MOVEMENT PATTERN AND ZONE IDENTIFICATION FOR PUBLIC TRANSPORT SYSTEMS – CASE STUDY CHANDIGARH REGION

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The professionals involved in transport and land-use planning have a strong relationship with statistics representing travel behaviour. Even if not directly conducting the surveys, they will certainly wish to use data at some point of time, and at that stage they will realize what should have been done in the design and administration phases of the survey. The combination of land-use activity and a transport system invariably results in trip-making, and to measure the type and extent of trip-making it is necessary to conduct travel pattern surveys by one mean or other. The travel patterns may be described in terms of who is going where, with whom, at what time, by which mode and route, and for what purpose. The measurement of such travel patterns is perhaps the unique part of transport survey methods, but determining the most effective way of obtaining this information has often received little attention.

Movement Pattern

Traffic phenomenon are complex and nonlinear, depending on the interactions of a large number of vehicles. Due to the individual reactions of human drivers, vehicles do not interact simply following the laws of mechanics, but rather show phenomena of cluster formation , both forward and backward, depending on vehicle density in a given area. It depends upon availability of modes, access, egress, passengers flow rate, peak utilization of different modes and directional flow of modes. The surveys like roadside origin-destination at cordon, O-D matrix (external to external, external to internal & internal to external) would define varying patterns.

Zone Identification

Zone is an area or stretch of land having a particular characteristic, purpose, or use, or subject to particular restrictions. In this case, the zones are identified on the basis of the character of the area and according to the traffic behavior. These zones will be like social zone, institutional zone, commercial zone, etc. The travel characteristics of the commuters will dictate the character of these different zones.The surveys like socio-economic characteristics, zone wise employment details, travel characteristics, mode & purpose-wise O-D matrices would help in carving various zones as well.

The paper will draw attention to the key role of movement pattern and zone identification for public transport systems, irrespective of the mode of public transport.

Road Network Characteristics

Road Network Inventory and coded road network within Chandigarh Urban Complex (Chandigarh, Panchkula, Mohali and Zirakpur) for primary and secondary roads has been prepared covering all primary and secondary roads. Each junction has been numbered as a node and the road connecting any two nodes is defined as a link. For the purpose of the network survey V1, V2 and V3 roads are considered. The total existing road network of Chandigarh Urban Complex considered for this study consists of total 514 links. The total length of covered road network is 487 Km with average link length of 0.95 Km. The basic character of Chandigarh plan is based on the sector plan and the transport network grids. Each sector is practically self contained, planned inwords, with all the properties having back on the sector dividing V3 roads. The entry for these sectors from the V2 & V3 roads is limited to a single intermediate entry either through V4 or V5. Thus there functions of V4/V5 with sector dividing roads V3 are the main points of traffic discharge and inlets for the sectors.

