Module 1

1.1. BASIC DEFINITIONS

Goals: Goal is defined as the end to which a plan tends. Goals may be thought of as a set of statements that attempt to convey to the planner an image of the ideal system and in this way provide him with overall direction.

Objective: A specific statement denoting a measurable end to be reached or achieved for a particular group of people, usually in a particular span of time.

Problem: A problem of individuals is the difference between the desired state for a given situation and the actual state.

Standards: A standard is of lower order than an objective and represents a condition that is capable of both measurement and attainment.

Values: An element of shared symbolic system acquired through social learning, which serves as a guide for the selection from among perceived alternatives of orientation.

Measure of Effectiveness (MOE): It is a measurement of degree to which an alternative action satisfies the objective. It is also known as the **Figure of Merit** (**FOM)**.It includes goals, objectives, values, and criterion. It includes Measures of Cost (MOC) as one of the subsets. Effectiveness and be determined by criteria known as standard. Always it has a positive impact and obtained from consequences of analysis.

Measure of Cost (MOC): The measure of benefits forgone or opportunities lost for each of the alternative measure of cost. Standard of MOC represents the cutoff point beyond which performance is rejected .It belongs to MOE. MOC has a –ve impact and consequences of decisions.

1.2. COMPONENTS OF A SYSTEM:

The various components of a system are:

1. Vehicle: Vehicle is one, which gives the object mobility on a particular type of path employed, and which acan be propelled on that path. It may also serve to protect the object from damage.

2. Container: It is the device into or onto which the objects to be transferred are placed in order to facilitate the movement.

3. Way-Link: Way links are the paths in which the flow is constrained to follow a particular route, as in the case of a railway track, highway, pipes, aircrafts, etc.

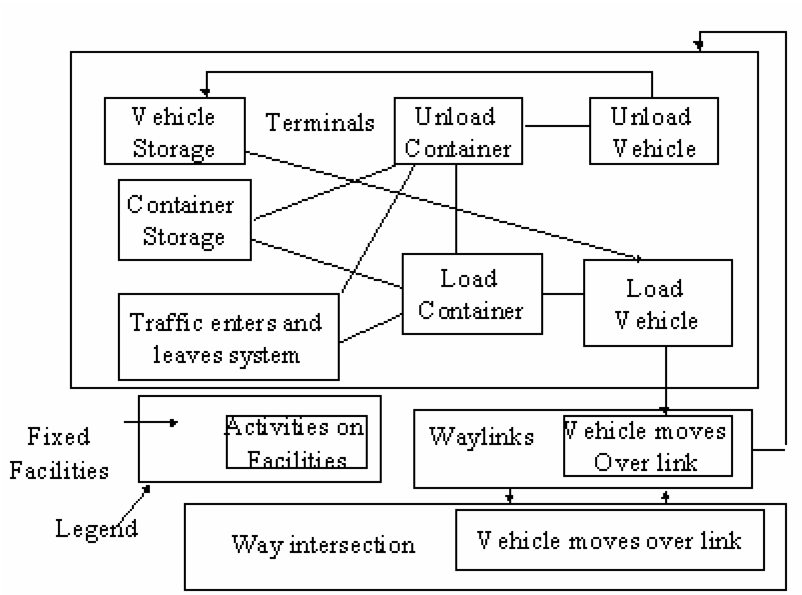
4. Way Intersections: flows of two or more links can be merged together at intersections, and a single flow can be separated to follow two or more distinct paths at intersections.

5. Terminal: Terminals are the points through which traffic is transferred from one vehicle or container to another.

6. Operations Plan: It is essential that the terminals be operated in a manner that the traffic flowing through them can be accommodated, that vehicles are available to accept the traffic, that the traffic is routed via the proper links and the intersections through the system to the final destination of the traffic. The set of the procedures by which the co-ordination of these activities is done is termed the operational plan.

7. Maintenance Subsystem: It is a system, which is primarily treated as a function of cost and management associated with each of the physical components identified earlier.

8. Information and Control subsystem: It is similarly treated in the context of components and operations where they apply.

