IQRA NATIONAL UNIVERSITY

Phase-1 Phase 2 Hayatabad, Peshawar, Khyber PakhtunKhwa

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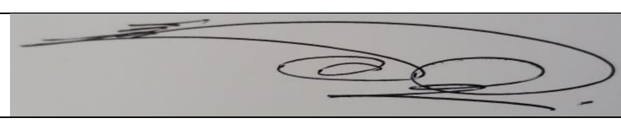
CANDIDATE SIGNATURE	


بسم الله الرحمن الرحيم

Q1: What is planning; Briefly describe the studies carried out in the scope of transportation planning strategies in their modeling with assumptions and limitations. Present your answer in the form of formal technical report?

PLANNING DEFINITION:

The goal of planning is to maximize the health, safety, and economic well-being of all people living in our communities. The goal of planning is to maximize the health, safety, and economic well-being of all people living in our communities. OR

Planning is the act of researching, analyzing, anticipating and influencing change in our society.

INTRODUCTION TO TRANSPORTATION PLANNING:

Transportation planning can be a highly technical process, which often relies on computer models and other sophisticated tools to simulate the complex interactions of transportation system performance. It is a public relationship-oriented process in that transportation planners often interact with a wide range of stakeholders and members of the public.

The transportation planning process lays the foundation for the decisions to improve the transportation system.

TRANSPORTATION PLANNING:

Transport planning is defined as planning required in the operation, provision and management of facilities and services for the modes of transport to achieve safer, faster, comfortable, convenient, economical and environment-friendly movement of people and goods.

TRANSPORTATION PLANNING STRATEGIES:

Transportation planning is a process that develops information to help make decisions on the future development and management of transportation systems, especially in urban areas. Typically transportation planning involves a forecast of travel patterns 15 to 25 years into the future with an aim to develop a future transportation system that will work effectively at that time.

Transportation can have significant effects on mobility, economic development, environmental quality, government finance and the quality of life. Significant transportation projects require a long lead time for their design and construction. Furthermore they can have major effects on future land use patterns which need to be assessed.

TRANSPORTATION PLANNING STRATEGIES MODELING:

Transportation planning uses the term 'models' extensively. The term models are used to refer to a series of mathematical equations that are used to represent how people travel. Models require a series of assumptions in order to work and are limited by the data available to make forecasts. For example, travel forecasting models usually exclude pedestrian and bicycle trips. Plans that include bicycle or pedestrian system improvements will not show any impact in the conventional modeling procedure since the models typically ignore these types of trips. It is not correct to conclude that pedestrian or bicycle improvements are ineffective.

POPULATION, ECONOMIC AND LAND USE FORECASTS:

Before forecasts are made of travel, it is necessary to determine how the community will look in the future. Transportation is directly linked to land use. Trips are assumed to follow future land use patterns. If land use is changed, there should be a change in travel.

1. POPULATION FORECASTS:

Future population forecasts are based on assumptions about birth rates, death rates and the rate of migration into or out of the study area. The forecasting process uses current information about the ages of the population and forecasts ahead by the calculation of the number of births, deaths and migrants added to the region in each year of the future. These rates are assumed to remain constant or to change in a specified way. These rates have changed substantially over the past 30 years so often several forecasts are made under different assumptions. A valuable output of this step is a forecast that indicates the age structure of the future population.

1. ECONOMIC FORECASTS:

Economic forecasts have to be done in conjunction with the population forecasts since the two are highly interrelated. Employment often grows because the population grows but migration rates into and out of the community depends upon the growth of the economy. Assumptions have to be made of the ability of a region to generate new basic employment and to hold onto its existing basic employment. These are based on past trends and judgments of future local economic conditions. Total employment is found by applying an economic multiplier to basic employment.

2. **<u>LAND USE:</u>**

Land use plans can be developed to continue existing trends or to change trends if is felt that current trends are undesirable. Land use planning can be done either through a judgment technique or through a modeling process. A modeling approach to land use planning can be used to determine the impact of transportation facilities on growth patterns. The locations of basic employment are set by hand and the model locates other employment and residential land use in relationship to the basic employment. This approach is relatively new and has only been used in limited locations.

Assumptions and limitations:

Some of the assumptions used to do land use plans are the following:

1. **No feedback with transportation plans:**

Land use plans are developed before transportation plans and assumed to not change as a result of the transportation improvements.

2. **Current development is fixed:**

Land used plans generally only deal with new growth and assume that current development will be unchanged. Effects of redevelopment programs, changing use of neighborhoods and so forth are normally not considered.

3. **Mixed use benefits are not considered:**

Land use patterns that facilitate walking and non-automobile travel are not easily dealt with in the model.

‘FOUR STEP’ MODELING:

The ‘four step’ model is a commonly used type of strategic transport model. The model involves the following steps:

1. **TRIP GENERATION:**

It estimates the number of trips that originate in particular spatial zones through land use, population and economic forecasts.

Assumptions and limitations: Some of the assumptions in trip generation are as follows:

1. **Independent decisions:**

Travel behavior is a complex process where often decisions of one household member are dependent on others in the household. For example, child care needs may affect how and when people travel to other places. This interdependency for trip making is not considered.

2. Limited trip purposes: With no more than four to eight trip purposes, a simplified trip pattern results. All shopping trips are treated the same weather shopping for groceries or lumber. Home based "other" trip purposes cover a wide variety of purposes - medical, visit friends, banking, etc. which are influenced by a wider variety of factors than those used in the modeling process.

