP Study Area 2010 Population by Town/ Tehsil

District	Town / Tehsil	Area (Km2)	2010 Population ('000)	Urban Population ('000)	Density (Persons/ ha)	% of Study Area
Lahore	Ravi Town	31	1,007	1,007	328	10.1
	Data Gunj Bakhsh Town	31	970	970	317	9.8
	Samanabad Town	38	984	984	262	9.9
	Shalamar Town	24	854	854	350	8.6
	Gulberg Town	44	778	778	178	7.8
	Aziz Bhatti Town	69	667	609	97	6.7
	Wagah Town	440	656	263	15	6.6
	Nishter Town	497	945	399	19	9.5
	Iqbal Town	520	960	424	18	9.7
	Cantonment	98	831	831	85	8.4
Sheikhupura	Ferozwala Tehsil	576	534	152	9	5.4
	Muridke Tehsil	224	266	143	12	2.7
	Sharaqpur Tehsil	140	101	36	7	1.0
Kasur	Kasur Tehsil	150	168	50	11	1.7
	Pattoki Tehsil	162	207	71	13	2.1
Lahore	Lahore District	1,792	8,652	7,119	48	87.1
Sheikhupura	Part of Sheikhupura	939	901	331	10	9.1
Kasur	Part of Kasur	312	375	121	12	3.8
LUTMP	Study Area Total	3,044	9,928	7,571	33	100

Source: Punjab Development Statistics-PDS-2010

Table 2.5.4 Trip Rate of Lahore Residents, 2010

Mode	Male	Female	Total
Including walking	1.59	0.60	1.14
Excluding walking	1.12	0.32	0.76

Source: LUTMP HIS

Section 4.3 table

		No. of Trips by Trip Purpose('000/day)					
	Travel Mode	**To Work**	**To School**	**Private**	**Business**	**To Home**	**Total**
Private	Bicycle	152	72	11	5	231	472
	MC(Driver)	775	206	123	76	1110	2,290
	MC(Passenger)	72	171	28	8	223	501
	Car	382	191	155	56	732	1,517
	Truck	2	1	1	0	4	7
	Sub-Total	1,383	641	318	145	2,300	4,787
Public	Bus/Mazda/Wagon	418	253	131	34	784	1,620
	Rail/Air	1	0	0	0	3	4
	Rickshaw	129	171	75	9	368	751
	Qinggi	170	71	53	7	311	612
	Sub-Total	718	495	259	50	1,466	2,987
Others	Taxi	1	1	1	0	3	6
	Private Bus	28	99	2	0	127	256
	Others	13	3	2	1	17	37
	Sub-Total	42	103	5	1	147	299
	Walk	**561**	**1,197**	**86**	**41**	**1,845**	**3,730**
Total	(including walk)	2,704	2,436	668	237	5,758	11,803
	(excluding walk)	2,143	1,239	582	196	3,913	8,073
Source: JICA							