Mode wise Distribution of Rail Passenger Dispersal

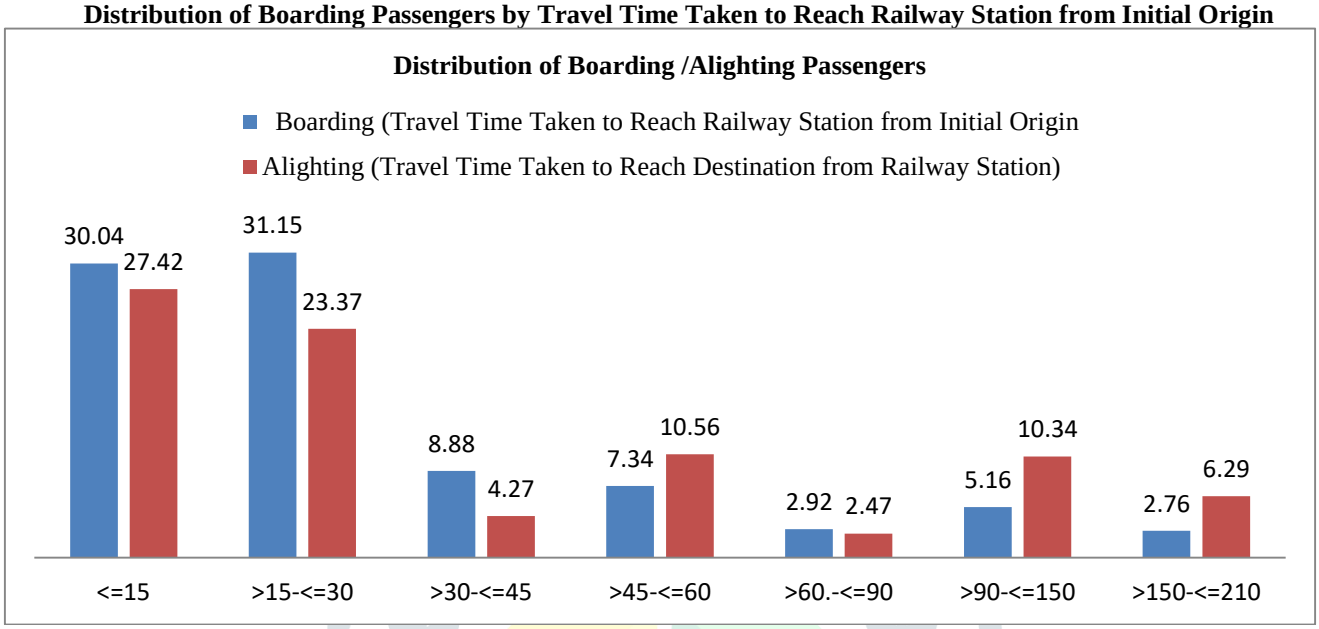
Table shows that about 35 percent passengers are dispersing through buses. Share of passenger dispersal by auto rickshaw is about 22 percent. The dispersal though bus is a positive indicator for planning bus rapid transit system as the commuters are already preferring bus for movement. On other hand, the usage of auto is also high, i.e. approximately 23 percent which means it can also act as a good feeder service while planning a transport system.

Table 1: Mode wise Distribution of Rail Passenger Dispersal

S. No.	Mode	Percentage
1.	Car	4.34
2.	T.W.	3.74
3.	Auto	22.44
4.	Shared Auto	0.26
5.	Bus	34.48
6.	Walk	12.04
7.	Cycle	1.29
8.	Cycle Rickshaw	1.76
9.	Train	19.65
	Total	100.00

Source: RITES Primary Survey 2008 – 09

Distribution of Boarding Passengers by Travel Time Taken to Reach Railway Station from Initial Origin



Source: RITES Primary Survey 2008 – 09

It is observed from given data is that about 61 percent of total passengers take upto 30 minute to reach station from their initial origins and about 51 percent of total passengers take upto 30 minutes to reach their final destinations. The percent for taking above 30 minutes is quite high which leads to wastage of time. From here the need of public transport arises as the existing system may fail in providing services to the commuters.