3. Combinations of trips are ignored: Travelers may often combine a variety of purposes into a sequence of trips as the run errands and link together activities. This is called trip chaining and is a complex process. The modeling process treats such trip combinations in a very limited way.

4. Feedback, cause and effect problems: Trip generation models sometimes calculate trips as a function of factors that in turn could depend on how many trips there are.

2. TRIP DISTRIBUTION:

Draws links between trip origins and destinations, forming an origin-destination (OD) pattern or matrix of trips. This pattern is based on the logic that a person is most likely to preference travel to nearby areas of high activity (e.g. services and employment opportunities) rather than low activity.

Assumptions and limitations: Some of the assumptions in trip distribution are as follows:

1. Constant trip times: In order for the model to be used as a forecasting tool it must be assumed that the average lengths of trips that occur now will remain constant in the future. Since trip lengths are measured by travel time this means that improvements in the transportation system that reduce travel times are assumed to be balanced by a further separation of origins and destinations. Thus faster speeds on the network will result in longer trips, measured by distance.

2. Use of automobile travel times to represent 'distance': The gravity model requires a measurement of the distance between zones. This is almost always based on automobile travel times rather than transit travel times and leads to a wider distribution of trips (they are spread out over a wider radius of places) than if transit times were used. This process limits the ability to represent travel patterns of households that locate on a transit route and travel to points along that route.

3. Limited effect of social-economic-cultural factors: The gravity model distributes trips only on the basis of size of the trip ends (trip productions, trip attractions) and travel times between the trip ends.

4. Feedback problems: Travel times are needed to calculate trip distribution; however travel times depend upon the level of congestion on streets in the network. The level of congestion is not known during the trip distribution step since that is found in a later calculation.

3. <u>MODAL SPLIT:</u>

It predicts the travel modes used to complete origin-destination trips, based on trip purpose. The characteristics of the trip maker, the trip itself and travel mode are considered in this step.

Assumptions: Some of the assumptions in mode choice analysis are as follows:

1. Choice only affected by time and cost characteristics: An important thing to understand about mode choice analysis is that shifts mode usage would only be predicted to occur only if there are changes in the characteristics of the modes, i.e. there must be a change in the in-vehicle time, out-of-vehicle time or cost of the automobile or transit for the model to predict changes in demand.

2. Omitted factors: Factors which are not included in the model such as crime, safety, security, etc. concerns have no effect. They are assumed to be included as a result of the calibration process. However, if an alternative has different characteristics for some of the omitted factors, no change will be predicted by the model. Such effects need to be done by hand and require considerable skill and assumptions.

3. Access times are simplified: No consideration is given to the ease of walking in a community and the characteristics of a waiting facility in the choice process. Strategies to improve local access to transit or the quality of a place to wait do not have an effect on the models.

4. Time and cost can be added: The disutility calculations assume that a traveler considers time and cost separately and mentally adds them up to determine their best choice for a trip.

5. Constant weights: The importance of time cost and convenience is assumed to remain constant for a given trip purpose. Trip purpose categories are very broad (i.e. 'shop', 'other'). Differences within these categories of the importance of time and cost are ignored.

4. TRIP ASSIGNMENT:

It allocates trips by purpose, mode, origin and destination to a certain transport route and simulates these trips on the network and determines the level of service. This provides an indication of the likely distribution of travel and traffic across the network.

Assumptions and limitations:

Some of the assumptions in traffic assignment are as follows:

1. Delay occurs on links: Most traffic assignment procedures assume that delay occurs on the links rather than at intersections. This is a good assumption for through roads and freeways but not for highways with extensive signalized intersections. Intersections involve highly complex movements and signal systems.

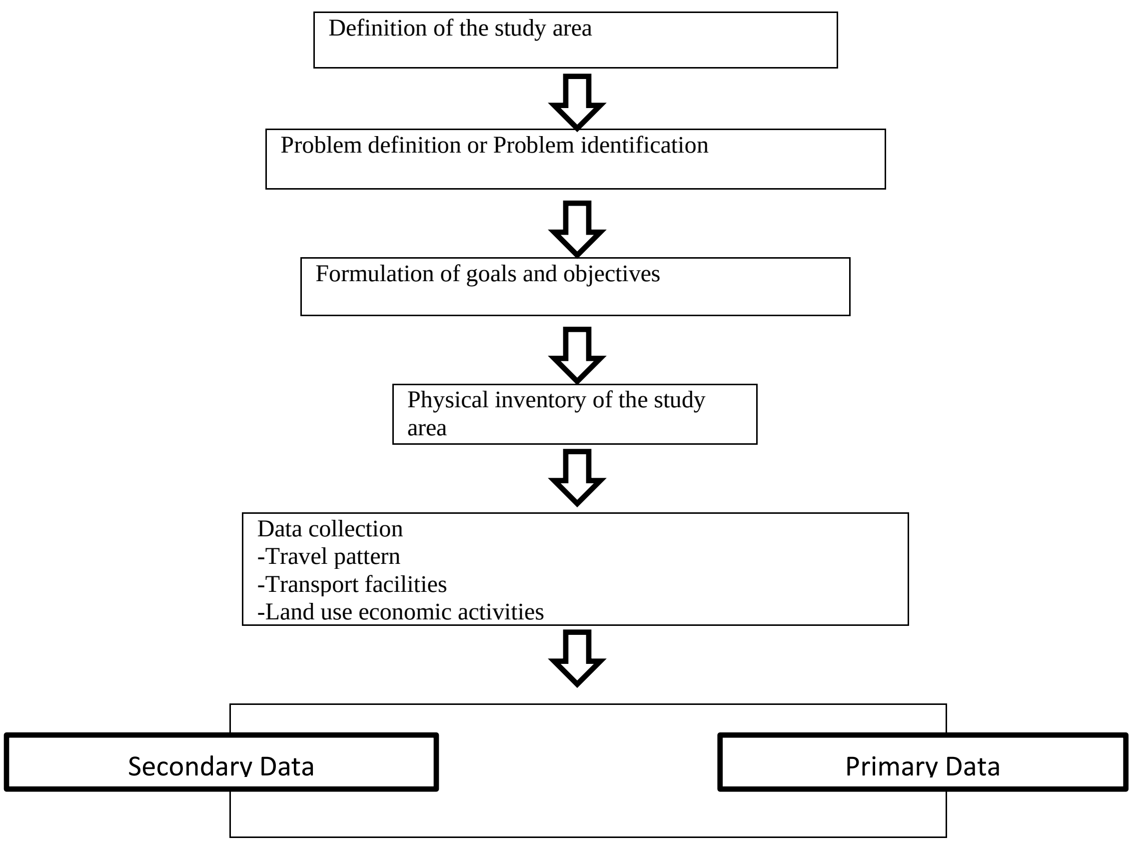
2. Travel only occurs on the network: It is assumed that all trips begin and end at a single point in a zone (the centroids) and occurs only on the links included in the network. Not all roads streets are included in the network nor all possible trip beginning and end points included. The zone/network system is a simplification of reality.