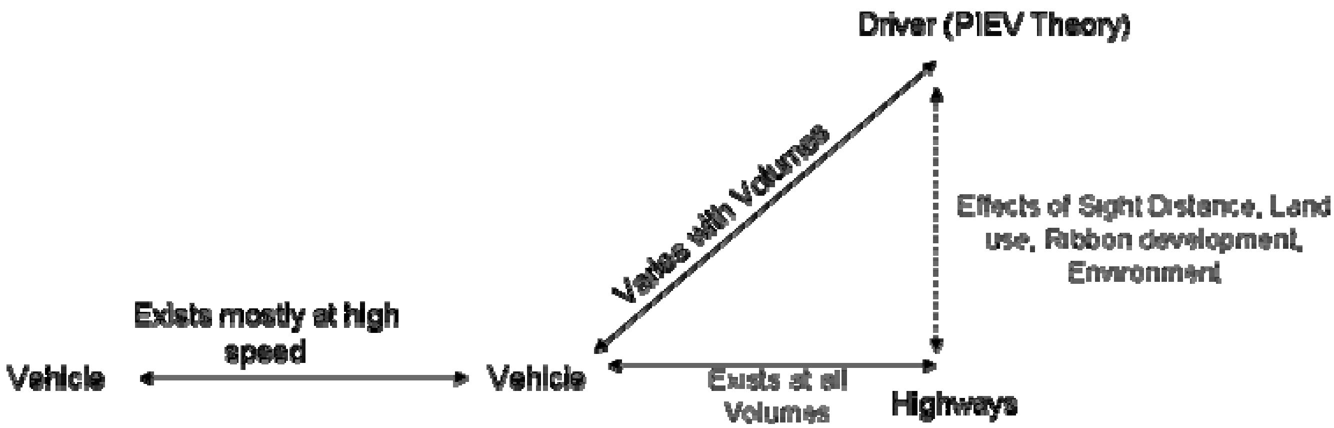


Basic Components of A System

AKOTECH'S MODEL:

Components of System:

- Users
- Vehicle / Carrier
- Roadway / Facility
- Environment



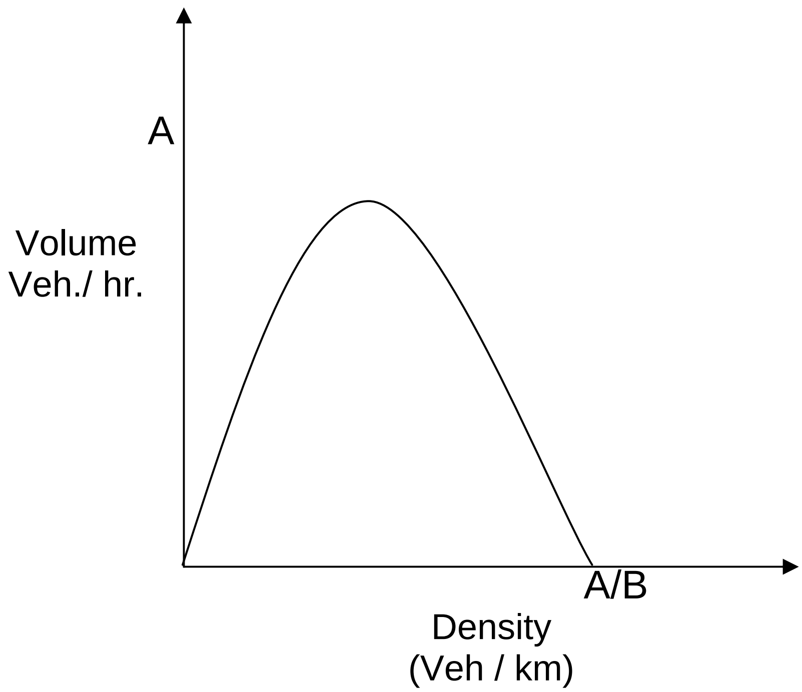
Traffic Volume (q): It is the number of vehicles passing a given point in a unit point of time. (Unit- veh/hr.)

Traffic Density (k): Number of vehicles per kilometer. (Unit – veh/Km)

