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

Ans: INTRODUCTION TO PLANNING:

Planning is a fundamental characteristic of all human beings and can be defined as the activity or process that examines the potential of future actions to guide a situation or a system toward a desired direction, for example, toward the attainment of positive goals, the avoidance of problems, or both.

The most important aspect of planning is the fact that it is oriented toward the *future:* A planning activity occurs during one time period but is concerned with actions to be taken at various times in the future. However, although planning may increase the likelihood that a recommended action will actually take place, it does not guarantee that the planned action will inevitably be implemented exactly as conceived and on schedule. As a matter of practicality, planning is not a search for ultimate answers but only a means to specific ends based on the proposition that better conditions would result from premeditative as opposed to impulsive actions. Planning occurs at many levels, from day-to-day decisions made by individuals and families, to complex decisions made by businesses and governments.

TRANSPORTATION PLANNING:

The ultimate purpose of transportation is to provide efficient access to various activities that satisfy human needs. Therefore Transportation Planning is defined as the 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.

Transport planning usually addresses specific problems or broad transport concerns at a local level and has been traditionally a preoccupation of lower-tier governments (state, county, municipal/local government). Because of this fact, transportation planning is most developed in the urban sphere, and it is there where most experience has been gathered. Moreover, Transportation Planning is the combination of art and science; in other words, it requires the skill of creativity as well as that of technicality.

Importance of Transportation Planning:

Transportation Planning plays a monumental role in the development of any area. For centuries, now, the importance of transportation planning has been recognized throughout the world. Transportation Planning aims for:

a) Efficiency:

The purpose of transportation planning is focusing on what's the most efficient movement for people and goods around the world. It focuses on the effective use of transportation systems and the use of technology for the convenience of the masses. Transportation Planning also aims to efficiently use land and to control and manage the resources of the adjacent locality.

b) Quality:

Transportation Planning plays an important role to reduce the negative impacts to the traffic on the surrounding population.

c) Equity

The ultimate end goal of Transportation Planning is to meet travel demand and response for all communities without any discrimination. It helps to achieve equity between all modes of transportation i.e. airway, railway, highway and Waterway.

BASIC ASSUMPTIONS IN TRANSPORTATION PLANNING:

An effective Transportation Planning policy, at its core, reflects the following assumptions:

- Travel pattern is a variable that is:
  a. *Tangible:* Travel patterns are tangible.
  b. *Predictable:* Movement demand can be determined.
  c. *Stable:* Travel patterns are assumed to be stable.
- Movement demands are directly related to the distribution, and intensity of land use, that can be accurately determined for some future date. This intrinsically means that movement demand is a function of land use and land distribution i.e. different land use and distribution will have different movement demand for any time in the future.
- All modes are interrelated:
  There is a fundamental relationship between all modes of transportation.
- The future role of a particular mode of transport cannot be determined without giving proper consideration to all other modes.
- Transportation System Influences development of an area. Additionally, transportation systems serve the surrounding area.
- Planning in transport is a continuous process which requires constant updating, validation and amendment.
- The transportation study is the essence of the overall planning process, and cannot adequately be considered in isolation.

TRANSPORTATION PLANNING AND STUDIES:

In the beginning of 20th century, the planning of highways was based on a single criterion i.e. connectivity. However, the 1930s and 1940s brought on a new dawn for the transportation planning by the recognition that planning highway network extensions should not be based merely on the static criterion of connectivity but also on continuous efforts to anticipate future demands for travel. Initially this was achieved by projecting current traffic measurements into the future using traffic growth factors based on discerned relationships between population and economic growth on one hand and traffic levels on the other.

Significant differences in the patterns of urban travel necessitated the development of more refined techniques such as:

1. Data Collection & Analysis:

Data collection and analysis is the process of gathering and measuring information on variables of interest, such as traffic, travel and socioeconomic impacts etc, in an established systematic fashion and then analyzing the collected data to achieve desired outcomes.