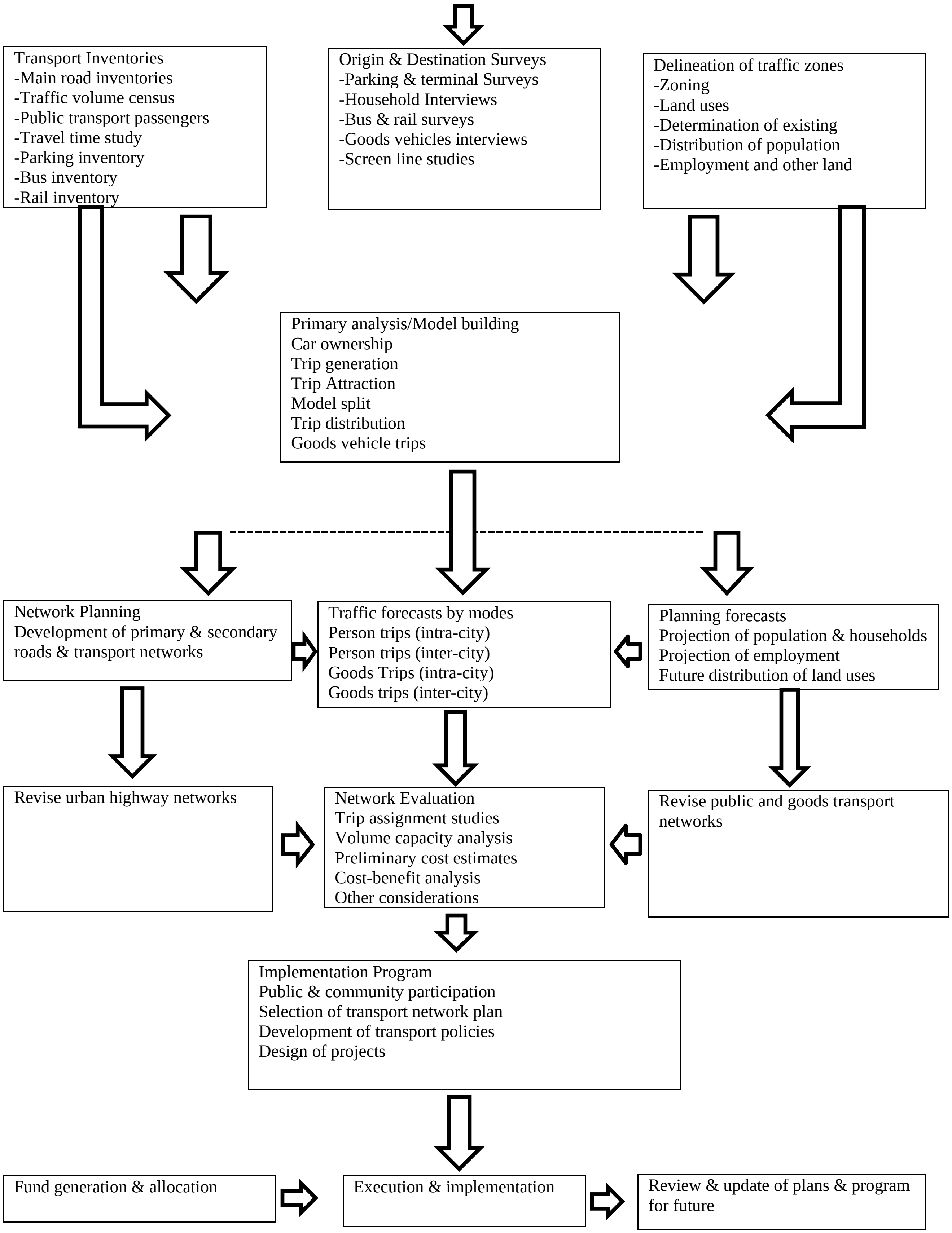
3. Capacities are simplified: To determine the capacity of roadways and transit systems requires a complex process of calculations that consider many factors. Capacity is found based only on the number of lanes of a roadway and its type (freeway or arterial).