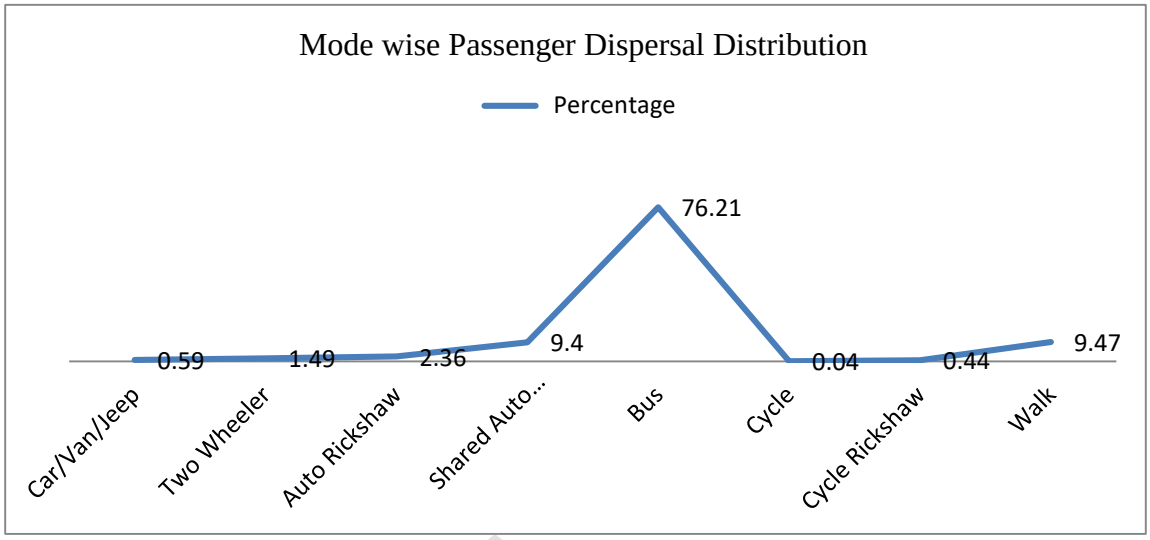
Interstate Bus Passenger Characteristics

The OD data collected and analysed at the 10 major Inter State Bus Terminus (ISBT) and 20 other bus terminals in study area indicates Sector 17 Chandigarh, Sector 43 Chandigarh, Kharar, Derabassi followed by others. At Zirakpur bus terminal the arrival and departure of buses is high but at the same time passenger flow (boarding/alighting) is low as compared to other bus terminals where buses generally halt for some time. The analysis further indicates that about 2.5 lakh commuters use the intercity bus terminals daily (for 16hrs).

Table 2: Daily Arrival/Departure at Major Interstate Bus Terminals

Sr. No.	Terminal Name	Daily Arrival		Daily Departure		Total	
		Buses	Passengers Inflow (Boarding)	Buses	Passengers Inflow (Boarding)	Buses	Passengers Inflow (Boarding)
1.	Baddi Bus Terminal	441	4817	441	5040	882	9857
2.	Dera Bassi Bus Terminal	623	12189	630	9876	1253	22065
3.	Kalka Bus Terminal	178	3511	168	3326	346	6837
4.	Kharar Bus Terminal	716	11691	716	12071	1432	23762
5.	Panchkula sec - 5 Bus Terminal	351	6480	353	4623	704	11103
6.	Pinjor Bus Terminal	779	6282	779	5569	1558	11851
7.	Sec-62 Mohali Bus Terminal	195	2272	194	2031	389	4303
8.	Sec 17 I S B T	1928	49112	1933	44909	3861	94021
9.	Sec 43 I S B T	1406	30206	1542	26107	2948	56313
10.	Zirak pur Terminal	1156	3611	1162	4086	2318	7697
	Total		130171		117638		247809

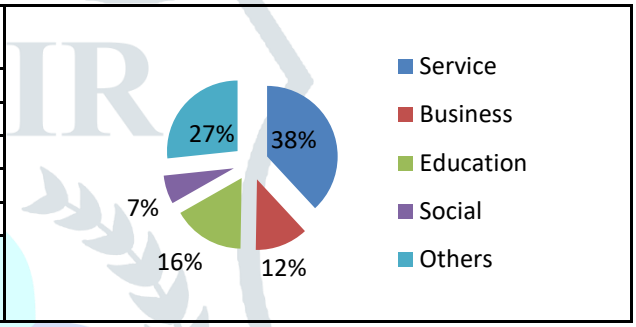
Source: RITES Primary Survey 2008 – 09



Source: RITES Primary Survey 2008 – 09

Table 3: Distribution of Passenger by Trip Purpose at Bus Terminals

S. No.	Trip Purpose	Total Passenger
1	Service	6893
2	Business	2201
3	Education	2987
4	Social	1186
5	Others	4824
	Total	18091



Source: RITES Primary Survey 2008 – 09

It is observed from Table that 50 percent of passengers use buses for their work purpose and 33 percent of passengers use it for social and other purposes.