Data collection and analysis is done for both Short & Medium term transportation planning (S&M) as well as Strategic transportation planning.

a. Short & Medium term transportation planning (S&M):

   Short & Medium term transportation planning is utilized for making existing system efficient as well as to achieve short range transportation needs. It has limited scope with local orientation. Such studies aim to increase efficiency of existing road space, to reduce vehicle use in congested area and to improve transit service.

b. Strategic Transportation Planning:

   Strategic Transportation Planning is a very complex activity and is based on long term predictions; which include new facilities, major changes in existing facilities, long range policy actions, future land development policies, adding highway link, and bus transit system.

   Strategic Transportation Planning is very capital intensive improvement where the focus is on travel demand forecasting.

2. Traffic Volume Studies:

To collect data on the number of vehicles / pedestrian that pass a point during a specified time period. It is done to know whether the existing road can accommodate the vehicles that are using the road.

Traffic volume study can be comprehensive counts covering the entire main road system in an area or Counts at specific points. Traffic counts give us information about: Traffic volume and the direction, volume of turning traffic at intersections, hourly, daily, and seasonal variations of traffic and proportion of cars, trucks and buses.

Application of traffic volume data:

Traffic volume data can be utilized in:

Design for road rehabilitation, Study the traffic at intersection, Study of traffic control systems, Forecast/predict traffic volumes, Study of traffic accidents, Analysis of costs - benefits for highway projects

3. Origin And Destination study (O-D):

Origin and destination survey shows the pattern and nature of daily trips made by the residents. The survey is mainly done for transportation planning, particularly the location, design, and programming of new or improved highways, public transport, and parking facilities. Various methods are employed for this survey such as; recording registration numbers, handing postcards to drivers, roadside interviews, tag-on-vehicle surveys and home interview surveys.

Application of O-D data:

Origin and Destination study is used to:

- To determine the traffic flow – if traffic congestion occurs, a short cut must be planned to give a comfortable travel to road users.
- To determine whether the existing road system is adequate or not.
- To determine the suitable/best position of a bridge or new transport terminal to be constructed and
- To Built a transportation models to make sure the transportation will be easier and also make a prediction about the traffic pattern in the future.

4. Speed Studies:

Speed studies are conducted to estimate the distribution of speeds of vehicles in a stream of traffic at particular location. They are carried out by recording the speed of a sample of vehicles at specific location. Speed of the vehicle is observed by using Radar meter and computed from photographs taken at a predetermined time interval. They are valid only for the traffic and environmental conditions that exist at the time of study in that particular locality.

Application of Speed Studies:

Speed Studies are utilized for:

- To establish parameter for traffic operation such as speed zones, speed limits, and passing restriction.
- To evaluate the effectiveness of traffic control devices such as variable message sign at work zone.
- To evaluate/determine the adequacy of highway geometric characteristic.
- To evaluate the effect of speed on highway and
- To determine speed trends.

5. **Travel Time And Delay Studies:**

Speed and delay studies give running speeds, overall speeds, fluctuations in speed and delay between two stations of a road spaced far apart. They also give the information such as amount, location, duration, frequency and causes of the delay in the traffic stream. Various methods to carry out speed and delay survey are: Floating Car method, License Plate record method, By Interview, By Photography and videography.

Application of Travel Time and Delay Data:

The data collected from travel time and delay study can be utilized to:

- Determine the efficiency of a route with respect to its ability to carry traffic.
- Identification of locations with relatively high delay and the causes for that delay.
- Determine the traffic times on specific link for use in trip assignment models.
- Performance of economic studied in the evaluation of traffic operation alternative that reduce travel time.
- To evaluate the change in efficiency and level of service with time.

6. **Parking Studies:**

Parking studies are performed to determine location, use and adequacy of existing parking facilities in the region. Information can also be gathered for planning parking facilities. Normally, studies are concerned with specific problem areas and are made in an effort to improve efficiency and safety.

For cities, an in-depth parking demand study is required which includes the determination of parking usage, parking habits as well as the origin, destination and purpose of trip of drivers parking in the area. The survey is carried out in the form of questionnaire cards or direct interviews.

Parking usage surveys are useful in determining areas with the greatest parking demand and where parking problems are critical due to inadequate capacity. They are helpful in identifying areas where time limits are not consistent with usage. This further aids in determining whether enforcement efforts should be lessened or increased. They evaluate efficiency of parking areas. An efficiency of 85 percent is considered maximum in short-time parking areas and 95 percent is maximum in long-time parking areas.