4. Time of day variations: Traffic varies considerably throughout the day and during the week. The travel demand forecasts are made on a daily basis for a typical weekday and then converted to peak hour conditions.

5. Emphasis on peak hour travel: As described above, forecasts are done for the peak hour. A forecast for the peak hour of the day does not provide any information on what is happening the other 23 hours of the day. The duration of congestion beyond the peak hour is not determined. In addition travel forecasts are made for a 'average weekday'. Variations in travel by time of year or day of the week are usually not considered.

Transportation Process:




Transport Inventories
-Main road inventories
-Traffic volume census
-Public transport passengers
-Travel time study
-Parking inventory
-Bus inventory
-Rail inventory
Origin & Destination Surveys
-Parking & terminal Surveys
-Household Interviews
-Bus & rail surveys
-Goods vehicles interviews
-Screen line studies
Delineation of traffic zones
-Zoning
-Land uses
-Determination of existing
-Distribution of population
-Employment and other land
Primary analysis/Model building
Car ownership
Trip generation
Trip Attraction
Model split
Trip distribution
Goods vehicle trips
Network Planning
Development of primary & secondary roads & transport networks
Traffic forecasts by modes
Person trips (intra-city)
Person trips (inter-city)
Goods Trips (intra-city)
Goods trips (inter-city)
Planning forecasts
Projection of population & households
Projection of employment
Future distribution of land uses
Revise urban highway networks
Network Evaluation
Trip assignment studies
Volume capacity analysis
Preliminary cost estimates
Cost-benefit analysis
Other considerations
Revise public and goods transport networks
Implementation Program
Public & community participation
Selection of transport network plan
Development of transport policies
Design of projects
Fund generation & allocation
Execution & implementation
Review & update of plans & program for future

OBJECTIVES & GOALS OF TRANSPORTATION PLANNING:

It is important to define the aims and objectives for which a transportation planning exercise is required to be carried out. The definition with respect to aims, objectives and scope becomes an integral part of the planning process, though this ignored the past most of the time. Before undertaking any transportation planning study, it is extremely important and useful to spell out specific objectives along with the scope of the study, otherwise the results can turn out to be inconsistent and unsatisfactory.

For example, most of the transportation studies carried out in the past in Pakistan were directed towards the preparation of traffic and transportation plans with the primary objectives of developing major expressways, new roads, traffic interchanges, flyovers, parking facilities, etc. to encourage the movement of vehicular traffic. The transportation studies related to planning of roads system for Karachi metropolitan region, traffic and transportation studies are the primary examples of these studies.

The other purposes of the transportation studies is to provide an efficient and safe access that satisfy human needs and to ensure the need for mobility for all section of people in the society.

The other goals and objectives of transportation studies are:

1. Community and Environmental Quality Goal
2. Sustainability - Affordability Goal
3. Business Goals
4. Policies
5. Investment

Q2.What activities are exercised in planning for a four step conventional transportation modeling, discuss in detail with reference to different zonal productions and attraction attributes?

INTRODUCTION:

In most of the countries transport planning is treated as a part of general economic planning and no special attention has been paid, but now not only developed countries but developing countries have also realized the need for separate planning for the transportation, not only for the existing system but for the future development also.

The study of development and planning is basically a study of interaction between man, land and activity in the form of spatial organization of economy. Nowadays every country of the world is having its own national transport system, not in isolation but as a part of international system of transportation. Transport now has, as ever, become an integral and essential part of the economy and requires a planned growth, which should be ‘sustainable’. The primary aim of transport planning is the identification and evaluation of the future transport needs.

The four steps recognized conventional transportation modeling are trip generation, trip distribution, traffic assignment and model split.

1. TRIP GENERATION:

Trip generation is the first step in the conventional four-step transportation planning process, widely used for forecasting travel demands. Trips are made for a variety of purposes and for various land uses. It predicts the number of trips originating in or destined for a particular traffic analysis zone. For convenience, trips are often split into two groups:

(i) Home-based trips:

Such trips have one trip end at the home of the person making the trip, which may be either the origin or destination of the given trip.

(ii) Non-home-based trips:

These have neither origin nor destination trip-end at the home of the person making the trip.

Trip generation uses trip rates that are averages for large segment of the study area. Trip productions are based on household characteristics such as the number of people in the household and the number of vehicles available. For example, a household with four people and two vehicles may be assumed to produce 3.00 work trips per day. Trips per household are then expanded to trips per zone. Trip attractions are typically based on the level of employment in a zone. For example a zone could be assumed to attract 1.32 home based work trips for every person employed in that zone. Trip generation is used to calculate person trips.

This initial part of the transport model expresses trip-making relationships in a mathematical form so that ultimately we can calculate the total number of trips-ends originating from the defined survey zones.

Multiple regression technique is often used to calibrate a trip-generation model incorporating the above household variables. This model takes the following general form:

$Y = a + b_1 x_1 + b_2 x_2 + \ldots + b_n x_n$

Where Y = number of trips (by mode and purpose) generated in a given zone

a = constant term

$b_1 \ldots b_n$ = regression coefficients relating to independent variables (e.g. household income, car-owner- ship, house-hold structure, etc.)

New estimates of the independent variables are made and inserted into the equation in order to estimate future levels of trips generation. Multiple regression analysis, therefore, provides a suitable method for estimating future trip levels. Its main disadvantage, however, is that the original regression estimates have been established at a given point in time and are expected to remain constant over the period for which the forecast is required.