Figure 7.1.1 RMTS/ BRT Network 2030

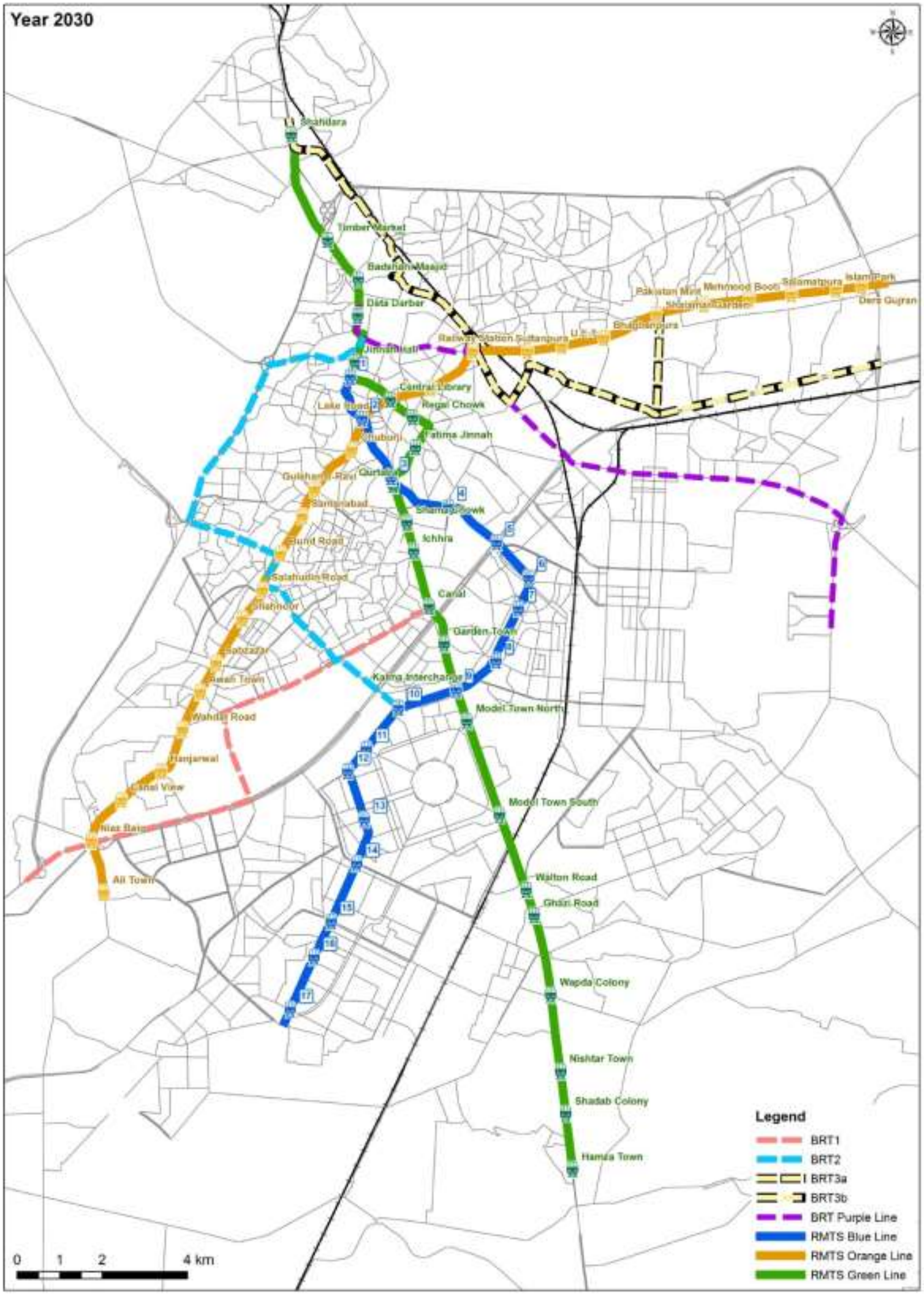


Table 7.4.2 Result of Economic Evaluation

Public Transport Project

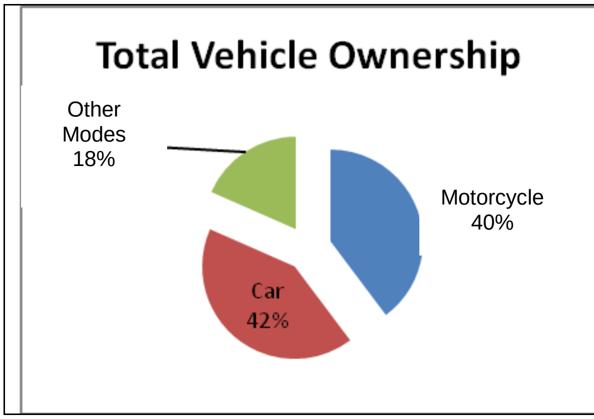
Project No.	Project Code	Project	Length (km)	Project Cost (US$ Mil)	O&M Cost (US$ Mil/ yr.) in 2020	EIRR (%)
PT06	RMS1	Green Line (RMTS)	26.7	2,583	32.8	12.11%
PT07	RMS2	Orange Line (RMTS)	27.1	2,330	32.1	10.30%
PT08	RMS3	Blue Line (RMTS)	24.0	1,908	26.1	8.02%
PT07	RMS2	Orange Line (BRT)	27.1	76.0	68.7	18.83%
PT08	RMS3	Blue Line (BRT)	24.0	73.7	71.8	16.68%
PT09	BRT1	Purple Line (BRT)	19.0	52.0	31.0	15.53%
PT10	BRT2	BRT A1 Line	14.1	39.1	17.8	37.63%
PT11	BRT3	BRT A2 Line	14.3	39.7	18.5	43.56%
PT12	BRT4	BRT A3a Line	15.7	35.9	20.7	20.37%
PT13	BRT5	BRT A3b Line	19.1	44.9	30.6	