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

Ans: Introduction to Four step conventional transportation modeling:

The travel forecasting process is at the heart of urban transportation planning. Originating from 1960s, and improved in the decades to come, four-step travel demand forecasting process is the central column of transportation planning throughout the world. Travel forecasting models are used to project future traffic and are the basis for the determination of the need for new road capacity, transit service changes and changes in land use policies and patterns. At first glance the process may appear to have remained unchanged since the time it was first conceived. In reality, however, it has undergone significant modification in response to an improved understanding of travel behavior by modelers, the need to address emerging policy questions (e.g., high-occupancy vehicle facilities and congestion pricing), and advances in computational technology. More powerful personal computers allowed the specification of more complex and detailed models. This evolutionary development will undoubtedly continue.

Travel Analysis Zones-TAZs:

As a starting point one can ask, how is the city or region represented for computer analysis? Travel simulation requires that an urban area or region be represented as a series of small geographic areas referred to as travel analysis zones (TAZs). Zones are characterized by their population, employment and other factors and are the places where trip making decisions are made (trip producers) and the trip need is met (trip attractors). Trip making is assumed to begin at the centre of activity in a zone (zone centroid).

Trips that are very short, that begin and end in a single zone (intrazonal trips) are usually not directly included in the forecasts. This limits the analysis of pedestrian and bicycle trips in the process. Zones can be as small as a single block but typically are 1/4 to one mile square in area. A planning study can easily use 500–2000 zones. A large number of zones will increase the accuracy of the forecasts but require more data and computer processing time. Zones tend to be small in areas of high population and larger in areas of low density and population. Internal zones are those within the study area while external zones are those outside of the study area. The study area should be large enough so that nearly all (over 90%) of the trips begin and end within the study area. The trips that do not begin or end within the study area but travel through it is considered to be through traffic.

The highway system and transit systems are represented as networks for computer analysis. Networks consist of links to represent segments of highways or public transport lines and nodes to represent intersections and other points on the network. Data for links includes travel times on the link, average speeds, capacity, and direction. Node data is more limited to information on which links connect to the node and the location of the node (coordinates). Node data could also include data on intersections to help calculate delay encountered at intersections. The travel simulation process follows trips as they begin at a trip generation zone, move through a network of links and nodes and end at a trip attracting zone.

The simulation process is known as the four-step process and includes:
1) Trip Generation
2) Trip Distribution
3) Mode Split and
4) Traffic Assignment

1) TRIP GENERATION:

The first step in travel forecasting is trip generation. In this step information from land use, population and economic forecasts are used to estimate how many trips will be made to and from each zone. This is carried out separately by trip purpose. Some of the trip purposes that could be used are: home based work trips (work trips that begin or end at home), home based shopping trips, home based other trips, school trips, non-home based trips (trips that neither begin or end at home), truck trips and taxi trips. Trips are calculated based on the characteristics of the zones. Trip productions are based on household characteristics such as the number of people in the household and the number of cars available. For example, a household with four people and two cars may be assumed to produce 3.00 work trips per day. 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 uses trip rates that are averages for large segments of the study area.

Trip Purpose:

In today's transportation planning process the zonal trip making is estimated separately for each of a number of trip purposes, typically including work trips, school trips, shopping trips, 'and social or recreational trips. The reason separate trip-generation models are usually developed for each trip purpose is that the travel behavior of trip-makers depends on the trip purpose. For example, work trips are undertaken with daily regularity, mostly during the morning and afternoon period of peak traffic, and overwhelmingly from the same origins to the same destinations. This is also true in the case of school trips. Social and recreational trips, on the other hand, are clearly of a different character.

Factors influencing Trip Production:

The main factors affecting personal trip production include income, vehicle ownership, house hold structure and family size. In addition factors like value of land, residential density and accessibility are also considered for modeling at zonal levels. In other words, Trip production of a zone depends on the following factors:

a. Number of workers in a household.

b. Number of Students.

c. Household size and composition.

d. The household income.

e. Some proxy of income such as number of cars etc.