Consequently, a more recent approach to trip generation has been to use a technique known as ‘category analyses. The trip-generation stage of the planning process estimates the total number of trips originating in the survey area at one or more future dates.

For example, a household with four people and two vehicles may be assumed to produce 3.00 work trips per day. Trips per household are then expanded to trips per zone. Trip attractions are typically based on the level of employment in a zone. For example a zone could be assumed to attract 1.32 home based work trips for every person employed in that zone. Trip generation is used to calculate person trips.

Zone	**Existing**		**After 10 Year**	
	Population (X1)	**Average Zonal Income(X2)**	**Population (X1)**	**Average Zonal Income(X2)**
Zone 1	116939	1931	116939	1931
Zone 2	473490	2133	473490	2133
Zone 3	376925	1980	376925	1980
Zone 4	451756	4898	451756	4898
Zone 5	484981	4920	484981	4920
Zone 6	284051	3753	284051	3753
Zone 7	467491	3202	467491	3202
Zone 8	525673	3164	525673	3164
Zone 9	325121	5280	325121	5280
Zone 10	193302	4735	193302	4735

Zone	**Existing**		**After 10 Year**	
	Employment (X1)	**Land Price(X2)**	**Employment (X1)**	**Land Price(X2)**
Zone 1	116939	1931	116939	1931
Zone 2	473490	2133	473490	2133
Zone 3	376925	1980	376925	1980
Zone 4	451756	4898	451756	4898
Zone 5	484981	4920	484981	4920
Zone 6	284051	3753	284051	3753
Zone 7	467491	3202	467491	3202
Zone 8	525673	3164	525673	3164
Zone 9	325121	5280	325121	5280
Zone 10	193302	4735	193302	4735

2. TRIP DISTRIBUTION:

Trip distribution is the second component in. This step matches trip makers' origins and destinations to develop a "trip table" a matrix that displays the number of trips going from each origin to each destination.

This is the next stage in the traditional 4-step transportation planning (or forecasting) model. it involves on analysis of trips between zones. Lane (1971) states the function of this stage of the model:

It is the function of trip distribution to calculate the number of trips between one zone and another, given the previously determined numbers of trip ends in each zone together with further information on the transport facilities available between these zones.

For example, given that in zone I, g_i trip ends are generated and that in zone j, a_i trip ends are attracted, it is the purpose of the trip distribution model to determine the number of trips (t_{ij}) which would go from zone i to zone j. That is, the trip distribution model calculates the proportion of trip ends generated in zone i which would travel between i and j and so take up a certain proportion of the available attractions in zone j.

Overall, the distribution stage of the transportation model has received considerable attention and has been the main source of research over the last quarter of a century. The earliest attempts to produce a future trip distribution matrix used simple growth factor methods, taking the following general form:

$T_{ij} = t_{jj} \times E$

Where T_{ij} = future flow from zone i to zone j

T_{jj} = base year flow from zone i to zone j

E = agreed expansion factor

The value of the expansion factor can take various forms. For example, Bevis (1956) put forward the idea of a crude expansion factor of the following format:

$E=1/2\ (T / t_i \times T_j / t_j)$

Where T_{ij}= future origin zone

T_i = base year origins zone i,

T_j = future destinations zone j,

T_j = base year destinations zone j.

This simple model was further refined, but growth-factor techniques are now rarely used. The method is a crude one and has been superseded largely because it does not attempt to measure any future resistance to travel between zones. For this reason, synthetic models tend to be widely used to model trip distribution. The trip-distribution stage of the transport model has received much attention and has been the source of many new developments.

O-D	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	∑10
Zone 1											
Zone 2											
Zone 3											
Zone 4											
Zone 5											
Zone 6											
Zone 7											
Zone 8											
Zone 9											
Zone 10											

3. MODAL SPLIT:

This term is used by transport planners to describe the phase where the choice of travel mode is incorporated into the model. The positioning of this stage is neither fixed nor singularly definable since elements of model split are part of the other stages. Its position within the transportation model differs between studies. It is either used at the trip generation stage by stratifying the total trips or at the assignment stage of the model. The main purpose of the model-split stage is to determine the trip shares of public, as against private, transport.

FUTURE LAND USE AND TRAVEL DEMAND FORECASTING:

The forecasting of future land use inputs is a precarious task, for two important reasons. Firstly, transport planners have to rely on the judgment of to the types of planner for most of their land use forecasts. This information is vitally important since it has a profound effect upon travel forecasts. Secondly, long-term forecasting is beset with many statistical problems.

Since transportation planners are usually working at least 10, and sometimes 25 years ahead, their estimates are inevitably open to much criticism. Nevertheless, estimates of future travel demands have to be made using the best methods, which are available. Some of these forecasting problems are amplified below in the listing of the main land use inputs necessary for travel forecasts to be made.

