A 'system' perspective may be viewed and applied in a transport sector. As we can view 'universe' as a system, the Solar System, Human body as a system etc.

System is an united or integrated whole which is composed of various interrelated but interconnected or interdependent sub-systems.

Here, State Transport Undertaking (H.R.T.C.) is considered as an 'open systems' because it is being affected by the external environmental factors and in turn affects them too.

Delineation of various components of an open transport system is to be done to understand applied concept of system approach.

This chapter highlights the views of different authorities on transport system. An effort is made to review the available literature on transport system so that the concept of transport system is operationalised and applied further to study H.R.T.C. as an open transport system.
3.1 CONCEPT OF SYSTEM:

At the turn of the century if we look back and try to take the stock of past 100 years, we may reach to a point where we can say that the fields of knowledge have been integrated to study a particular field or a problem significantly.

If one considers contemporary science on the whole, it is hard to find a word that is used more frequently than the term 'system'. Biologists, physicists, sociologists, linguists, cyberneticists, psychologists, cosmologists and economists argued about systems, investigate system of various kinds, discuss systems at many conferences and symposia specially convened for the purpose.

During 1960's systems ideas have penetrated the field of management and control, they formed the basis for rapidly developing methods for the solution of major complex problems in defence, economics, education, communications, transport, city development etc. This methodology known as systems analysis has stimulated the training of highly specialised professionals, not only possessing the necessary knowledge, but also capable of seeing the problem from a systems angle.

The systems approach is one of the methodological trends in modern science that was born of the need to find a way out of the crisis in scientific knowledge at the turn of the 20th century.

Ludwig Von Bertalanffy is the pioneer system thinker. He used the word 'system' when he declared that an organism is not a machine but a system. In a machine different elements or constituent parts are static but in a system different elements are dynamic and active and possess organisation and wholeness. Later he evolved the 'theory of open system' which had methodological principle for the study of system. His formulation of open system theory established system thinking as a major
scientific movement. The thesis of open system has further led to the 'General System Approach' which in turn has opened the vista for understanding and making methodological research in various disciplines.⁴

He defined system as a 'Complexes of elements standing in interaction'. The system is called closed, if it neither takes in nor emits matter (only energy exchange is possible and taken in to account). The system is called open if there is a continual input and output of both energy and matter in it.⁵

Bertalanffy made the thermodynamics of irreversible process as the theoretical ground and an apparatus for the development of the 'theory of open system.' He formulated some key concepts, defined them because he wanted to make them somewhat different from the traditional treatment of these nations in statistical physics. Equilibrium is a time-independent state of the closed system in which all microscopic quantities are invariable and all microscopic processes discontinue. According to second law of thermodynamics each closed system finally reaches a time-independent state of equilibrium with maximum entropy and minimal free energy. By steady state we mean a time-independent state of an open system in which all microscopic quantities remain constant, although microscopic process of the input and output of matter go on continuous. Under certain conditions an open system may reach the steady state— as opposed to a close system which, left to itself, must reach the state of equilibrium.⁶

The word 'System' is derived from late Latin and Greek words, meaning, a complex whole; set of connected things or parts; organised body of material or immaterial things.⁷

In the literature, the term 'system' is taken to mean 'a set of elements standing in interrelations'; 'any set of variables.... available on the real
machine' \(^9\); 'a set of objects together with relationships between the objects and between their attributes \(^10\); 'a set of activities (functions) that are connected both in time and space by a set of decision-making and behaviour-evaluation (that is, control) practice' ; 'anything that consists of parts connected together'\(^12\); 'the mapping of one subset of terms (inputs and states) into another (outputs)' \(^13\) etc.

How is one to make head or tail of this diversity and single out the meaning of the term 'system' that conform best to understanding it as a special object of research ?\(^14\)

It is comparatively easy to identify two main points around which most of existing meanings of the term 'System' are concerned (both from the historical and the modern point of view). Firstly, system as a special object is opposed to the non-system (i.e., broken into elements) object; as the many, the plural (a certain set of elements) is opposed to the unity, the singular (an object consisting of one or, at best, a few elements). Secondly, the system appears not just as a set but as a connected set of elements possessing wholeness owing to its connectedness.\(^15\)

These pivotal points in the formation of the 'system' concept may serve as the clue to the wide scattering of meanings given to this term in modern literature. Some of the existing definitions emphasize the plurality of elements of the system, others are focused on the interaction of elements of the system and on its wholeness.\(^16\)

Taking the wholeness of the system as the starting point, one may define the system on the non-formal level through the following features.\(^17\)

1. The system is an integral complex of interconnected elements; (2) it forms a special unity with the environment (in some problems the system cannot be considered in isolation from the environment, although this does not mean that all problems of system and structural research are of this nature); (3) usually any investigated
system is an element of a higher-order system (that is, it may, in other problems, appear as a subsystem or element of a broader system); (4) elements of any investigated system in their turn usually appear (again in special problems) as systems of a lower order.

One must pay special attention to the hierarchical character of the system intimately connected with its wholeness. The hierarchy is manifested both in the chain of systems' inclusions into one another and in the interaction of individual subsystems, including the character of the functioning of goal-directed subsystems and their impact upon the system concerned of great importance for understanding the hierarchy is the fact that different 'levels' of the system may consist of one and the same material.18

In general, we can say that three different levels of description are minimally required for any system under study:
1. from the point of view of its external, integral or wholeness properties;
2. from the point of view of its internal structure and the 'contribution' of its components into the formation of the system's wholeness properties;
3. from the point of view of the interpretation of a given system as a subsystem of a larger system19.