Table 4: Distribution of Boarding Passengers by Travel Time Taken to Reach Terminal from Initial Origin

S. No.	Travel Time	Percentage
1.	<=15	22.82
2.	>15-<=30	27.25
3.	>30-<=45	18.21
4.	>45-<=60	10.91
5.	>60.-<=90	5.53
6.	>90-<=150	6.73
7.	>150-<=210	2.16
8.	>210	2.39
	Total	100.00

Source: RITES Primary Survey 2008 – 09

Line graph shows that about 76 percent passengers are dispersing through city buses. Share of passenger dispersal by auto rickshaw/ shared auto rickshaw is about 12 percent. This indicates that intercity buses are being used by lower and lower middle class. It is observed from Tables that about 50 percent of total passengers take upto 30 minute to reach terminal from their initial origins and about 65 percent of total passengers take upto 30 minute to reach their final destinations.

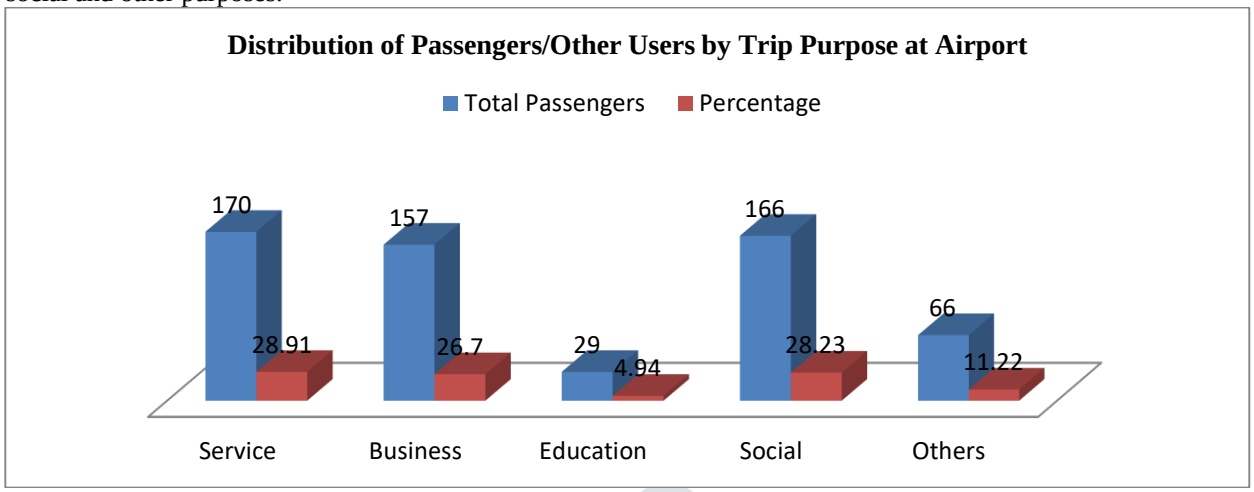
Air passenger characteristics

The Air Passenger Surveys were conducted to ascertain travel characteristics of air passengers. The survey was administered by counting the number of passengers boarding and alighting the trains along with O-D survey on random sampling basis by interviewing passengers. This survey was conducted at 1 Airport within the study area for a period of 24 hours. The information included:

- Boarding/Alighting passenger volume count
- O-D survey of passengers at railway stations
- Trip purpose, travel time, travel cost etc.
- Travel frequency of passengers

Chandigarh Airport caters 1993 total passenger per day. The daily passenger volume along with the peak hour factor at Chandigarh Airport 220.

Table bar that approximately 56 percent of trips are contributed by service and business purpose and 39 percent of trips are social and other purposes.