UTILITY MATRIX

O-D	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10
Zone 1	-00	-00	-00	-00	-00	-00	-00	-00	-00	-00
Zone 2	-00	-00	-00	-00	-00	-00	-00	-00	-00	-00
Zone 3	-00	-00	-00	-00	-00	-00	-00	-00	-00	-00
Zone 4	-00	-00	-00	-00	-00	-00	-00	-00	-00	-00
Zone 5	-00	-00	-00	-00	-00	-00	-00	-00	-00	-00
Zone 6	-00	-00	-00	-00	-00	-00	-00	-00	-00	-00
Zone 7	-00	-00	-00	-00	-00	-00	-00	-00	-00	-00
Zone 8	-00	-00	-00	-00	-00	-00	-00	-00	-00	-00
Zone 9	-00	-00	-00	-00	-00	-00	-00	-00	-00	-00
Zone 10	-00	-00	-00	-00	-00	-00	-00	-00	-00	-00

4. TRIP ASSIGNMENT:

Trip assignment, traffic assignment or route choice concerns the selection of routes (alternative called paths) between origins and destinations in transportation networks. It is the fourth step in the conventional transportation planning model. Mode choice analysis tells which travelers will use which mode. To determine facility needs and costs and benefits, we need to know the number of travelers on each route and link of the network. Its aim being to stimulate route choice through a defined transport network, Traffic assignment may be considered in two parts.

First, it is necessary to define the transport network and determine criteria for route choice through the network.

Second, using the inter-zonal trip matrix as the input data, trips are assigned to this network.

When future trip levels are assigned it is possible to assess deficiencies in the existing transport network and so determine a list of construction priorities. Network description refers to the process where the highway network is broken down into links and nodes. For each link, data is required on its length, road type, and vehicle travel time and traffic capacity. When coding the road network, links are usually identified by the node numbers at each of its ends. In addition to such route-intersection nodes, zone-centroid nodes are also defined. In the assignment process, all traffic originating in a particular traffic zone is assumed to be loaded on to the network at this latter type of node.

The early transportation studies used manual assignment techniques, but with the universal use of computer analysis, the transport network can be specified to the computer in a most detailed manner. Special data collection surveys (especially of journey times) are usually needed to provide this network specification information.

For deriving minimum route paths through the network, it is normally assumed that travelers choose the path, which minimizes travel time. This applies for both private and public transport journeys. Travel time has been used in most transportation studies although it is usually used as an approximation for minimizing the travel costs of a journey.

A more recent and more realistic assignment procedure is that of capacity restraint. This may be used, with or without diversion curves, for assignments to road and public transport networks. After the initial assignment to the given network, new travel times are calculated for each link. New minimum path trees are then calculated and the assignment procedure reiterated. Further reiterations may follow until most or all of the future traffic volume has been assigned to the network.

This type of procedure has tended to supersede other assignment techniques and has been used in most of the second-generation transportation studies. The assignment stage of the transportation model therefore is the process by which trips are assigned or loaded on to the road network. At the end of this stage, construction priorities can be established and alternative proposals put forward.

Link	Bus			Car			Rickshaw		
	Flow	Occupancy	Number	Flow	Occupancy	Number	Flow	Occupancy	Number

CONCLUSION:

Transportation models are being called upon to provide forecasts for a complex set of problems that in some cases can go beyond their capabilities and original purpose. Travel demand management, employer based trip reduction programs, pedestrian and bicycle programs and land use polices may not be handled well in the process. Transportation travel forecasting models use packaged computer programs which have limitations on how easily they can be changed. In some cases the models can be modified to accommodate additional factors or procedures while in other cases major modifications are needed or new software is required. All models are based on data about travel patterns and behavior. If this data is out-of-date, incomplete or inaccurate, the results will be poor no matter how good the models are. One of the most effective ways of improving model accuracy and value is to have a good basis of recent data to use to calibrate the models and to provide for checks of their accuracy. Models need to demonstrate that they provide an accurate picture of current travel before they should be used to forecast future travel. Better data, improved representation of bicycle and pedestrian travel, better auto occupancy models, better time of day factors, use more trip purposes, better representation of access, incorporate costs into trip distribution, add land use feedback, add intersection delays- are some important points which should be considered and included in the traditional transport modeling system to make it much more convenient and realistic.

Q3: The settle area of KPK is being divided into different districts. Few of them are as 1.Peshawar, 2.Charsada, 3.Mardan, 4.Nowshera, 5.Swabi, 6.Abbotabad, 7.Kohat. Consider each district an independent zone having attributes of area as given in table below. Calculate the trip generation and attraction of each zone. Comments your answer.

		Area (Hectors)						
Land use category		**Zone 1**	**Zone 2**	**Zone 3**	**Zone 4**	**Zone 5**	**Zone 6**	**Zone 7**
Residential		7740	24900	17064	40204	29317	576416	53445
	Retail	6972	5688	26220	6172	126091	15270	1290
Commercial	**Wholesale**	14940	10744	20976	7715	90065	7635	1935
	Services	5976	2528	1748	6172	162117	10180	1720
Manufacturing		1290	4980	1264	1748	4629	36026	12725
Transportation		1935	8964	5688	5244	4629	90065	10180
Public Buildings		2580	9960	4424	6992	3086	252182	30540
Public Open Space		3010	22908	15800	71668	92580	468338	114525

ZONE 1

Land Use Category			Area (ha)	Area (sft)	Trips per 1000sft per day from table 11-2	Trips per 1000 sft per day
Residential			7740	833125860	3.92	3265853371
	Retail		6972	750459108	9.23	6926737567
Commercial	Wholesale		14940	1608126660	4.81	7735089235
	service		5976	643250664	5	3216253320
Manufacturing			1290	138854310	3	416562930
Transportation			1935	208281465	4	833125860
Public Buildings			2580	277708620	5	1388543100
Public Open Space			3010	323993390	2	647986780