Therefore, it becomes impertative to identify the elements of a system. Because, a system is a set of interconnected, interrelated and interdependent elements, which operates together to achieve definite objectives.

3.2 ELEMENTS OF A SYSTEM:

i. External Environment.
ii. Inputs

iii. Internal Environment

iv. Transformation Process

v. Output(s)

vi. Feedback and Feed forward.

3.21 EXTERNAL ENVIRONMENT:

No system works in an isolation but it functions in relation to other systems, which are subject to certain set of ever changing conditions and forces that affect the strategic options of the system but these are beyond its control. These conditions and forces constitute an external environment.

The external environment may be classified as Micro and Macro environment.

Micro environment is an immediate environment of a system, that affects the performance of the system. Where as macro environment consists of larger societal forces, which affects all the actors in the systems micro environment.20

The specific variables of external environment of a system may be as follows:

ECONOMIC ENVIRONMENT:

Economic conditions, economic policies and the economic system are the vital external factors that constitute the economic environment of a system.21

SOCIAL ENVIRONMENT:

The beliefs, desires, values, attitudes, opinions, expectations, customs, life style of those in a system as developed from their cultural ecological,
demo graphic, religions, educational and ethnic conditioning.

POLITICAL ENVIRONMENT:

Political environments the attitudes and actions of political and government leaders and legislatures do change with the ebb and flow of social demands and beliefs. The direction and stability of political factors is also a major consideration.

TECHNOLOGICAL ENVIRONMENT:

A technological innovation can have a sudden and dramatic effect on the environment of a system. One of the most pervasive factors in the environment is technology. It is a science that provides the knowledge and it is technology that uses it. The term technology refers to the sum total of knowledge we have of way to do things. It includes inventions, it includes techniques, and it includes the vast store of organised knowledge about everything.

DEMOGRAPHIC ENVIRONMENT:

Demographic factors like the size, growth rate, age composition, sex composition, etc. of the population, family size, economic satisfaction of the population educational levels, language, caste, religion etc. are all factors which are relevant to system.

NATURAL ENVIRONMENT:

Geographical and ecological factors, such as natural resource endowments, weather and climatic conditions, topographical factors, locational aspects in the global context, etc., are all relevant to system. The micro environment involves factors which are more intimately linked with the system than the macro factors. These includes Customers,
Suppliers, Competition, Marketing intermediaries, Market types, Market demands, Financial institutions, Regulatory Provisions, Industrial relations climate, Availability of skilled manpower etc.

### 3.22 INPUTS:

The inputs of a system are information, energy, materials or goods in terms of demands and support. Demands of the system are independent and supports may be shared. These demands and supports enter into the transformation process through an internal environment of the system.

### 3.23 INTERNAL ENVIRONMENT:

The internal environment again mends the inputs before transformation because of some crucial internal factors of a system. Informal structures, and processes of a system constitutes the internal environment. Its elements are individuals, groups, informal organisations, work culture, interpersonal relationships, situational factors, desire and needs of an organisation's management, employees unions, the relationship of employees with authorities, their level of satisfaction etc.

### 3.24 TRANSFORMATION PROCESS:

It is concerned with effective conversion of inputs into outputs. Here authority structure and operational structure both facilitates this process. Authority structures are the decision making agencies and operational structures are the bodies which carry on decisions taken at higher level.

### 3.25 OUTPUT:

The processing unit, after processing convert the inputs and provide them to the system in terms of outputs. These outputs are diversified and needs congruance with inputs. In this process resources which are applied
from time to time to fulfill the demand of a system will emerge in a shape of developed resources. Ultimately, components of outputs affect the micro as well as macro environment.

3.26 FEEDBACK AND FEED FORWARD:

Each system may establish its own mechanism of feedback or feed forward. It may rely on informal network also.

Feedback in a system refers to the process of communication both formal and informal, which conveys back the reactions of its subsystems or patrons. That may stimulate the system to restructure the pattern of its activities or even the reformulation of its basic objectives through transformation process or inputs.

Feedback is a new element of a system. It also refers to the process of communication both formal and informal, conveys the achievements of the system are achievable and guides them for standardisation.

Now we shall try to search and review the application of systems concept in Transport sector i.e., to identify a Transport System.

SYSTEMS APPROACH TO TRANSPORT MANAGEMENT:

Prof. G.M. Andavan has suggested a system view for transport management. He expressed his views in a paper presented at the seminar on Transport Management organised by Institution of Engineers and Indian Institute of Public Administration in Madras.

A system can be described as a number of parts making a complex whole, and system analysis means consideration of the complex whole as opposed to project analysis that considers the individual part separately. Although each part of a system may play an individual role in the operation of that system, no part is entirely independent of the
others, and a change in the operation of one part will have significant effects on the operation of other parts.

A transportation programme or plan is just such a system. System approach to transportation management involves maximisation or optimisation of various modes of transportation and the integration and coordination of the various modes to achieve balanced transportation. The final quality of transportation is reflected by various factors like

  Accessibility (or the nearness to activity zones).
  Adequacy (or the ability to handle normal amounts of traffic)
  Reliability (or the degree to which published schedules are kept up)
  Completeness (without need for interchange)
  Continuity (without dislocation or suspension of services)
  Safety (to passengers)
  Minimum loss or damage (to freight)
  Financial Responsibility (for accidents and loss or damage etc.)