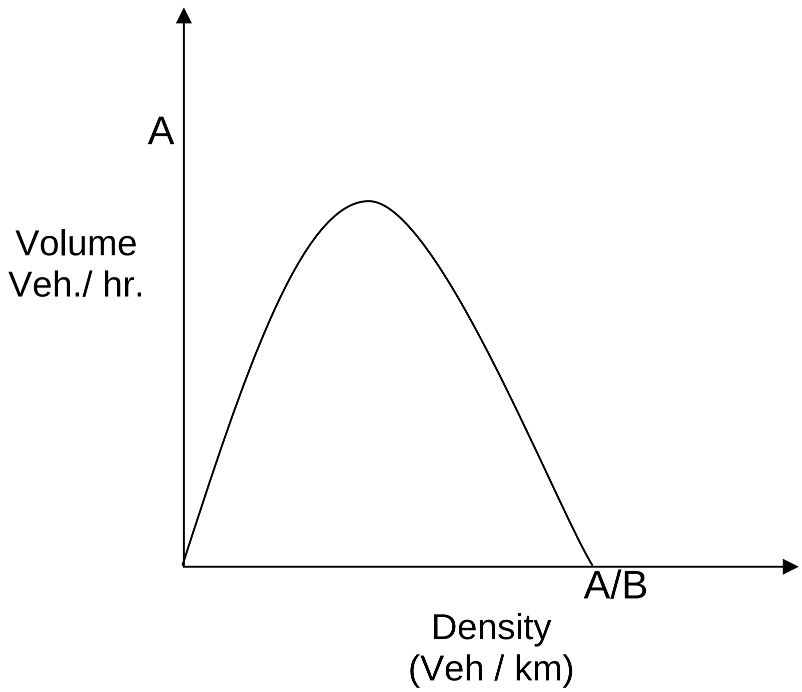
Speed (v): The distance covered per unit of time. (Unit- Km/hr)