Factors influencing Trip Attraction:

The personal trip attraction, on the other hand, is influenced by factors such as roofed space available for industrial, commercial and other services. At the zonal level zonal employment and accessibility are also used. In other words, trip attraction of a zone depends on:

a. Floor area and number of employment opportunities in retail trade, service, offices manufacturing and wholesale areas.

b. School and college enrolment

c. Other activity centres like transport terminals, sports stadium, major recreational/ cultural/religious places.

Common limitations and issues:

Some of the common limitations which could be of concern in trip generation are the following.

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 work. 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 whether shopping is done 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. *Limited variables.* Trip making is found as a function of only a few variables such as auto ownership, household size and employment. Other factors such as the quality of transit service, ease of walking or bicycling, fuel prices, land use design and so forth are not typically included.

4. Combinations of trips (trip chaining) 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. For example, non home based trips are calculated based only employment characteristics of zones and do not consider how members of a household coordinate their errands.

5. 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. For example shopping trip attractions are found as a function of retail employment, but it could also be argued that the number of retail employees at a shopping center will depend on how many people come there to shop. This 'chicken and egg' problem comes up frequently in travel forecasts and is difficult to avoid. Another example is that trip making depends on auto availability, but it could be also argued that the number of automobiles a household owns would depend upon how active they are in making trips.

The purpose of trip generation is to estimate the target-year trip ends by travel purpose for each zone within the region. Commonly, these trips are expressed as residential trip productions and nonresidential trip attractions. The most common mathematical forms of trip generation models are multiple regression equations, trip-rate-models, cross classification models, and their combinations.

2) TRIP DISTRIBUTION:

Trip generation only finds the number of trips that begin or end at a particular zone. The process of trip distribution links the trip ends to form an origin destination pattern. Trip distribution is used to represent the process of destination choice, e.g. "I need to go shopping but where should I go to meet my shopping needs?" Trip distribution leads to a large increase in the amount of data which needs to be dealt with. Origin–destination tables are very large. For example, a 1200 zone study area would have 1,440,000 possible trip combinations in its O–D table for each trip purpose. The most commonly used procedure to predict trip distribution is gravity modelling. The gravity model takes the trips produced at one zone and distributes to other zones based on the size of the other zones and on the basis of the distance to other zones.

A zone with a large number of trip attractions (say a large shopping centre) will receive a greater number of distributed trips than one with a small trip attraction (a small shopping centre).

Trips to a given destination decreases with the distance to the destination (it is inversely proportional). For example, you would expect more trips to a nearby shopping centre than one further away. The distance effect is found through a calibration process which gives travel times to destinations from the model similar to that found from field data. "Distance" can be measured in several ways. The simplest way this is carried out is to use car travel times between zones is as the measurement of distance.

3) MODE CHOICE/SPLIT:

Mode choice is one of the most critical parts of the travel demand modeling process. It is the step where trips between a given origin and destination are split into trips using transit, trips by car pool or as automobile passengers and trips by automobile drivers. Calculations are conducted that compare the attractiveness of travel by different modes to determine their relative usage. All proposals to improve public transit or to change the ease of using the automobile are passed through the mode split/auto occupancy process as part of their assessment and evaluation. It is important to understand what factors are used and how the process is conducted in order to plan, design and implement new systems of transportation.

Mode split is carried out by a comparison of the "disutility" of travel between two points for the different modes that are available. Disutility is a term used to represent a combination of the travel time, cost and convenience of a mode between an origin and a destination.

The disutility equations do not normally recognize differences within travel modes. A bus system and a rail system with the same time and cost characteristics will have the same disutility values. It is possible that mode bias factors could be different for different technologies, to represent a preference for light rail over bus, but this must be specifically included.

Mode split and car occupancy analysis can be two separate steps or can be combined into a single step, depending on how a forecasting process is set up. In the simplest application, a highway/public transport split is made first which is followed by a split of car trips into car driver and car passenger trips. More complex analysis splits trips into multiple categories (single occupant auto (SOV), two-person car pool, 3–5-person car pool (HOV), van pool, local bus, express bus, etc.). Car occupancy analysis is often a highly simplified process which uses fixed car occupancy rates for a given trip purpose or for given household size and car ownership categories. This means that the forecasts of car-pooling are insensitive to changes in the cost of travel, the cost of parking, the presence of special programs to promote car-pooling, etc.