Of the various forms of transportation available to man-road transport is by far the most important. Only road transport provides complete "Door to Door" service, whereas all other forms of transport like rail, water, air etc. have to be supplemented by road transport for at least a portion of the journey. From the beaten tracts and beasts of burden used by the early man, road transport has undergone innumerable changes to reach the present stage of advanced development. During the last three or four decades there has been a phenomenal increase in the number of road vehicles in most countries of the world. The vehicle ownership in some of the advanced countries has reached a rate of one vehicle for every three persons. The concentration of population and vehicles in urban areas has created very serious traffic problems like congestion, delay, accidents, noise, pollution and deterioration of the urban environment. Road transport, which by its mobility, once contributed
to the growth and development of the central areas of cities, is now strangling their very existence. Various attempts are being made to improve the urban traffic conditions and arrest the further deterioration of the urban environment. Parking restrictions like prohibition, regulation and charging a fee for parking have been extensively used in many cities to discourage the use of private vehicles in central areas. Also road pricing policies like licencing of vehicles for entering central areas and also metering their actual usage in Central areas are under active consideration in some cities. Fortunately, the situation has not reached such a crisis in the cities of developing countries like India. To prevent similar conditions developing in our cities, it is desirable to initiate early and effective action for extensive and intensive application of measures like:

- Traffic management and traffic planning techniques,
- Transportation management and transportation Planning methods, &
- Environmental management and environmental Planning measures.

As the quality of transportation depends on the accessibility, adequacy, reliability, completeness and continuity. Systems approach to transportation should take into account the total aspect of transportation and all the available transport facilities should be integrated and coordinated to achieve a balance. The integration and coordination can be achieved in the following aspect:

**BETWEEN DIFFERENT SYSTEMS OF THE SAME MODE OF TRANSPORT:**

The intercity transportation system and the intra-city transportation system should be integrated and coordinated. The regional bus transport could be integrated with the urban bus transport system at the terminals along the periphery of the urban area as in Poona. The regional railway
transport could be integrated with the urban railway transport by having
inter change at the periphery as in London. There is good interchange
of railway passengers at Tamaram railway station.

**BETWEEN DIFFERENT SYSTEMS OF PUBLIC TRANSPORT :**

Railways and buses can be integrated by having convenient
locations of bus stops near the suburban railway stations. The Egmore
station is a good example of interchange of persons between rail and
bus. This is also said to be the case in many suburban stations at Bombay.
In Melbourne, Australia, there is a good system of interchange between
rail, bus and trams. The buses connect outlying areas with the suburban
railway stations and act as collectors for the railways. The suburban trains
are operated at frequent intervals carrying large numbers of commuters
into the central city during the peak periods. A good network of tram
lines emanating from the central city connect all parts of the urban areas
and act as distributors for the railways.

**BETWEEN PUBLIC AND PRIVATE TRANSPORT :**

The private transport can be integrated with public transport by
 provision of car-parks, cycle stands and other facilities. Park and Ride
and kiss and Ride facilities are becoming very popular in other countries.
The use of cycle-stand is very popular in all the suburban stations in
Madras Tambaram section.

**BETWEEN DIFFERENT SYSTEMS OF PUBLIC TRANSPORT AND PRIVATE
TRANSPORT :**

The different systems of public transport like road, rail and water as
well as private transport modes like cars, taxis etc., should be integrated.
A good example of integration of long distance regional railway
transportation, suburban railway transportation, public transport by bus
and private transport is Victoria station in London. Another example of
good integration between the ferry service, bus, taxi and cars is in the
efficient operation of the Star Ferry in Hongkong.

The approach to transport management should be in achieving
maximum efficiency and convenience for the passengers by optimising
the individual transportation facilities and by integration and co-ordination
of such facilities.

Many states in U.S.A. have now created Departments of
Transportation covering all the different modes. Perhaps some such
arrangement may have to be thought of in our country also in the near
future.

This paper emphasised the application of system concept by
considering a transportation programme or plan a system and involves
maximisation or optimisation of various modes of transportation and the
integration and coordination of the various modes to achieve balanced
transportation. Examples of India and advanced countries are taken to
perceive the future perspective.

TRANSPORTATION SYSTEM ANALYSIS:
Marvin L. Manheim\textsuperscript{52}, in his book Fundamentals of Transportation Systems
Analysis Vol 1: Basic concepts, provides a basic introduction to the field
of transportation system analysis.

BASIC PREMISES\textsuperscript{53}.

Two basic premises underline our approach to the analysis of
transportation systems:

1. The total transportation system of a region must be viewed as a single,
multimodel system.
2. Consideration of the transportation system cannot be separated from consideration of the social, economic and political system of the region.

   In approaching the analysis of a transportation systems problem, initially we must consider the total transportation system of the region.

 1. All modes of transportation must be considered.

 2. All elements of the transportation system must be considered; the persons and things being transported; the vehicles in which they are conveyed, and the network of facilities through which the vehicles, passengers, and cargoes move including terminals and transfer points as well as line-haul facilities.

 3. All movements through the systems must be considered, including passenger and goods flow from all origins to all destinations.

 4. For each specific flow, the total trip, from the point of origin to final destination, over all modes and facilities must be considered.

   The transportation system of a region is tightly interrelated with the socioeconomic system. Indeed the transportation system will usually affect the way in which the socioeconomic system grows and changes. And changes in the socioeconomic system will in turn call forth changes in the transportation systems.

   The systems of interest can be defined by three basic variable: T, the Transportation systems; A, the activity system, that is, the pattern of social and economic activities and F, the pattern of flows in the transportation systems, that is, the origins, destinations, routes and volume of goods and people
moving through the system. Three kinds of relationships can be identified among these variables:

1. The flow pattern in the transportation system is determined by both the transportation system and the activity system.

2. The current flow pattern will cause changes over time in the activity system: through the pattern of transportation services provided and through the resources consumed in providing that service.

3. The current flow pattern will also cause changes over time in the transportation system: in response to actual or anticipated flows, entrepreneurs and governments will develop new transportation services or modify existing services.