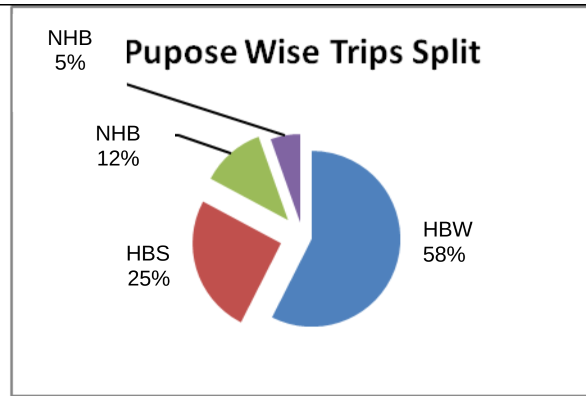
4.4. Rawalpindi / Islamabad Model Outputs

	Population			
Study Area	**Pop. 1998**	**Pop 2014**	**Annual Growth (%)**	**% of Study Area**
Rawal Town	781,927	1,332,977	3.39	29
Pothohar Town	485,730	677,340	2.10	15
Chaklala Cantt	320,164	545,794	3.39	12
Rawalpindi Cantt	627,841	1,070,302	3.39	23
Islamabad	410,721	985,593	5.1	21
Total	2,626,383	4,612,006		

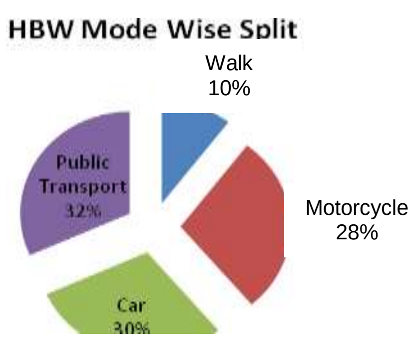
Study Area	**Bike Owning HH**	**% Bike Owning HH**	**Car Owning HH**	**%Car Owning HH**	**No vehicle Owning HH**	**% No vehicle Owning HH**	**% Car & Bike Owning HH**
Rawal Town	*115,911*	*36*	51,326	20	33,898	54	56
Chaklala Cantt	52,131	16	27,565	11	7,525	12	27
Rawalpindi Cantt	81,856	26	63,779	25	10,495	17	50
Islamabad	69,279	22	114,721	45	11,380	18	66
Total	**319,177**		**257,391**		**63,298**		

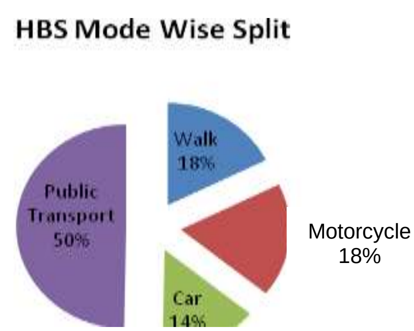
Road Class	Road Length (km)
Motorway	74
G. T. Road	145
Primary Roads	315
Secondary Roads	544
Tertiary / Collectors	906
Street / Locals	1063