Common limitations and issues: some of the common limitations which could be of concern in mode split are as follows:

1. Mode choice is 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. Thus if one substitutes a light rail transit system for a bus system without changes in travel times or costs from the bus system, the model would not show any difference in demand. People are assumed to make travel choices based only on the factors in the model, factors not in the model will have no effect on results predicted by the models.

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 factored in 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. 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 in the importance of time and cost within these categories are ignored.

4) <u>TRIP ASSIGNMENT:</u>

Once trips have been split into highway and transit trips, the specific path that they use to travel from their origin to their destination must be found. These trips are then assigned to that path in the step called traffic assignment. Traffic assignment is the most time consuming and data intensive step in the process and is done differently for highway trips and transit trips. The process first involves the calculation of the shortest path from each origin to all destinations (usually the minimum time path is used). Trips for each O-D pair are then assigned to the links in the minimum path and the trips are added up for each link. The assigned trip volume is then compared to the capacity of the link to see if it is congested. If a link is congested the speed on the link needs to be reduced to result in a longer travel time on that link. Changes in travel times mean that the shortest path may change. Hence the whole process is repeated several times (iterated) until there is an equilibrium between travel demand and travel supply. Trips on congested links will be shifted to uncongested links until this equilibrium, condition occurs. Traffic assignment is the most complex calculation in the travel modeling sequence and there are a variety of ways in which it is done to keep computer time to a minimum.

Transit trip assignment is done in a similar way to auto trip assignment except that transit headways are adjusted rather than travel times. Transit headways (minutes between vehicles) affect the capacity of a transit route. Short headways mean more frequent service and a greater number of vehicles. Normally short headways are assumed initially. Trips are assigned to vehicles and if the vehicles have low ridership, headways are increased to provide fewer vehicles and higher ridership per trip. This process is repeated until transit supply and demand are in balance.

Some of the assumptions in traffic assignment are as follows:

- *Delay occurs on links:* Most traffic assignment procedures assume that delay occurs on the links rather than at intersections.
- *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.
- *Capacities are simplified:* To determine the capacity of roads and public transport systems requires a complex process of calculations that consider many factors. In most travel forecasts this is greatly simplified.
- *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. Daily trips are multiplied by a "hour adjustment factor", for example 10%, to convert them to peak hour trips. The number assumed for this factor is very critical. A small variation, say plus or minus one percent, will make a large difference in the level of congestion that would be forecast on a network. Most models are unable to represent how travelers often cope with congestion by changing the time they make their trips.
- *Emphasis on peak hour travel:* As described above, forecasts are carried out 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 an "average or typical weekday". Variations in travel by time of year or day of the week are usually not considered.

Continued…

Question # 3

Solution:

Trip generation is defined as a trip end connected with a residential land use in a zone.
Trip attraction is defined as a trip end connected to a nonresidential land use in a zone.
The above definitions are from Engineering Transportation Engineering & Planning by Papacostas.

<u>Zone # 1 (Peshawar)</u>

i) Residential Area:

Residental Area = 7740

Person Trip per ha = 128 From Given table

Trip generation per ha = 60.5

ii) Commercial Area:

a) Retail Area: 6972

Person Trip per ha = 850 From Given table

Trip attraction per ha = 8.2

b) Wholesale Area: 14940

Person Trip per ha = 135 From Given table

Trip attraction per ha = 110.6

c) Services Area: 5976

Person Trip per ha = 445 From Given table

Trip Attraction per ha = 13.4

iii) Manufacturing Area:

Manufacturing Area = 1290

Person Trip per ha = 353 From Given table

Trip attraction per ha = 3.6

iv) Transportation Area:

Transportation Area = 1935

Person Trip per ha = 73 From Given table

Trip Attraction per ha = 26

v) Public Buildings Area:

Public Buildings Area = 2580

Person Trip per ha = 595 From Given table

Trip Attraction per ha = 4.3

vi) Public Open Space:

Public Open space area = 3010

Person Trip per ha = 5 From Given table

Trip Attraction per ha = 602

Zone # 1 (Peshawar)

Total Trip Generation = 60.5

Total Trip Attraction = 768.1

Zone # 2 (Charsadda)

i) Residential Area:

Residental Area = 24900

Person Trip per ha = 108 From Given table

Trip generation per ha = 230.5

ii) Commercial Area:

a) Retail Area: 5688

Person Trip per ha = 423 From Given table

Trip attraction per ha = 13.4

b) Wholesale Area: 10744

Person Trip per ha = 90 From Given Tables

Trip attraction per ha = 119.4

c) Services Area: 2528

Person Trip per ha = 258 From Given Tables

Trip Attraction per ha = 9.8

iii) Manufacturing Area:

Manufacturing Area = 4980

Person Trip per ha = 183 From Given Tables

Trip attraction per ha = 27.2

iv) Transportation Area:

Transportation Area = 8964

Person Trip per ha = 25 From Given Tables

Trip Attraction = 358.6

v) Public Buildings Area:

Public Buildings Area = 9960

Person Trip per ha = 265 From Given Tables

Trip Attraction per ha = 37.6

vi) Public Open Space:

Public Open space area = 22908

Person Trip per ha = 3 From Given Tables

Trip Attraction per ha = 7636

Zone # 2 (Charsadda)

Total Trip Generation = 230.5

Total Trip Attraction = 8202

Zone # 3 (Mardan)

i) Residential Area:

Residental Area = 17064

Person Trip per ha = 93 From Given table

Trip generation per ha = 183.5

ii) Commercial Area:

a) Retail Area: 26220

Person Trip per ha = 563 From Given table

Trip attraction per ha = 46.6

b) Wholesale Area: 20976

Person Trip per ha = 115 From Given Tables

Trip attraction per ha = 182.4

c) Services Area: 1748

Person Trip per ha = 505 From Given Tables

Trip Attraction per ha = 3.5

iii) Manufacturing Area:

Manufacturing Area = 1264

Person Trip per ha = 83 From Given Tables

Trip attraction per ha = 15.2

iv) Transportation Area:

Transportation Area = 5688

Person Trip per ha = 35 From Given Tables

Trip Attraction per ha = 162.5

v) Public Buildings Area:

Public Buildings Area = 4424

Person Trip per ha = 375   From Given Tables

Trip Attraction per ha = 11.8

vi) Public Open Space:

Public Open space area = 15800

Person Trip per ha = 10   From Given Tables

Trip Attraction per ha= 1580

Zone # 3 (Mardan)

Total Trip Generation = 183.5

Total Trip Attraction = 2001.2

Zone # 4 (Nowshera)

i) Residential Area:

Residential Area = 40204

Person Trip per ha = 75 From Given table

Trip generation per ha = 536

ii) Commercial Area:

a) Retail Area: 6172

Person Trip per ha = 670   From Given table

Trip attraction per ha = 9.2

b) Wholesale Area: 7715

Person Trip per ha = 73   From Given Tables

Trip attraction per ha = 105.7

c) Services Area: 6172

Person Trip per ha = 385   From Given Tables

Trip Attraction per ha = 16

iii) Manufacturing Area:

Manufacturing Area = 1748

Person Trip per ha = 73 From Given Tables

Trip attraction per ha = 23.9

iv) Transportation Area:

Transportation Area = 5244

Person Trip per ha = 25 From Given Tables

Trip Attraction = 209.7

v) Public Buildings Area:

Public Buildings Area = 6992

Person Trip per ha = 245 From Given Tables

Trip Attraction per ha = 28.5

vi) Public Open Space:

Public Open space area = 71668

Person Trip per ha = 5 From Given Tables

Trip Attraction per ha = 14333

Zone # 4 (Nowshera)

Total Trip Generation = 536

Total Trip Attraction = 14726

Zone # 5 (Swabi)

i) Residential Area:

Residential Area = 29317

Person Trip per ha = 55 From Given table

Trip generation per ha = 533

ii) Commercial Area:

a) Retail Area: 126091

Person Trip per ha = 463 From Given table

Trip attraction per ha = 272

b) Wholesale Area: 90065

Person Trip per ha = 60 From Given Tables

Trip attraction per ha = 1501

c) Services Area: 162117

Person Trip per ha = 365 From Given Tables

Trip Attraction per ha = 444

iii) Manufacturing Area:

Manufacturing Area = 4629

Person Trip per ha = 55 From Given Tables

Trip attraction per ha= 84.2

iv) Transportation Area:

Transportation Area = 4629

Person Trip per ha = 13 From Given Tables

Trip Attraction = 356.1

v) Public Buildings Area:

Public Buildings Area = 3086

Person Trip per ha = 90 From Given Tables

Trip Attraction = 34.3

vi) Public Open Space:

Public Open space area = 92580

Person Trip per ha = 5 From Given Tables

Trip Attraction per ha = 18516

Zone # 5 (Swabi)

Total Trip Generation = 533

Total Trip Attraction = 21207

Zone # 6 (Abbottabad)

i) Residential Area:

Residential Area = 576416

Person Trip per ha = 45 From Given table

Trip generation per ha = 12809

ii) Commercial Area:

a) Retail Area: 15270

Person Trip per ha = 485 From Given table

Trip attraction per ha = 31.5

b) Wholesale Area: 7635

Person Trip per ha = 48 From Given Tables

Trip attraction per ha = 159.1

c) Services Area: 10180

Person Trip per ha = 338 From Given Tables

Trip Attraction per ha = 30.1

iii) Manufacturing Area:

Manufacturing Area = 36026

Person Trip per ha = 53 From Given Tables

Trip attraction per ha = 679.8

iv) Transportation Area:

Transportation Area = 90065

Person Trip per ha = 18   From Given Tables

Trip Attraction = 5003.6

v) Public Buildings Area:

Public Buildings Area = 252182

Person Trip per ha = 48   From Given Tables

Trip Attraction = 5253.8

vi) Public Open Space:

Public Open space area = 468338

Person Trip per ha = 3   From Given Tables

Trip Attraction per ha = 156112.6

Zone # 6 (Abbottabad)

Total Trip Generation = 12809

Total Trip Attraction = 167270.5

Zone # 7 (Kohat)

i) Residential Area:

Residential Area = 53445

Person Trip per ha = 38 From Given table

Trip generation per ha = 1406.4

ii) Commercial Area:

a) Retail Area: 1290

Person Trip per ha = 380   From Given table

Trip attraction per ha = 3.4

b) Wholesale Area: 1935

Person Trip per ha = 40   From Given Tables

Trip attraction per ha = 48.4

c) Services Area: 1720

Person Trip per ha = 328 From Given Tables

Trip Attraction per ha = 5.24

iii) Manufacturing Area:

Manufacturing Area = 12725

Person Trip per ha = 35 From Given Tables

Trip attraction = 363.6

iv) Transportation Area:

Transportation Area = 10180

Person Trip per ha = 15 From Given Tables

Trip Attraction = 678.7

v) Public Buildings Area:

Public Buildings Area = 30540

Person Trip per ha = 10 From Given Tables

Trip Attraction = 3054

vi) Public Open Space:

Public Open space area = 114525

Person Trip per ha = 3 From Given Tables

Trip Attraction = 38175

Zone # 7 (Kohat)

Total Trip Generation = 1406.4

Total Trip Attraction = 42328

Zone	Total Trip Generation	Total Trip Attraction
1	60.5	768.1
2	230.5	8202
3	183.5	2001.2
4	536	14726
5	533	21207
6	12809	167270.5
7	1406.4	42328

Comments:

- In all the seven zones, Zone # 6 has the highest number of trip end connected with residential land use, moreover Zone # 6 also has the highest number of trips end connected with non-residential land use.
- Zone 6 has produced the most trips but zone 6 has also attracted the most trips.
- Zone 1 has produced the least number of trips and also attracted the least number of trips.
- While forecasting the data extra care should be given to distribute the trips proportionally over the area.
- To get a clear picture of these zones, other socio-economic factors and transportation-systems characteristics should also be taken into account.