The activity systems of a metropolitan area or a megalopolitan region or a developing country consists of many subsystems, overlapping and interrelated -- social structures, political institutions, housing markets, and so on. Transportation is only one of these subsystems.

The evolution of activity systems is determined by a large number of forces and pressures. The internal dynamics of this system are very complex.

Transportation plays a role in influencing the evolution of the activity system, but, except in very special situations, it is not the role determinant of that evaluation. The development of automobiles and of extensive systems of freeways does not alone cause suburbanization and dispersal of metropolitan areas, but it does interrelate closely with the dynamics of rising income, changing housing and labour markets, and other subsystems. Even
the provision of access roads to a hitherto virgin area of an underdeveloped country will not by itself stimulate agricultural development. There must be a market for the produce and, there must be an array of adequate incentives to development.

The interrelation between transportation and the activity system is fundamental to our approach. The challenge of transportation systems analysis is to intervene, delicately and deliberately, in the complex fabric of a society to use transportation effectively, in coordination with other public and private actions, to achieve the goals of that society. Responding to this challenge is not easy. We must understand transportation as a technology, a system of physical elements managed by human organisations to move people and goods. We must also understand transportation as a subsystem of the complex of social, economic, political, and other forces we so tersely summarize as "the activity system". Most important of all, we must know how to use this understanding effectively.

COMPONENTS OF A SYSTEMS:

A transportation system has many components. Some are physical, others institutional. An illustrative list is displayed with the variety of components and functions that interact to influence system performance.

| TABLE No. 3.1 |
| COMPONENTS OF TRANSPORTATION SYSTEMS |

<table>
<thead>
<tr>
<th>MAJOR COMPONENTS</th>
<th>SUBSYSTEMS</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load carrying</td>
<td>Load containing</td>
<td>Passenger and cargo</td>
</tr>
<tr>
<td>System (vehicle, conveyor belt, pipeline)</td>
<td>System</td>
<td>compartments (truck, rail, air)</td>
</tr>
</tbody>
</table>
Support System
(Transmits load from vehicle to guideway or other supporting medium)

Chassis and suspension system including wheels (truck, rail); airframe, wings and landing gear (air), ship hull (marine)

Power and propulsion system

Fuel tanks, engines, transmission, drive wheels (truck, rail), fuel tanks, engines, propellers (air, marine)

Guidance and control system

Driver, steering system, wheel interactions with roadways (truck, rail); pilot navigation, communication and control equipment (air, marine)

Crew support

Driver’s compartment (truck); cockpit and related area (air); crew quarters (marine)

Load support services

Galleys, food and other services (air, rail); hold-cleaning mechanisms (marine, rail)
<table>
<thead>
<tr>
<th>Guideway</th>
<th>Support system (transmits load subgrade)</th>
<th>Pavement and subgrade (truck); track and to supporting (rail); air medium (air); water medium (marine)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading/ Unloading System</td>
<td>Power and propulsion system</td>
<td>Railside or overhead power distribution system (rail); fuel storage and distribution systems (truck, air, marine)</td>
</tr>
<tr>
<td>Guidance and control System</td>
<td></td>
<td>Traffic signals, control devices regulations (truck); navigation control system, enroute air traffic control, airport approach and ground control (air) navigation aids, piloting systems, harbor procedures (marine); signal and communication systems for headway and speed control, dispatching system for movement control (rail)</td>
</tr>
<tr>
<td>Transfer facilities (intra-and intermodal)</td>
<td>Guidance and control system</td>
<td>Dispatching and train make up (rail)</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-------------------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Loading/Unloading system</td>
<td>Passenger boarding gates and ramps (air); cargo belts, cranes, other loading equipment (marine, rail, air); internal materials handling equipment such as conveyors or forklifts</td>
</tr>
<tr>
<td>Vehicle service systems</td>
<td></td>
<td>Fueling, cleaning, maintenance, checks.</td>
</tr>
<tr>
<td>Storage systems</td>
<td></td>
<td>Cargo storage, short term and longer term</td>
</tr>
<tr>
<td>Load support systems</td>
<td></td>
<td>Documentation, Passenger waiting areas and services</td>
</tr>
<tr>
<td>Maintenance System</td>
<td>Vehicle maintenance system</td>
<td>Facilities, personnel, equipment, spare parts, policies, procedures</td>
</tr>
<tr>
<td></td>
<td>Guideway maintenance system</td>
<td>Facilities, personnel, equipment, spareparts, policies, procedures</td>
</tr>
<tr>
<td></td>
<td>Transfer facility maintenance system</td>
<td>Facilities, personnel, equipment, spare parts, policies, procedures</td>
</tr>
<tr>
<td>Management System</td>
<td>Load support services</td>
<td>Fare collection, load processing, documentation, reservations, tracing</td>
</tr>
<tr>
<td>Operating System</td>
<td>Scheduling dispatching, resource assignment, emergency procedures.</td>
<td></td>
</tr>
<tr>
<td>Marketing system</td>
<td>Load procurement, Sales force, advertising, follow-through incentives.</td>
<td></td>
</tr>
<tr>
<td>Communications and control system</td>
<td>System status monitoring, channels for issuing changes to current operations</td>
<td></td>
</tr>
<tr>
<td>Personnel System</td>
<td>Recruiting, training, management, career ladders, incentives</td>
<td></td>
</tr>
<tr>
<td>Financial System</td>
<td>Cash management, billing, internal accounting and analysis</td>
<td></td>
</tr>
<tr>
<td>Planning and analysis system</td>
<td>Corporate Planning, short range planning</td>
<td></td>
</tr>
<tr>
<td>Organisational structural</td>
<td>Internal organisation structure for accountability and control</td>
<td></td>
</tr>
</tbody>
</table>