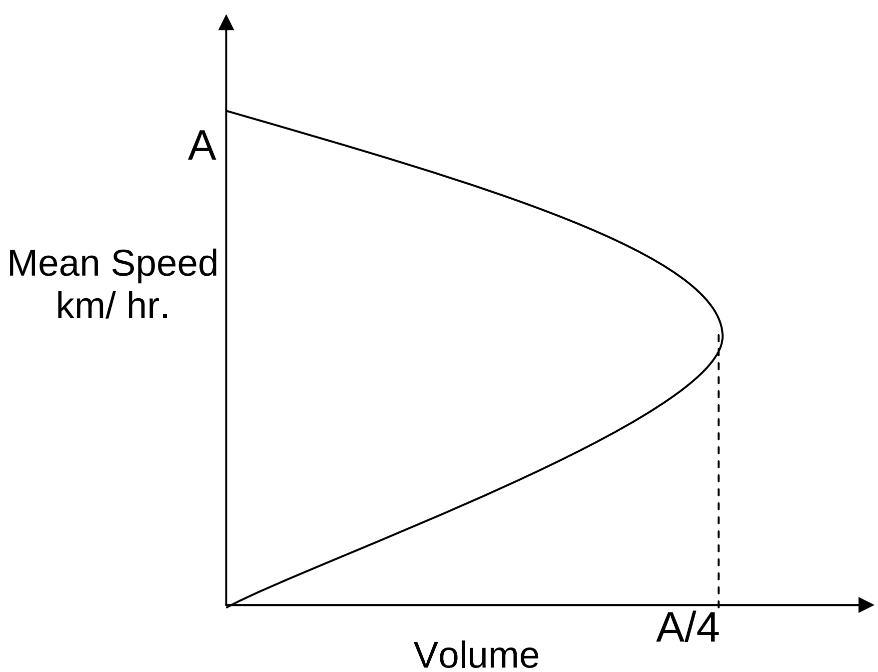
Relationship: **q = k*v**

$$q = k.U = k(A- Bk)= Ak- Ak^2$$

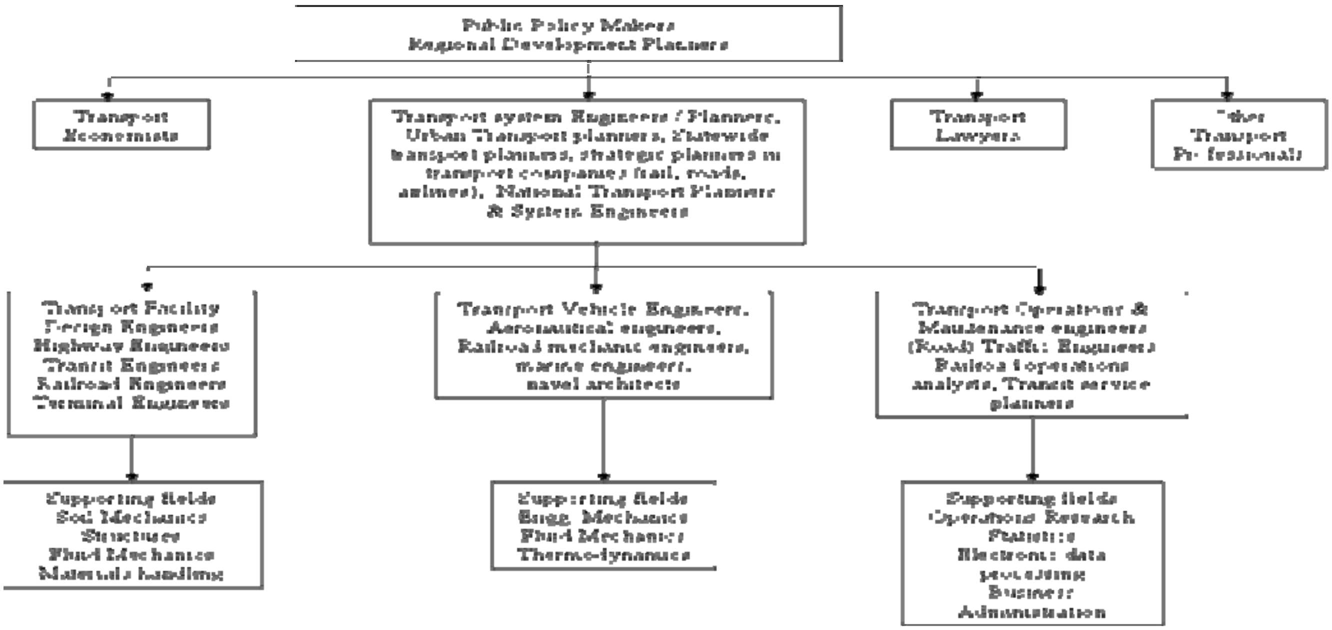


$$q = k.U = k(A- Bk)= Ak- Ak^2$$





1.3. SPECIALTIES IN TRANSPORTATION ENGINEERING:



Fields of Transportation Engineering

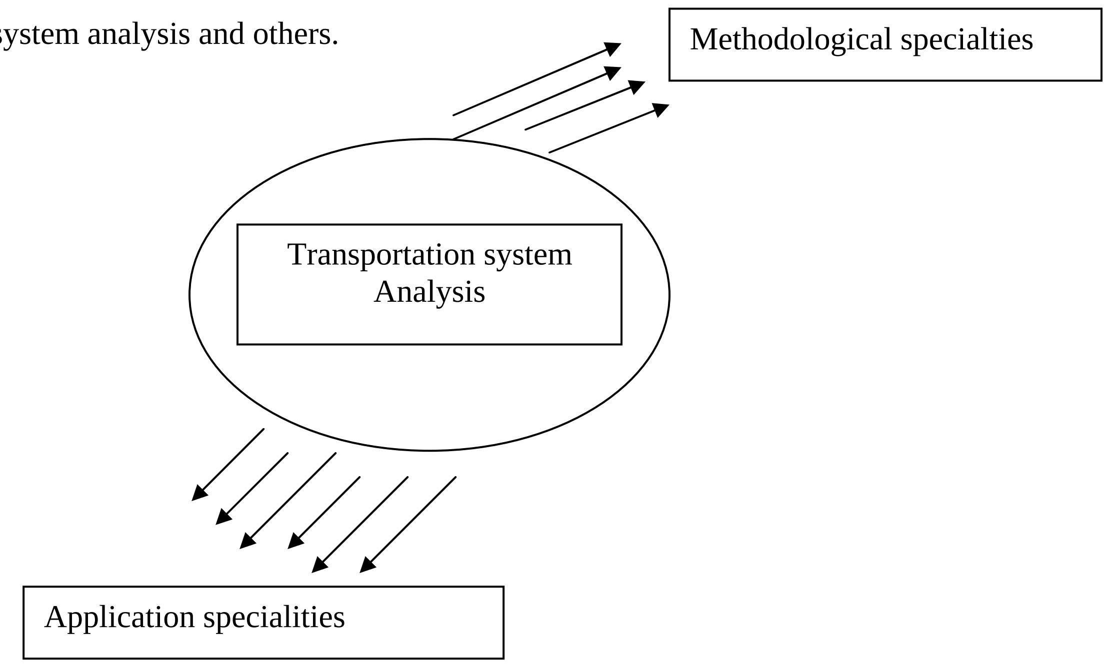
1) Application Specialties:

- Highway Engineering
- Freight transportation
- Marine transportation
- Transportation Management
- Traffic engineering.
- Urban transportation planning
- Developing country transportation planning
- Rail transport
- Port development and planning
- Airport planning
- Transit operations
- Trucking
- Transportation regulation
- Transportation and economic development
- Transportation engineering

- Transportation economics
- National transportation policy
- Transportation environmental analysis and others.