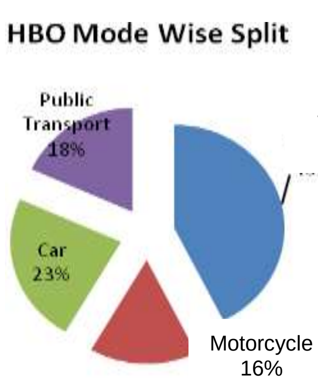


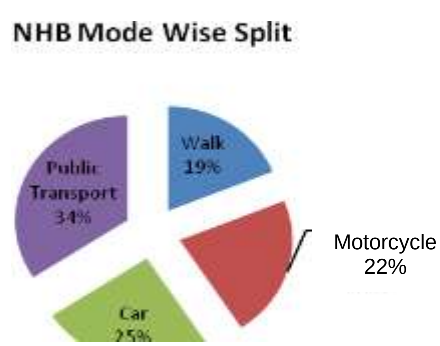


	Walk		Motorcycle		Car		Public Transport	
	Count	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
HBW	1000	10%	2740	28%	2846	30%	3057	32%
HBS	752	18%	770	18%	616	14%	2111.5	50%
HBO	840	43%	310	16%	460	23%	360	18%
NHB	172	19%	200	22%	228	25%	312	34%

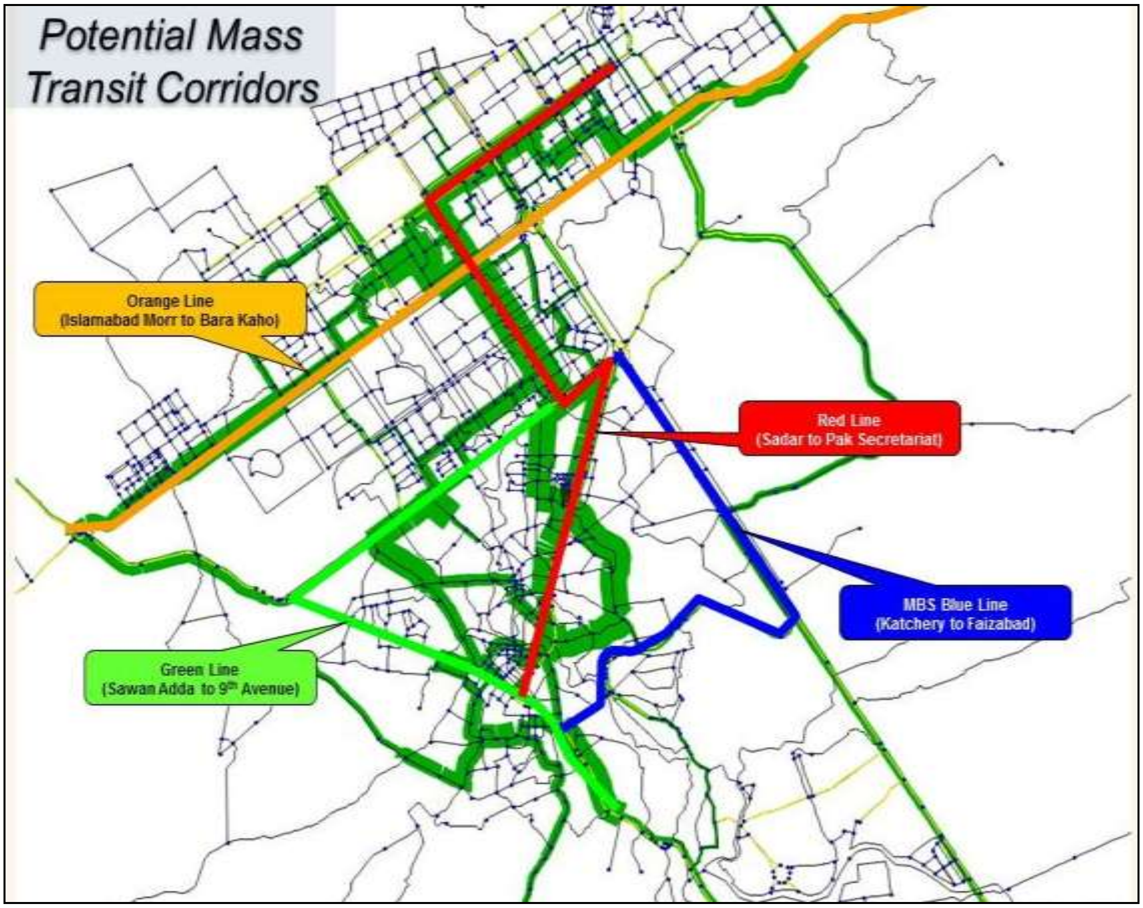








* HBW – Home Base Work Trips
* HBO – Home Based Other Trips
* HBS – Home Based School Trips
* NHB – Non Home Based Trips



These Corridors with their priority of construction are as follows.