Building and operating a system require an input of resources. Typical resources consumed in building and operating a transportation system may be depicted through an illustrative list:

| Labour | Vehicle operations |
|        | Fixed facilities |
| operations (guideways), | transfer facilities |
| | Vehicle maintenance |
| | Fixed facilities maintenance |
| | Management system |
| | Vehicle facilities fabrication |
| | Fixed facilities fabrication |
| Materials | Vehicle fabrication (metals, rubber, plastic, etc.) |
| **Land** | Fixed facilities for the system  
(guideways, transfer facilities, management facilities)  
Fixed facilities for the fabrication of materials. |
| **Energy** | Power for system operations  
Power for vehicle fabrication  
Power for facilities fabrication |
| **Environmental Degradation** | Air quality  
Noise level  
Water quality  
odors |
| **Ecological effect** | Effects on animals life  
Effects on plant life |
| **Social effects** | System as a physical barrier effects of displacement of homes and businesses  
Effects on community cohesion  
Effects on social stability |
| **Aesthetic effects** | View of the system from the outside  
View of the system to uses  
View of the environment from the system |
FIGURE 3.1
SYSTEM APPROACH MODEL
TRANSPORT SYSTEM

Ministry of
Road Transport

Ministry of
Shipping

Ministry of
Railways

Ministry of
Civil Aviation

Road Transport
Board

Shipping
Board

Railway
Board

Air Board

Central
Board of
Transport

State Board
of Transport

District Board
of Transport

District Highways

Block Highways

Project Roads

Urban Roads

1. State P.W.D.
2. Zila Parishads
1. Village Panchayats
2. CD/Panchayat Samities
1. Forest Department
2. Irrigation Department
3. Electricity Department
4. Steel Authority
5. Coal Mines Authority
1. Municipal Roads
Railway Roads
Port Roads
CPWD Roads

Source: Transport Management p. 21.
The magnitudes of the various resources consumed by a system will depend on the specific decisions taken about the design and operation of the system, represented by the vector of transportation options, the geographic and economic environment in which the system exists and the volume of users of the system.

Thus a transportation system can be viewed as a process in which resources are consumed to produce transportation services in a particular environment.

Marvin. L. Mahheim provided a basic introduction to the field of transportation systems, analysis and put emphasis on an activity of identification of the important elements of the transportation system and putting them in comparison to the other related elements. He has also stressed the coordination of various modes of transportation to form a single multimodal system which is tightly inter related to the socioeconomic systems and other environmental factors.

TRANSPORTATION SYSTEM:

Dr. R.R. Khan,\textsuperscript{36} states that, The various kinds of transport - rail, road, water and air- constitute the transport system provided that they function in a coordinate manner. It is futile to speak of transport as a system when its various kinds are not fully coordinated with their functional needs. Coordination avoids un-necessary duplication and overlapping of efforts, and enables us to rationalise transport services. A good transport system ensures optimal utilisation of the various forms of transport. It extends the area of the market, i.e. increases the area over which raw materials can be carried. A balanced transport system makes for speedy delivery of goods and for the mobility of labour. These advantages make large scale industrial production possible, as a result of which comparatively cheaper products can be offered to a large section of the people. It also increases the range and diversity of goods.
The development of a transport network in this country has been an evolutionary process. Many segments are poorly equipped for the functions which they are now required to perform. The unplanned development of the transport network without the visualisation of present traffic thrombosis which has developed in it has jeopardised the smooth flow of traffic. Defective and deficient transport planning, lack of co-ordination between the various authorities, multiplicity of ownership and management, bad and inefficient land use - these are the major causes of traffic and transport problems. The entire issue of transport should, therefore, be regarded as a master system consisting of separate but closely inter-related and inter-connected sub-systems, with all the sub-systems operating in an integrated and co-ordinated manner to provide adequate and efficient movement facilities of men and materials. An application of the systems approach to transport will ensure a co-ordinated strategy and synchronize the activities of various disintegrated fields of transport; it would also help in curbing wasteful competition among road, rail, water and air transport.

A system approach model has been drawn, which would help one to develop a balanced transport system in which the functions and activities of the various sub-systems have been integrated and co-ordinated. The entire issue of transport should be regarded as a system consisting of road transport, rail transport, shipping transport and air transport as sub-systems.
The organisational structure of a unified transport authority represents the devolution of authority at the district level. The system approach model is nothing more than development thinking, which may be modified to the specific requirements of a particular area. The transport network in any country should function as a system in which each section assists, and is assisted by, the other in a coordinated manner; in which each individual mode is planned and each facility is designed as part of the total system.

Dr. Khan has laid strong emphasis on integration and coordination of different modes of transport. He considered them the sub-systems of a master system. He has gone to the extent of suggesting a system approach model to develop a balanced transport system in which the functions and activities of the various sub-systems are integrated and coordinated without wasteful competition amongst them.

**TRANSPORT SYSTEMS:**

David Sewart, in his book *The Theory and practice of Transport*, defined transport system as a planned network of transport facilities. A system contains four physical components. These are: The way; Terminals; Motive power and carrying units (vehicles). These four elements rely for their efficient operation on the effective use of the crucial fifth element staff. Without qualified manpower a transport system cannot be operated efficiently. Effective transport planning involves the application of the 'Systems concept'. This concept involves an awareness of the inter-relationship of the elements of the transport system. The systems concept may be consciously applied, for instance, when long-term plans for a rapid transit system are devised using mathematical models to study (for example) the relationship between passengers boarding time and track capacity. The systems concept is also applied (although almost
unconsciously) by a railway signal man who, with a 'feel' for a situation sidetracks a late running train into a passing loop in order to avoid congestion at a terminal in the knowledge that the more powerful locomotive of the following train will enable it to overtake quickly and cause the minimum of additional delay to the late running train.