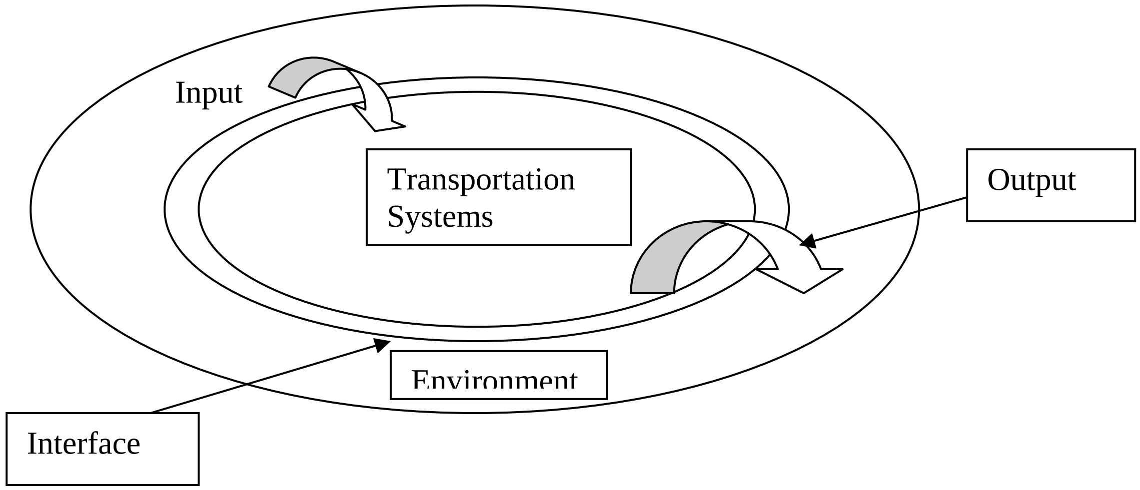
2) Methodological specialties:

- Demand analysis
- Transportation system performance and evaluation
- Policy analysis and Implementation.
- Urban planning and development management
- System analysis methods
- Environmental impacts
- Economics
- Activity system analysis and others.



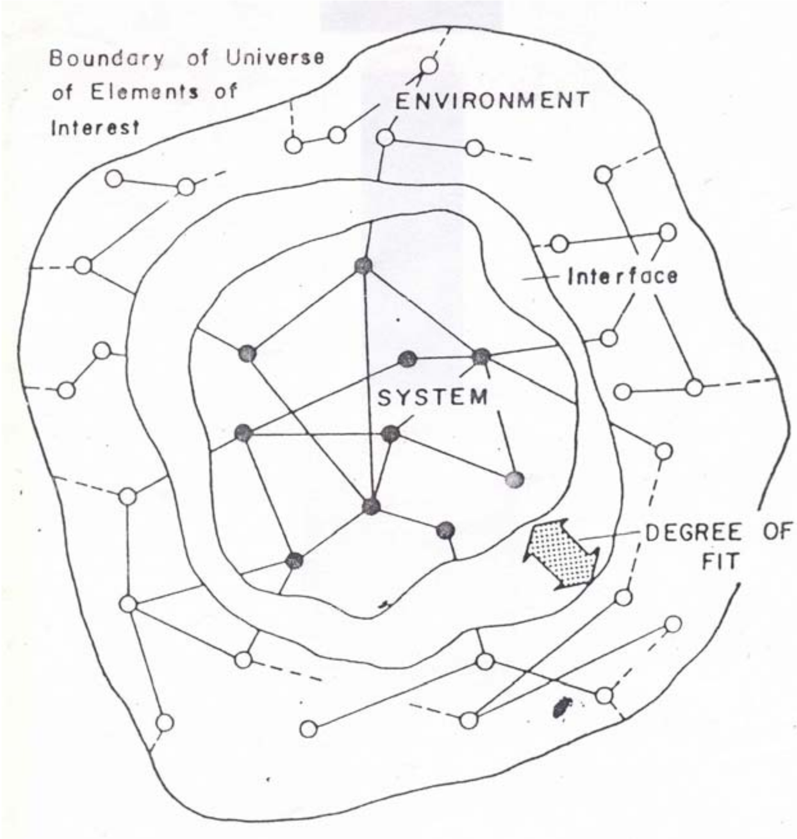
1.4. SYSTEM ENVIRONMENT ENSEMBLE

A system may be defined as the set of components, activities and entities that is organized meaningfully in such a manner as to direct the action of system under inputs towards specific ***goals*** and ***objectives.***



Note: Inputs and Outputs can be + ve or –ve

- Urban Transportation System is a system responding to social and economical factors. These factors are again influenced by transportation system
- The land use development with the environment influence the transportation system
- The changes in transportation system may also cause changes in landuse development
- Changes may come both in system and environment .If these are less the environment balances it , hence the system is in stable position
- If the changes are high the system may not be in equilibrium. Then the system may completely collapse.