- **Priority 1:** Red Line- Sadar to Pak Secretariat via Murree Road, Faizabad, IJP, 9th Avenue and Jinnah Avenue (Length =24km).
- **Priority 2:** Green Line- Sawan Adda to 9th Avenue Via GT Road, Pir Wadhai Mor, IJP (Length = 18km.
- **Priority 3:** Orange Line-Islamabad Morr to Bara Kaho Via Kashmir Highway (Length = 19km).
- **Priority 4:** Blue Line- Katchery to Faizabad via Airport Road , Koral chowk and Islamabad Highway (15.8km).

4.5. OUTPUTS / RESULTS USAGE

In all of the above models following are the key usages.

- Projects can be planned for 20 to 30 years.
- V / C data of Roads and Junctions helps in deciding road widening and grade separation not on the study area level but on whole city level.
- Seeing the congestion on Road networks the demographic characteristics of certain areas can be changed / altered in Master planning level.
- Traffic Signals can be planned, coordinated and designed on city level.

- Public routes can be planned, integrated and managed on city level. Their revenue Bus Kilometers and passengers can be calculated for operations.
- Mass transit routes, station wise rider ship, critical passenger load, fare integration, feeder routes and transfers can be planned and designed on city level.
- On certain corridors new public routes can be introduced to reduce congestion.
- Impact of grade separation can be studied on the whole corridor.
- EIRR and FIRR can be calculated considering whole city level impacts.
- Environment impacts can be studied on whole city level.
- Realistic short term and long term transport budgets can be made.

5. WHY TO GO FOR PUBLIC TRANSPORT

5.1. GENERAL

All the three studies called for a Mass Transit Solutions in their respective cities to reduce congestion. The main theme comes out as.

- The result of growing population and consequent increase in transportation demand is worst congestion in coming years.
- Therefore new solutions are required.

5.2. SOLUTION

To cope with the congestion the city planners have only two options left.

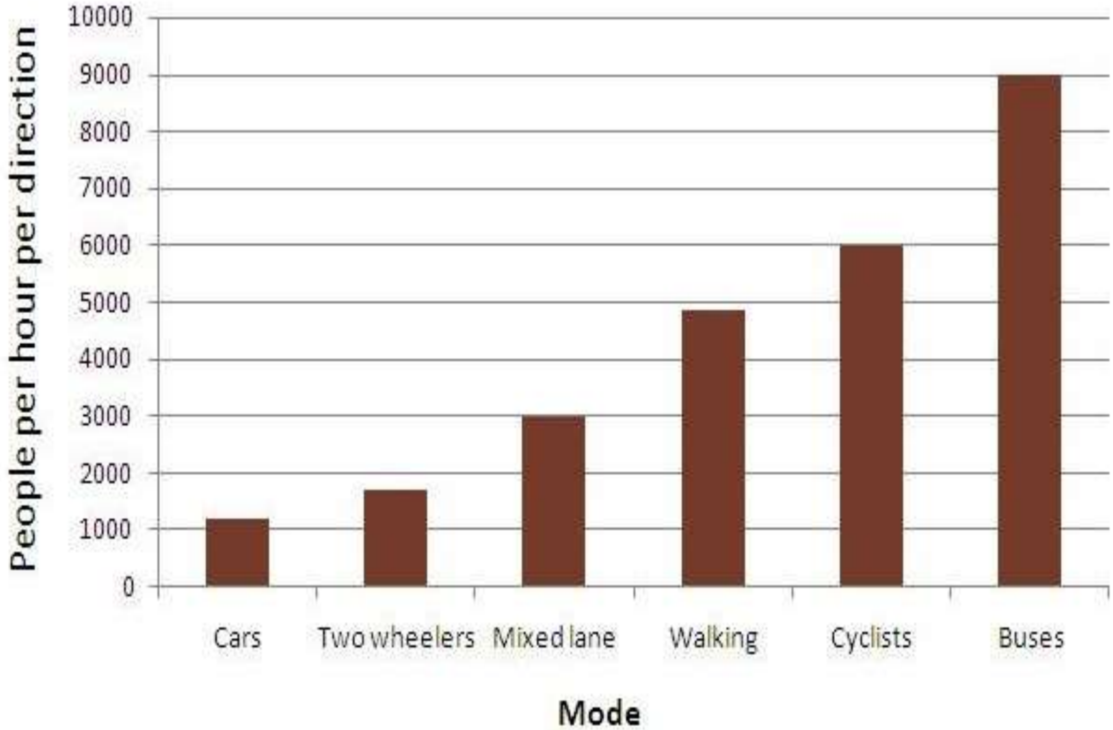
- Adding capacity by constructing new roads, interchanges, widening exiting roads etc.
- Or providing efficient public transport.