ZONE 2

Land Use Category			Area (ha)	Area (sft)	Trips per 1000sft per day from table 11-2	Trips per 1000 sft per day
Residential			24900	2680211100	3.92	10506427512
	Retail		5688	612250632	9.23	5651073333
Commercial	Wholesale		10744	1156473416	4.81	5562637131
	service		2528	272111392	5	1360556960
Manufacturing			4980	536042220	3	1608126660
Transportation			8964	964875996	4	3859503984
Public Buildings			9960	1072084440	5	5360422200
Public Open Space			22908	2465794212	2	4931588424

ZONE 3

Land Use Category			Area (ha)	Area (sft)	Trips per 1000sft per day from table 11-2	Trips per 1000 sft per day
Residential			17064	1836751896	3.92	7200067432
	Retail		26220	2822294580	9.23	26049778973
Commercial	Wholesale		20976	2257835664	4.81	10860189544
	service		1748	188152972	5	940764860
Manufacturing			1264	136055696	3	408167088
Transportation			5688	612250632	4	2449002528
Public Buildings			4424	476194936	5	2380974680
Public Open Space			15800	1700696200	2	3401392400

ZONE 4

Land Use Category			Area (ha)	Area (sft)	Trips per 1000sft per day from table 11-2	Trips per 1000 sft per day
Residential			40204	4327518356	3.92	16963871956
	Retail		6172	664347908	9.23	6131931191
Commercial	Wholesale		7715	830434885	4.81	3994391797
	service		6172	664347908	5	3321739540
Manufacturing			1748	188152972	3	564458916
Transportation			5244	564458916	4	2257835664
Public Buildings			6992	752611888	5	3763059440
Public Open Space			71668	7714271852	2	15428543704

ZONE 5

Land Use Category			Area (ha)	Area (sft)	Trips per 1000sft per day from table 11-2	Trips per 1000 sft per day
Residential			29317	3155652563	3.92	12370158047
	Retail		126091	13572309149	9.23	125272413445
Commercial	Wholesale		90065	9694506535	4.81	46630576433
	service		162117	17450111763	5	87250558815
Manufacturing			4629	498260931	3	1494782793
Transportation			4629	498260931	4	1993043724
Public Buildings			3086	332173954	5	1660869770
Public Open Space			92580	9965218620	2	19930437240

ZONE 6

Land Use Category			Area (ha)	Area (sft)	Trips per 1000sft per day from table 11-2	Trips per 1000 sft per day
Residential			576416	62044841824	3.92	243215779950
	Retail		15270	1643647530	9.23	15170866702
Commercial	Wholesale		7635	821823765	4.81	3952972310
	service		10180	1095765020	5	5478825100
Manufacturing			36026	3877802614	3	11633407842
Transportation			90065	9694506535	4	38778026140
Public Buildings			252182	27144618298	5	135723091490
Public Open Space			468338	50411433982	2	100822867964

ZONE 7

Land Use Category			Area (ha)	Area (sft)	Trips per 1000sft per day from table 11-2	Trips per 1000 sft per day
Residential			53445	5752766355	3.92	22550844112
	Retail		1290	138854310	9.23	1281625281
Commercial	Wholesale		1935	208281465	4.81	1001833847
	service		1720	185139080	5	925695400
Manufacturing			12725	1369706275	3	4109118825
Transportation			10180	1095765020	4	4383060080
Public Buildings			30540	3287295060	5	16436475300
Public Open Space			114525	12327356475	2	24654712950

Comments:

The above are given trips per 1000 square feet per day for each zone. Seven different independent zones/districts are mentioned, with area of each zone given in hectare. The area is converted to square feet and then according to Table 11-2 given below, Sample Trip Generation Rates, Trips/1000sft/day is taken for the attributes mentioned and those which are not mentioned, data has been assumed i.e. trips per 1000sft per day. The population will be taken from 2017 census for each district. The rest of the data may be collected from the tables given below:

TABLE 11-3 Average Vehicle Trip Rates and Other Characteristics of Generations

Generator[a]	Vehicle-Trips[b] to and from per Day per: Dwelling Unit	Acre	Percent Trips in Hour Shown: A.M. Peak	P.M. Peak	Peak Hour of Generation	Typical Auto Occupancy	Typical Percent Transit of Total Person-Trips[c]
Residential							
Single family							
1 DU/acre	9.3	9.3	8.0	10.8	10.8	1.62	3.2
2 DU/acre	9.3	18.6	8.0	10.8	10.8	1.62	3.2
3 DU/acre	10.2	30.6	8.0	10.8	10.8	1.67	3.2
4 DU/acre	10.2	40.8	8.0	10.8	10.8	1.67	3.2
5 DU/acre	9.1	45.5	8.0	10.8	10.8	1.62	3.2
Medium density (duplex, townhouses, etc.)							
5 DU/acre	7.0	35.0	8.0	10.8	10.8	1.57	5.6
10 DU/acre	7.0	70.0	8.0	10.8	10.8	1.57	5.6
15 DU/acre	7.0	105.0	8.0	10.8	10.8	1.57	5.6
Apartments							
15 DU/acre	6.0	90.0	7.9	10.8	10.8	1.56	12.4
25 DU/acre	6.0	150.0	7.9	10.8	10.8	1.56	12.4
35 DU/acre	6.0	210.0	7.9	10.8	10.8	1.56	12.4
50 DU/acre	6.0	300.0	7.9	10.8	10.8	1.56	12.4
60 DU/acre	6.0	360.0	7.9	10.8	10.8	1.56	12.4
Mobile home park							
5 DU/acre	5.5	27.5	8.3	10.8	12.5	1.54	1.0
10 DU/acre	5.5	55.0	8.3	10.8	12.5	1.54	1.0
15 DU/acre	5.5	82.5	8.3	10.8	12.5	1.54	1.0
Retirement community							
10 DU/acre	3.5	35.0	12.1	12.1	12.1	1.48	6.0
15 DU/acre	3.5	52.5	12.1	12.1	12.1	1.48	6.0
20 DU/acre	3.5	70.0	12.1	12.1	12.1	1.48	6.0
Condominiums							
10 DU/acre	5.9	59.0	7.1	7.1	7.1	1.56	9.0
20 DU/acre	5.9	118.0	7.1	7.1	7.1	1.56	9.0
30 DU/acre	5.9	177.0	7.1	7.1	7.1	1.56	9.0
Planned unit development							
5 DU/acre	7.9	39.5	10.1	10.1	10.1	1.58	7.1
15 DU/acre	7.9	118.5	10.1	10.1	10.1	1.58	7.1
25 DU/acre	7.9	197.5	10.1	10.1	10.1	1.58	7.1