Source: RITES Primary Survey 2008 – 09

From terminal survey it is concluded that terminals at Chandigarh, Kalka, Derabassi, and Kharar are major rail and bus terminal where maximum boarding alighting is observed. These terminals should be upgraded to act as interchanges for mass public transport system as they are the major points of passenger dispersals. At some terminals like at railway station, it takes more than 30 minutes to reach the destination which is quite high. So from here the need for planning of transport system arises which can connect all nodes of the city with high frequency. If these potentials and the above problems are combined together, then it can be stated that the area is growing rapidly in terms of population & activities, and to match this growth, there is an immediate need to increase the connectivity of this area by some feeder service. Bus rapid transit system is the most suitable option for this area, which will be less space consuming and will be sustained by the middle income groups of the area.

Socio-Economic

Socio economics (also known as socio-economic or social economics) is the social science that studies how activity affects social processes. In general it analyzes how societies progress, stagnate, or regress because of their local or regional economy, or the global economy. The term 'Social economics' may refer broadly to the "use of economics in the study of society. More narrowly, contemporary practice considers behavioral interactions of individuals and groups through social capital and social "markets" (not excluding for example, sorting by marriage) and the formation of norms. In the latter, it studies the relation of economics to social values1. The goal of socioeconomic study is generally to bring out the outcomes related to transportation.

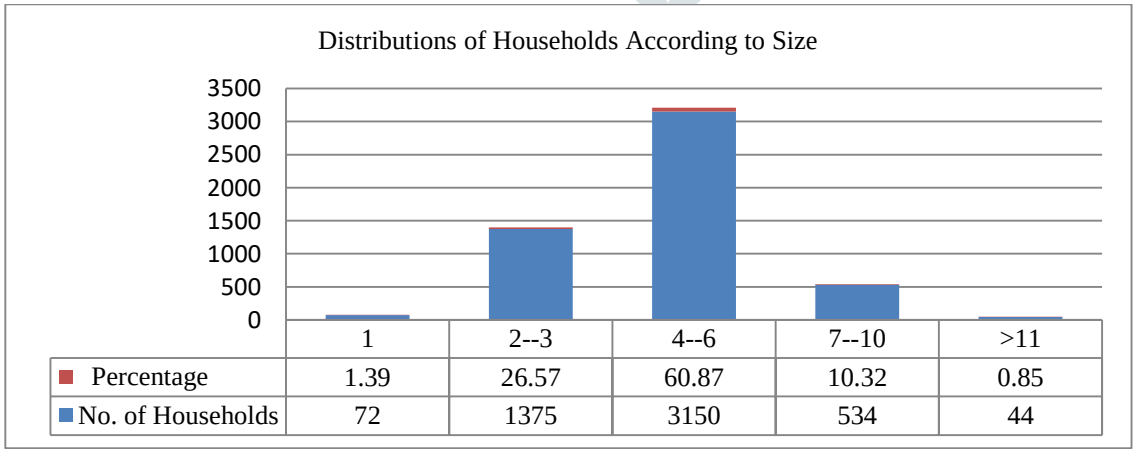
Socio-economic characteristics and Zone identification

The following outputs were derived from the analysis of the Household survey.

- Zone wise distribution of the households according to household size, household income and vehicle ownership.
- Zone wise distribution of the individuals by their occupation, education and expenditure on transport.
- Distribution of trips by mode and purpose and by trip length.