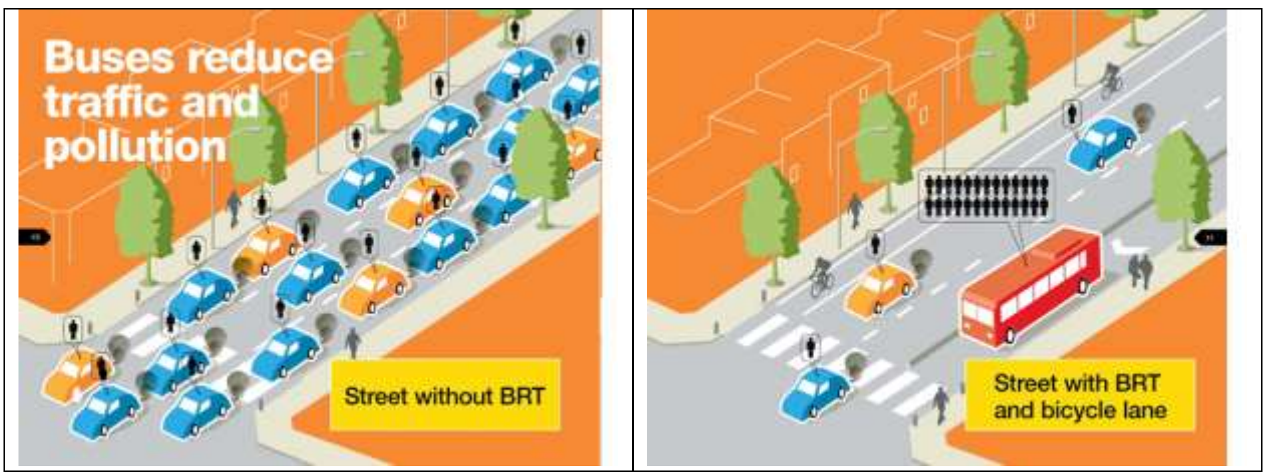
According to an estimate, only 30-40% population use private vehicles currently but we see congestion everywhere. Cars and two wheelers carry only 15-20% people but occupy 85% of road space. The solution is **to move ‘People” not Vehicles.**

5.3. HOW TO MOVE PEOPLE

The following graph shows persons per hour per direction which a standard lane can carry. The BRT can carry 9000 pphpd per lane and two lane BRT can carry upto 20,000 to 25,000 pphpd which is closed to a Light Rail carrying capacity.

The only solution for the city planners left is ***“Mass Transit Corridors to Move People”.***





6. CONCLUSIONS

Based on the studies carried out following conclusions have been drawn :

- City Transport Authority should develop its own transport model to investigate different scenarios on yearly basis and to keep it updated.
- Socio-economic data shall be with Transport Planning Authority.
- At least on city level one type of traffic Model Software shall be used.
- Mass transit solutions are the only solution left with the city planners to control congestion and to move people.

7. RECOMMENDATIONS

To plan the city properly following recommendations are made based on this study:

- Comprehensive Transport Models for private and public transport users shall be built for all big cities.
- Legally bound Transport Master Plans based on Traffic Model results shall be implemented.
- Traffic Models shall be validated and updated each year.

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