The system environment ensemble.

Boundary of Universe of elements of Interest:

The aim of transportation problem definition step is to define the interface between the system and its interface.

To identify a rule or criterion which may be used by planner to identify the optimal system, by the following,

- System Objectives
- System Standards
- System Constraints
- System Inputs
- System Outputs
- Value Functions
- Decision Criterion

System Objectives

It may be conceived as a lower order goal which at least conceptually capable of being measured.

Before start of plan we set some objectives and these should be achieved at the completion

System Standards

A standard is a lower than objective and represents a condition that is capable of both measurement and attainment.

These are lower order limits beyond which performance is rejected.

Constraints

The constraints on a system may be defined as the characteristics of the environment that limit the extent of feasible solutions.

Inputs

The inputs to a system may be defined as those characteristics of the environment that a system must transform into outputs in the light of system objectives

Outputs

The output of a system may be defined as thiose characteristics of a system that influences the system directly

Output = f^n (System Inputs and System Properties)

Value Function

A value function may be defined as a procedure for mapping the magnitude of an output variable into the units of value in which objectives are measured.

1.5. Challenges in transportation systems

1. Human behavior
2. Size of the problem
3. Multi modal
4. Selection of technology

5. Multi objective, Multi criteria, Multi sectoral
6. Value of System
7. Squeezing space availability
8. Environmental Aspects.

1.6. PROBLEMS IN PROBLEM DOMAIN AFFECTING TRANSPORTATION:

A problem for an individual or group of individuals is the difference between the desired and actual state.

GOALS ---- OBJECTIVES = PROBLEM

These transportation problem have been divided into **three classes**

A. The problems that are direct transportation service problems
B. Those in the problem domain **affected by** transportation
C. Those problem domain **affecting** transportation

A. Transportation Service Problems:

1. Congestion
2. Inadequate Capacity
3. High User Cost
4. High facility Cost
5. Low rate of return
6. Lack of Safety
7. Lack of privacy
8. Discomfort

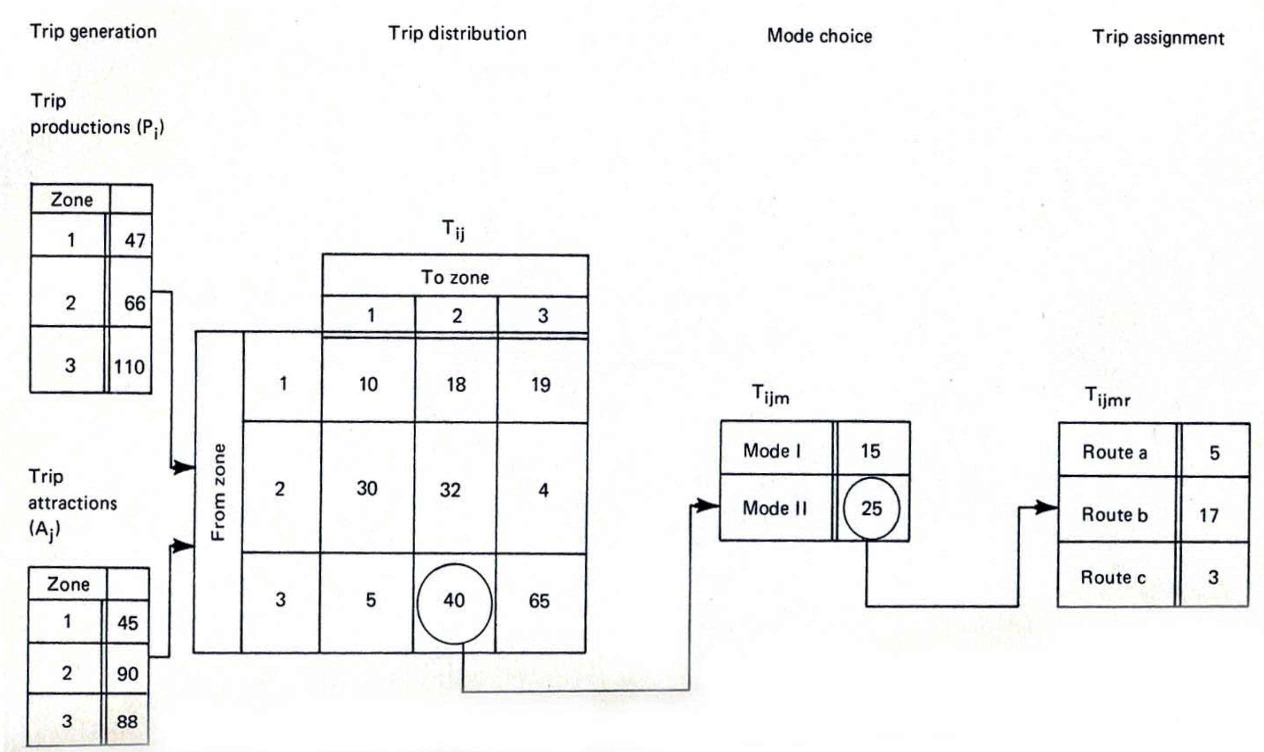
B. Problems In the domain affected by Transportation