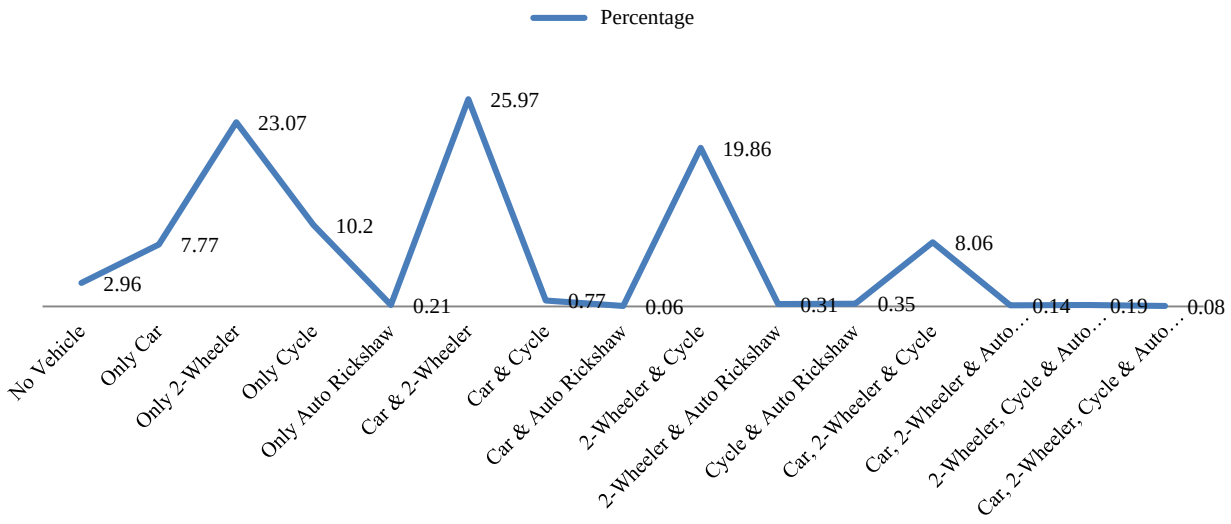
Distribution of household by size.

Distribution of households according to its family size is presented in table and indicates that only 1.39 percent of the households have 1 member and also 0.85 percent of the households belong to the category of households, which have over 11 persons per house hold. Majority of households (60.87 percent) have between 4 to 6 persons per households. The average household size is 4.46.



	1	2--3	4--6	7--10	>11
Percentage	1.39	26.57	60.87	10.32	0.85
No. of Households	72	1375	3150	534	44

Distribution of Household by Vehicle Ownership



Distribution of households owning vehicles is presented in Table shows that only 3 percent of Households have no vehicle. It is also evident that 43 percent of the household have at least one car and nearly 7 percent households have more than 1 car. Almost 78 percent of households have at least 1 scooter/motor cycle. It can be observed that nearly 30 percent households own at least 1 cycle.

Table 5: Distribution of Households According to Vehicle Ownership

Sr. No.	Type of Vehicle	Number of Households	Percentage
1	No Vehicle	153	2.96
2	Only Car	402	7.77
3	Only 2-Wheeler	1194	23.07
4	Only Cycle	528	10.2
5	Only Auto Rickshaw	11	0.21
6	Car & 2-Wheeler	1344	25.97
7	Car & Cycle	40	0.77
8	Car & Auto Rickshaw	3	0.06
9	2-Wheeler & Cycle	1028	19.86
10	2-Wheeler & Auto Rickshaw	16	0.31
11	Cycle & Auto Rickshaw	18	0.35
12	Car, 2-Wheeler & Cycle	417	8.06
13	Car, 2-Wheeler & Auto Rickshaw	7	0.14
14	2-Wheeler, Cycle & Auto Rickshaw	10	0.19
15	Car, 2-Wheeler, Cycle & Auto Rickshaw	4	0.08
	Total	5175	100.00

Distribution of Individual by Occupation

Distribution of individuals of sampled households according to their occupations is presented in. It is observed that nearly 36 percent of individuals are engaged in occupations like (Govt. Service, Pvt. Service & Business). The number of students is accounted for 28 percent and house-wives to 24 percent.