(continued)

TABLE 11-3 *(continued)*

Generator[a]	Vehicle-Trips[b] to and from per Day per: Dwelling Unit		Acre	Percent Trips in Hour Shown: A.M. Peak	P.M. Peak	Peak Hour of Generation	Typical Auto Occupancy	Typical Percent Transit of Total Person-Trips[c]
	See individual generator below							
Miscellaneous								
Service station	*Station* 748	*Pump* 133		1.5	3.0	4.0	1.55	
Race track	*Seat* 0.61	*Attendee* 1.08		—	—	—	2.05	—
Pro baseball	0.16	1.18		—	—	—	2.05	—
Military base	*Military personnel* 2.2	*Civilian employees* 7.1	*Total employees* 1.8	—	—	—	1.42	—
	1000 ft² GFA	Employee	Acre					
Retail								
Freestanding								
Supermarket	135.3	—	1000	0	8.7	12.6	1.64	1
Discount store	50.2	57.2	—	0	5.1	9.7	1.64	1
Discount store with supermarket	81.2	30.3	—	0	6.9	11.1	1.64	1
Department store	36.1	32.8	900	—	—	—	1.64	2
Auto supply	88.8	—	—	—	—	—	1.64	1
New car dealer	44.3	—	—	—	—	—	1.64	1
Convenience								
24 hr	577.0	—	—	—	—	—	1.64	1
15–16 hr	322.0	—	—	—	—	—	1.64	1
Shopping center regional								
(over 1 million ft²)	33.5	30.9	580	1.9	9.7	11.5	1.64	3
½–1 million ft²	34.7	20.4	370	2.8	9.6	—	1.64	3
Community								
100,000–500,000 ft²	45.9	20.6	330	—	11.2	11.3	1.64	3
Neighborhood								
under 100,000 ft	97.0	—	—	3.3	11.5	12.4	1.64	3
Central area								
(high density)	40.0	—	900	—	—	—	1.64	12

TABLE 11-3 *(continued)*

	Vehicle-Trips[b] to and from per Day per			Percent Trips in Hour Shown				
	1000 ft² GFA	Employee	Acre	A.M. Peak	P.M. Peak	Peak Hour of Generation	Typical Auto Occupancy	Typical Percent Transit of Total Person-Trips[c]
Industrial/Manufacturing								
Freestanding general manufacturing	4.2	2.3	40.5	18.4	19.3	32.2	1.33	5
Warehouse	5.3	4.4	67.5	12.7	32.2	—	1.25	5
Research/development	5.1	2.4	60.8	21.1	20.4	—	1.33	5
Industrial park	8.8	3.9	71.9	13.2	14.7	—	1.33	5
General light industrial	5.5	3.2	52.4	21.1	20.4	21.2	1.33	5
All industry average	5.5	3.0	59.9	15.8	19.4	—	1.40	5
Offices								
General	11.7	3.5	145	20.7	19.1	—	1.35	5
Medical	63.5	25.0	426	—	—	8.5	1.45	5
Governmental	48.3	12.0	66	8.5	16.0	—	1.35	5
Engineering	23.0	3.5	282	16.9	14.6	—	1.35	5
Civic center	25.0	6.1	33	9.0	11.4	—	1.35	5
Office park	21.0	3.3	277	16.9	14.6	—	1.35	5
Research center	9.3	3.1	37	16.0	18.5	20.2	1.35	5
Restaurants								
High-quality restaurant	56.3	—	200	1.8	6.0	12.5	1.93	3
Other sitdown	198.5	—	932	29.0	6.4	—	1.93	3
Fast food	533.0	—	1825	16.0	5.7	—	1.93	1
Banks	388	75	—	—	—	—	1.45	—
Parks and recreation								
Marina	—	259.0	18.5	—	—	—	2.05	—
Golf course	—	34.2	7.4	—	—	—	2.05	—
Bowling	—	—	296.3	—	—	—	2.05	—
Participant sports	—	—	26.5	—	—	—	2.05	—
City park	—	—	60.0	—	—	—	2.05	—
County park	—	26.5	5.1	—	—	—	2.05	—
State park	—	61.1	0.6	—	—	—	2.05	—
Wilderness park	—	—	0.7	—	—	—	2.05	—

[a]Most of the generators are located outside the CBD. DU stands for dwelling unit.

[b]The vehicle trip rates are actually volumes into and out of the site. As such, they may include some trips that would be passing the site. Their percentage is not established.

THE END