If the system approach is neglected obvious inefficiencies arise. One of the most obvious examples of such inefficiencies is road traffic congestion. This traffic congestion occurs because the number of road vehicles exceeds the designed capacity of the road network and parking spaces. In other words the vehicle investment has not been related to the investments in track and terminals. The function, nature and ownership of the physical elements of a transport system vary in the different modes of transport.

David's viewpoint may be summarised as follows:

1. The system concept of transport involves adopting a balanced approach to the physical elements to avoid delay or waste of resources.

2. The effective adoption of the system approach involves the employments of properly qualified manpower.

3. The physical elements of a transport system are the way, terminals, the carrying unit and motive power.

**TRENDS IN INDIAN TRANSPORT SYSTEM:**

Dr. Desai Panduranga Rao observed that the existing system of transportation is undoubtedly an example of the brilliant human endeavour and achievement in the development and sustenance of the human race basing on the ancient and primitive systems of transportation.
The transportation system is the culmination of all technical instruments and organisations designed to enable persons, commodities and news to master space.42

The extent and model structure of a transport system reflects many influences, including the country's geography terrain, the structure of its economy, and the history of its growth and development. Factors such as density of population and the disposition of resources, i.e. the basic supply and demand for goods and travels, are by far most significant in determining the density and mix of transport modes. Transportation needs can be met by any one or combination of the following modes: Rail or Road services, Aviation, Inland water way, coastal and ocean shipping, and Pipeline Port.43

In India the modes of transport are mainly three: i.e., land surface transport, water transport and air transport. Railway and road transport are the two important constituents of the land surface transport system in any country.44

Dr. Rao feels that, frequent development in the trend of modern transport system goes hand in hand with scientific and industrial growth. Moreover, industrially and technologically advanced countries have an unfailingly efficient transportation network to help, boost and promote their rapidly growing industrial and scientific ventures. But unfortunately in Indian, where an ambitious industrial and technological future is nurtured the transport system is not yet a well organised economic sector. It would be rather appropriate to sat that it is a neglected field of economic activity and proper research has also not been undertaken to locate its problem spots. That's why he suggested to strengthen it from district level to the national level by selecting Visakhapatnam district (a unit) as a workable model to study the entire infra-structure of India in comparative details.

Dr. Rao has another title 'Transportation System Studies: Analysis and Policy', to his credit which was published in 1993, but we were unable to have the book while reviewing the research studies and literature on the subject at different libraries.
Society includes in additions to the operator and the user, all non-
uses of the system.

TRANSPORTATION SYSTEM:

P.G. Patankar, in his book Road Passenger Transport in India while
dealing with the operational productivity and efficiency issue referred to
a study on operational productivity and efficiency in road passengers
transportation systems, and wrote that, it is implicitly related to the
viewpoints considered for the study. Further he expressed that,
traditionally, the study considers the transport system providing service to
the travelling public, covering factors of production to increase output
and to reduce unit cost of production. This is, no doubt, important; but in
a transportation system there are three other 'actors' whose point of view
must also be considered for a comprehensive study, through the operator
of the system is the most important actor who makes a direct impact of
the system. The second major actor is the user of the system, viz., the
passenger. He represents the raison d'être of the system itself and,
therefore, his point of view should be a vital part of the system. While
considering the productivity and efficiency, quality of service cannot be
ignored. The user of the system also contributes major inputs to the
operation of the system and is the first to realise the system's output. In
terms of input he contributes his time, out-of-pocket costs and fares, accident risks and personal efforts. In terms of output, he receives the
trips completed in the system, plus a level of comfort and contentment.
It is, therefore, apparent that productivity and efficiency must be
synchronized with the satisfaction of the user.

Even the society's point of view must enter the discussion on
productivity and efficiency because of the social significance of the
passenger transportation system, whether urban or rural, as the society is
called upon to provide or receive from the transportation system, this is
shown with the help of table as follows:
While raising the level of productivity and reducing costs, it would be necessary to understand the extent of which the transportation system produces desirable outcomes, reduces the production of undesirable outcomes, and restricts the need for additional social inputs. The transportation perse is only an intermediate product, and therefore, any resource conserved from its use is bound to be available to another sector of the economy. Society includes in addition to the operator and the user, all non-users of the system.

The point of view of Government must also be considered because of increased involvement that it has at all levels with operations. Government provides carriage-ways, a part of finance and extensive regulatory mechanisms, and all these must be given an important consideration in any productivity discussions. Government has a special role as it acts as a specific instrument of the society to achieve collective goals. The prudent management of public funds, wise allocation of present resources, the anticipation of future growth and problems, emergence of new needs and fulfilment of societal requirements, all play an important role and involve Government's point of view. Ultimately, it is the Government which invests and the society at large collects.
The transportation systems thus means actions of FOUR agencies. The operator, i.e., a STU, in many cases, receives inputs from users, the society and the Government while it delivers services primarily to users but indirectly to the society at large and the government. On the other hand, society receives support from users and delivers it to the operator. Finally, Government receives support from users specifically and the society in general and delivers it to the operator. This continuous flow of inputs is essentially a closed system and a study on productivity and efficiency cannot be achieved unless an equilibrium exists between support received and support provided by each of the four actors of the system. It is imperative to conceive the system in its totality and then to dissect the overall system appropriately for achieving balanced results in respect of productivity, economy, efficiency and quality of service in the transportation system. A schematic presentation of the relationship of the four actors in the transport system is given in a figure 3.2.