1. Air Pollution
2. Noise
3. Visual Intrusion
4. Poor Appearance
5. Increase in cost of abutting land
6. Excessive right of way and relocation requirements
7. Inappropriate and undesirable development

8. Moral, religious and biological problems
9. Unequal impart and certain population groups

C. Problems In the domain affecting Transportation

1. Increased population growth and dispersion
2. Increased automobile ownership
3. Packed ness in the amount
4. Time of Travel



Overview of Travel Demand Modelling

1.7. CONCEPT OF A MODEL

Def: "Something, which in some respect resembles or describes the structure or behavior of its real life counterpart"

It's "**Abstract of Reality**"

Types of Models

1. ***Iconic Models:*** Models which are having visual geometric equivalents (Example: Model Airplane)

2. ***Analogical Models:*** Models in which there is a correspondence between elements and actions in the model and those in reality but no physical resemblance.
   (Example: Football Play diagram)
3. ***Symbolic models:*** Models which compactly and abstractly represent the principle of reality.
   (Example: F=m*a)

In general, a model of any situation contains the following five steps of elements:

1. Variables over which the designer has complete control, X_i
2. Variables over which the designer has no control, Z_j
3. Variables over which the designer has indirect control, Y_k
4. General relationships between the above variables, R_m
5. Parameters (coefficients, constants, exponents, etc.) in the above relationships: P_n

Symbolically, a model M is represented by:

$$M = \{ X_i, Z_j, Y_k, R_m, P_n \} \text{ for some or all } i, j, k, m, n \text{ ---------------------(1)}$$

Where the brackets indicate a set of items

An example may help to clarify the above equation. Suppose that the monthly revenue, r, from a given bus line operation depends on the fare charged, f, and the monthly number of passengers, P, riding the buses. Revenue then would be the product of the fare (R_s /person) and the number of passengers (persons)

$$r = fP \text{ ---(2)}$$

It is also found that the number of passengers riding the bus in any month is a function of the number of inches of rain in that month, i, and the bus fare, with the general relationship being

$$P = \frac{b}{(i+1)f^{\phi}} \text{ --(3)}$$

The " +1 " after i is included so that "if there is no rain" will not result in an infinite number of passengers (division by 0). The b and ϕ are parameters established from an analysis of past events. For example, in a hypothetical case it may have been found that the ridership is 10,000 passengers when there is no rain in a month and the fare is R_s 1.00. This would give

$$10{,}000 = \frac{b}{(1+0)(1.00)^{\phi}} \qquad \textit{from this } b = 10{,}000$$

Similarly, let us assume that past data have shown that there are 40,000 passengers in a month when there is no rain and the fare is R_s 0.50. With the above value of b, these figures would lead to

$$40{,}000 = \frac{10{,}000}{(1+0)(0.5)^{\phi}} \qquad \textit{from this } (0.50)^{\phi} = \frac{10{,}000}{40{,}000}$$ which gives

$$\phi = 2$$

Stopping here, we notice that the fare is a variable over which we as problem solvers hired by the bus company have control (on X_i), where we do not have control over the rain in a given month (a Z_j). Moreover, we have only indirect control over the number of passengers and revenue (Y_k) since the weather influences their values. Continuing in our effort to derive a completed model, we find the equations (2) and (3) and from the above discussion that

$$r = fP = \frac{fb}{(i+1)f^{\phi}} \qquad \text{---(4)}$$

Which leads to:

$$r = fP = \frac{fb}{(i+1)f^{\phi}} = \frac{f*10{,}000}{(1-i)f^{2}} = \frac{10{,}000}{(1+i)f} \text{-------------------------------------(5)}$$