Table 6: Distribution of Individuals by Occupation

S. No.	Occupation	No of Individuals In Sampled Households	Percentage
1.	Govt. Service	2682	11.62
2.	Pvt. Service	3308	14.34
3.	Business	2260	9.79
4.	Student	6463	28.01
5.	House Wife	5620	24.36
6.	Retired	1063	4.61
7.	Unemployed	605	2.62
8.	Others	1073	4.65
	Total	23074	100.00

Source: RITES Primary Surveys – 2009

Distribution of households according to monthly income ranges is presented in Table. It is observed that nearly 3 percent of households have monthly income less or equal to Rs. 5000 and another 19 percent have income between Rs. 5001 – 10,000 per month. The percent of household having monthly income more than Rs. 25,000 was observed about 30 percent. Average household income per month in the study area was observed to be Rs. 22857

Table 7: Distribution of Households According to Monthly Income

S. No.	Income Group	No of Sampled Households	Percentage
1.	<=Rs 5000	177	3.42
2.	Rs 5001 - Rs 10000	988	19.09
3.	Rs 10001 - Rs 15000	943	18.22
4.	Rs 15001 - 20000	951	18.38
5.	Rs 20001-25000	537	10.38
6.	>Rs 25000	1544	29.84
7.	No Response	35	0.68
	Total	5175	100.00

Source: RITES Primary Surveys – 2009

Distribution of Trips by Mode of Travel

Distribution of trips according to mode of travel is given in Table. It is observed that about 17 percent of the trips are walk trips. However, the trips performed by 2 wheelers are about 35 percent and 11 percent performed by bus. A trip performed by auto rickshaw and shared auto is about 7 percent whereas trips performed by cars are nearly 15 percent. Per capita trip rate including walk is 1.32, excluding walk is 1.1 and for motorised trips is 0.9.The share for using bus as a public transport is just 12 percent which is very less. This may be due to lack of bus services provided. So there is need to plan an appropriate transport system which can fulfill the demand of existing as well as future population.

Table 8: Modal Split - 2009

S. No.	Mode	No. of trips/day	Percentage
1.	Car	358352	15.07
2.	T.W.	841025	35.38
3.	Auto	30728	1.29
4.	S. Auto	139040	5.85
5.	Bus	267268	11.24
6.	Cycle	260139	10.94
7.	Rick	68160	2.87
9.	Walk	412417	17.35
	Total	2377129	100.00

Source: RITES Primary Surveys – 2009

Purpose wise Distribution of Trips

Table gives the purpose wise distribution of the trips. It is observed from the table that about 25 percent of the trips are performed for work and business purpose together, where as 19 percent trips are education and about 6 percent for other trips which includes shopping, social heath and recreation. About 50 percent are return trips.