Basically a road passenger transport system produces seat kilometres for serving the community. Improving productivity will mean producing seat kilometres, being the most perishable commodity, by keeping costs as low as possible and at the same time ensuring the desired level of passenger satisfaction. To achieve this, of course, there would be a number of action areas that could bear a great deal of scrutiny. It is in these areas that components of productivity exist and various factors pertaining to these areas have to be scientifically analysed, if productivity is to be seriously contemplated. Productivity will engulf all areas such as (a) fleet utilisation, (b) vehicle utilisation, (c) crew utilisation, (d) carrying capacity, (e) avoidance of cancellations, (f) minimisation of breakdowns, (g) conservation of fuel, (h) improving tyre performance, (i) quality assurance in respect of incoming stores, (f) avoidance of accidents, (k) reduction of staff cost, (l) Improvement of earnings, (m) cost reduction, etc., and involve a well knit action plan on the part of all four agencies as described.
FINANCIAL ASSISTANCE AND CARRIAGeways

GOVERNMENT

TAXES AND LEVIES

SOCiETY

LAND, LABOUR, ENERGY RESOURCES

ECONOMIC ENVIRONMENTAL SOCIAL IMPACTS

TRANSPORTATION SYSTEM ACTORS

OPERATOR

MONEY

MEN

MATERIALS

ROADS, VEHICLES, INFRASTRUCTURE

TIME

EFFORT

SERVICE

USERS

REVENUE

FARE
THE ENVIRONMENT OF A ROAD TRANSPORT SYSTEM
It is certain that productivity must improve considerably in the road transport industry. There is no alternative to achieving better productivity in every area of the activity if the road passenger transport system has to render quality service to the travelling public. The industry must ensure scientific and efficient scheduling, optimise fleet and vehicle utilisation, induct motivation, ensure quality, preventive and corrective maintenance, practise effective materials management, and so on. To ensure productivity and quality in the overall operations, knowledge of the environment of a road transport system which is complex indeed, is so necessary. Figure 3.3 shows this environment.

Road passenger transport industry is highly labour intensive and again a service organisation, handling large masses of the travelling public. As internally the labour force can bring the vehicle wheels to a grinding halt, so also externally passengers can do the same. Apart from passengers, even the general public seems to make a transport vehicle their target while expressing dissatisfaction or revolt against Government policies, programmes and actions, whether they relate to transport or not. It is amazing, to say the least, that students dissatisfied with their teacher come out on streets to halt the wheel by stoning buses, by burning them, by hijacking them, and so on. It is thus the manpower management internally and public relations externally that influence the productivity so much. The external factors, no doubt, are by and large beyond the control of the Management; but internally science of motivating staff to attain the highest productivity takes precedence over other techniques. What is very vital is the evolution of proper manpower planning programme for the acquisition, development, presentation and utilisation of human resources of any transport organisation. The key asset, through not appearing on the balance sheet of an undertaking, is the contented worker. A professional manager can use money and
materials to achieve higher productivity but only with the help and co-operation of willing workers. If this co-operation is not forthcoming, productivity techniques, whatever they may be, to harness material resources will fail miserably. In fact, the key to productivity in road transport industry is the contented and willing worker. It is obvious that in a labour intensive industry like road transport, good industrial relations would be in a sine-qua-non for effective operations.

Dr. Patankar talked about system in relation to road passenger transport keeping in view the Indian perspective in mind. He believes that as half of the rural population still lives below poverty line. The benefits of economic development have yet to reach them. Road passenger transport can accelerate the development process in these villages. It has therefore to be geared to reach the teeming millions and bring them close to the mainstream of national development. That's why he emphasise to conceive the transportation system by identifying its four vital elements and relevant environment in its totality and then to dissect the same appropriately for achieving balanced results in respect of productivity, economy, efficiency and quality of service.

SYSTEMS APPROACH TO TRANSPORTATION PLANNING:

S. Sriromon*, based this paper on the proceedings of International conference on Transportation System studies, the event's theme being "Man - Material Transportation systems" hosted by Indian Institute of Technology Delhi in the month of December 1986.

Urban transport planning was the focus of a number of papers under various themes. The trend was towards an integrated land-use and transport planning process and the emphasis was on the study of land-uses that give rise to traffic flows and the effects on land-use patterns resulting from the operation of the transport system. Transport and land-
use planners have come to realise the potential of transport to shape
the urban environment by influencing the accessibility of locations within
an urban area. Thus, attempts are being made to utilise the long term
influence of accessibility and changes in accessibility brought about by
the implementation of transport proposals. Moreover, from the point of
view of evaluation of services, it was generally felt that there was a need
to develop meaningful measures to reflect the level to service that a
transport system provides in terms of accessibility, travel times, reliability,
etc. thereby generating the necessary feedback from the users of the
system.

One dominant issue concerned was the growing role of the railways
in India.

In one of the sessions various aspects of vehicular and infrastructural
design were examined. The application and use of computer aided
control systems in the transport sector was also highlighted. The relevance
of non-mechanised transport came up for detailed discussion at a stage
when the focus shifted to a consideration of the urban and rural poor.
In the rural context, the bullock cart continues to be the chief mean of
transport, especially for short distances.

In larger terms, the thrust of the arguments were in favour of a systems
approach to the transportation planning process. Also, the transportation
sector cannot be considered in isolation and its study must be conducted
within an integral part of the overall planning strategy, whether this is
considered on an area, regional or even national basis.