Searching further, we may find that (5) holds true only for high income riders (a Z variable but stated as a category), while for lower income riders the proper relationship might be

$$r_h = \frac{10{,}000}{(1+i)f} \text{---(6)}$$

And for lower income group:

$$r_l = \frac{12{,}000}{(1+i)f} \text{--- ------------------------------(7)}$$

$$r_t = r_h + r_l \text{---(8)}$$

$Y_k = fn(X_i, Z_j)$ and $r = fn(i, f)$

if i =1, f = 0.20

$$r_t = \frac{10{,}000}{(1+i)(0.2)} + \frac{12{,}000}{(1+1)(0.2)} = 55{,}000 Rs/month$$

- Revenue is not adequate
- Go to equation (7) and calculate for f >0.20
- This process is repeated for different values of f and we try to maximize the revenue
- Even after number of iterations the satisfactory results are not obtained then modification is required in the model.

But in the above given example if the equation of higher income group is replaced with

$$r_h = \frac{8{,}000}{(1+i)f} \text{---(9)}$$

By entering equations (8) and (9) with the values for i and f the company then is assured that

$$r_t = \frac{8{,}000}{(1+1)(0.2)} + \frac{12{,}000}{(1+1)(0.2)} = 100{,}000 Rs/month$$

1.8. GENERATION OF ALTERNATIVES

In the generation stage of the transportation planning process the four components of transportation system (Vehicles, Networks, Terminals, Controls) are brought together to fulfill transportation and environmental objectives which when evaluated will prove to be more beneficial or effective. Many techniques have been developed as aids both in the development of better solutions and prevention of poor ones. Most sophisticated of these techniques are those of mathematical programming -linear programming, Non linear programming, Dynamic programming. Two other approaches to generation are search and experimental design. Search deals with the set of models and values of input variables are altered accordingly. Whereas experimental design deals with the actual design. The last approach and most prevalent approach is that of trial and analysis, which is, nothing more than an unsystematic searches of very limited set of possible modification alternatives.

- Goal Programming
- Brain storming
- Synthetic Analysis

1.9. PROBLEMS IN A CITY

- Congestion
- Pollution
- Safety
- Parking
- ITS (Disaster Management).

1.10. PROBLEM SOLVING PROCESS:

The product of the problem solving process usually is a fairly well defined entity yet the actual process itself often is a rather vague and undefined procedure, so that any representation of it would not necessarily be satisfactory to all concerned. Each link indicates both the direction of movement and the flow of information through the process whereas each stage indicates an action to be taken.

Referring back to the bus line operation model in the previous section can create a simple example of the use of the problem solving process. Suppose the bus company has the problem of having revenue that is too low (1) and realizes that the fare charged, weather and income status of riders all have a bearing on the problem (the problem domain). The company would like to increase the net revenue as much as possible (objective) by modifying the fare but taking into consideration of the relevant governmental restrictions (constraints). The model the company uses is given by the equations Eqn 5 & 6.It is also found at this stage that the company requires that the fare, f, fall within the range between 10 cents and 40 cents. The net revenue for the next month is calculated based on the projection that the amount of rain in the next month will be 1 inch and that the fare will remain 20 cents (stage 5). Under these circumstances the total revenue is sum of that from both the higher and lower income riders or from Eqn 5 & 6.

I.e., r = 10,000 / (1+1)(0.02) + 12,000/(1+1)(0.02) = 55,000

This revenue is not deemed adequate (Stage 6), so a modification in the fare to 30 cents is proposed. These modification leads to a revenue of 22,000/(2) (0.30) = $ 36,630(stage 5 and 6 again). As this is also found to be not feasible, finally a fare of 10 cents is fixed. To implement this fare change, the bus company must notify prospective passengers, get new change machines for the drivers and in general specify many of the details (stage 8) needed for the satisfactory fulfillment of the innovations. Finally, the fare change is brought into effect (stage 9) and operated and maintained (stage 10). After a month of experience with the modification, it turns out that the revenue is not $110,000/month but 100,000.To locate possible causes for this discrepancy, the bus company collects more details more data (stage 4) and finds that eqn 5 is really: fn = 8000/(I+1) f.