Table 9: Purpose wise Distribution of Total Trips – 2009

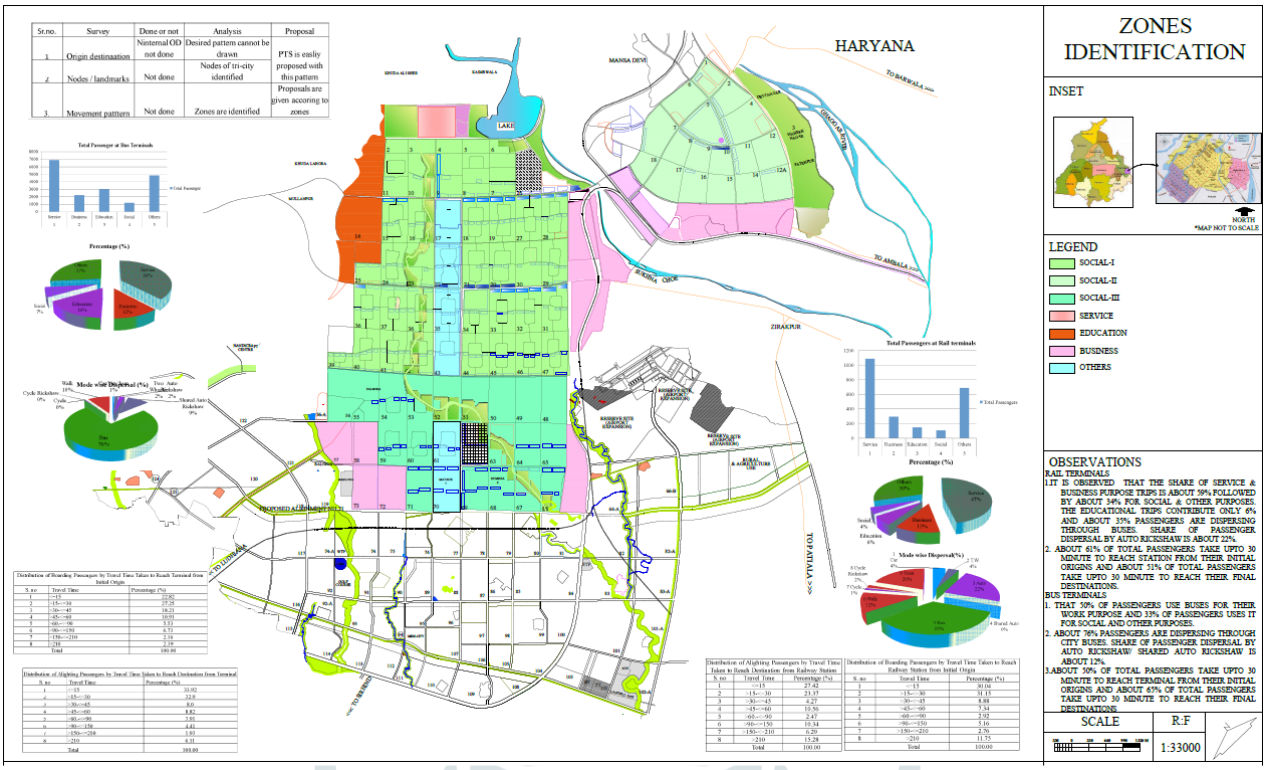
S. No.	Purpose	No of trips/day	Percentage
1	Work	598446	25.16
2	Education	457449	19.23
3	Others	138332	5.82
4	Return Work	592445	24.91
5	Return Education	455295	19.14
6	Return Others	136577	5.74
	Total	2378544	100.00

Source: RITES Primary Surveys – 2009

Way forward

It is observed that monthly household income per month of the residents of urban complex is about Rs 22857/- which is quite high w.r.t to other metropolitan cities. Average monthly household expenditure on transport is about Rs 2474/- which is about 10.8 percent of the total monthly income. About 70 percent of the motorised trips are performed by private modes due to lack of good and citywide mass public transport system. Only 10 percent of the total motorised trips are made by bus system which is very low. If a good citywide public mass transport system is provided in the urban complex at a reasonable fare and with good feeder service the use of private vehicle will be reduced thereby reducing the vehicle loads on the road network. The share of service & business purpose trips at rail terminals is about 59% followed by about 34% for social & other purposes. The educational trips contribute only 6% and about 35% passengers are dispersing through buses. Share of passenger dispersal by auto rickshaw is about 22%. About 61% of total passengers take upto 30 minute to reach station from their initial origins and about 51% of total passengers take upto 30 minute to reach their final destinations. On the other hand, at bus terminals, 50% of passengers use buses for their work purpose and 33% of passengers uses it for social and other purposes. About 76% passengers are dispersing through city buses. Share of passenger dispersal by auto rickshaw/ shared auto rickshaw is about 12% and about

50% of total passengers take upto 30 minute to reach terminal from their initial origins and about 65% of total passengers take up to 30 minute to reach their final destinations.



On this basis, different zones are identified on their socio-economic and travel behavior characters. The zones based upon economy are zones Social I, II and III which will help in planning public transport systems as higher income groups should be encouraged to move on public transport system and other hand the lower income group should be proved with better access to public transport system which actually will help them to reduce the overall monthly expenditure on transport. The other zones which are identified are education zone (i.e. Panjab University, P.G.I.,Punjab Engineering College), Service zone and industrial zone. The different zones have different travel behavior, travel time as well as travel nature. So the movement pattern and zone identification shoul be identified before making any mobility plan as it helps to make cities better as well as efficiently workable by planning such kind of systems which actually works according to the travel behavior of individuals.

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