INTELLIGENT ROAD TRANSPORT SYSTEM - AN OVERVIEW AND PERSPECTIVES
FOR INDIA:

R.K. Arora and Som Dutt Dadheech,⁷ in their paper highlighted the
international developments pertaining to a number of programmes/
projects which are underway in the developed world to utilise electronics and Information Technology involving heavy investments, in the name of Intelligent Road Transport Systems.

There is a vast potential for application of electronics and information technology in improving efficiency and safety of roads, vehicles and drivers while reducing pollution and fuel consumption. Realising this long-term and short-term programmes and projects on inter-disciplinary approaches involving huge funds are being undertaken worldwide. Applications like dynamic route guidance, automatic vehicle location and navigation, fleet management, electronic toll collection, urban traffic control, traffic information broadcasting and monitoring and classification are being used on commercial basis. Development and demonstration work on projects like intelligent car, collision avoidance, automated highway system are in progress and may take some more time to be available commercially. With the availability of mobile communication services and positioning products available indigenously, and harnessing system engineering capacity, cost-effective solutions for various applications can be evolved and implemented in India for realising an improved road traffic system.

At the turn of the century, without any doubt electronics and information technology has proved that it will reign the next century and future time to come. Therefore, it is to be considered as a most dominating element of a transport system and to be included in the list of inputs of a system.

**TRANSPORT SYSTEM MANAGEMENT—NEED OF THE DAY:**

T.S. ReadY: The urban areas are growing in size and population at a rapid rate. The population densities are increasing demanding higher capacities on urban transport system. Before taking decisions on long
term infrastructure development the existing infrastructure should be exploited to the maximum. Transport Management System (TMS) actions are the means to optimise the use of our infrastructure.

This paper attempts to briefly touch upon the possible TMS actions for application in our cities and also raises some related issues for discussion.

Evolution of TMS actions would basically involve the following stages:

- Identification of problems
- Quantification of problems
- Identification and evolution of objectives and goals.
- Identification of TMS actions (alternatives).
- Developing evaluation mechanism.
- Evaluation of the proposed actions against expected objectives and goals (choosing the best option).
- Implementation of the chosen alternatives.
- Monitoring the impacts of the implemented alternative to effect mid-course corrections, if needed.

COORDINATED TRANSPORT SYSTEM

The various Transport systems in India consist of a number of subsystems namely rail, bus, Taxi, cars, scooters, auto-rickshaws, cycles, cycle-rickshaw etc. The scope of these systems vary from city to city, depending upon the size and socio-economic structure. For example in smaller cities the IPT (Intermediate Public Transport) modes like auto-rickshaws, cycle-rickshaws perform the role of public transport and also more or less become a primary mode of transport in these cities. In cities like Bombay, Delhi, Calcutta, Madras, their role in more or secondary mode, in the sense that a part of the trip is performed on this mode to access the primary mode like train, bus etc., for making longer trips. Such a role is very predominant in Bombay and New Bombay. In other words market
forces are dictating the coordination of different modes of transport systems. Another form of coordination that can be visualised is park and ride system. In the recent past this system has emerged in the natural course in Bombay and New Bombay. The commuters use their individual private modes of transport to reach the nearest railway station or bus terminal park in their own vehicle and perform the trip on the Public Mass Transport. While in New Bombay the terminal parking spaces have been proper conceived and planned, in other cities like Bombay, Delhi, Madras they have not been planned on a systematic basis. Keeping the emerging trends there is a need to carry out indepth research studies to identify the requirements of park and ride systems in different cities.

Apart from this there is another form of coordination that can be visualised is bus-rail coordination. This is found maximum in Bombay followed by New Bombay and Madras. In Delhi the MRTS planning studies have conceived this system of coordination where bus routes and rail routes are to operate in a complementary and coordinated manner. As one can visualise is the system of such coordination in Delhi is apparently unlikely because of comparatively shorter trip lengths. For example the average trip length in Bombay is 30 Kms where as in Delhi that is around 10 Kms. For shorter trip lengths involving a journey of less than about 45 minutes the change of mode is rarely preferred. In Delhi recently emerging market is for cycle rickshaws where this mode is used to feed the bus routes from residential colonies. However, these developments are organic and need to be studied on a systematic basis and harmonised to avoid conflicts between fast moving heavy vehicles and these slow moving cycle rickshaws.

In a nutshell it can be said that systematic studies are required to be undertaken in major metropolitan cities to evolve coordinated transport systems to make the lives of residents more comfortable and make the cities worth living in.
Issues To Be Addressed:

Our urban areas are growing in size requiring huge investments in Transport Infrastructure. Before deciding on the long term developments of transport system it is essential to make the optimum use of the existing infrastructure. Therefore there is a definite need to identify the appropriate TMS actions applicable to our urban areas.

The problems of our urban areas are very different from those experienced in developing countries from where the TMS technology is being transferred. Therefore it is very necessary to conduct necessary research and evolve appropriate TMS actions to suit our needs.

Parking demands are continuously on the rise and the inner-areas as well as outer areas of cities are gradually becoming inadequate in providing for the needed parking spaces. Therefore there is an urgent need to evolve policies relating to the provision of parking spaces in our developmental plans and more urgent need is to evolve parking as an effective tool to manage parking demands as well as reducing travel needs.

In cities wherever roads are sufficiently wide designed busways/bus lanes should be adopted to encourage mass transport systems.

As observed in many cities the mass transport systems are inadequate to cater to needs and IPT modes are substituting the role of Mass Transport. There is an imminent need to regulate the operation of these modes and also evolve proper terminal facilities for these modes.

In larger cities park and ride system is catching up and as such there is a need to assess the needs of these systems in terms of parking and circulation spaces and evolve design standards.
Urban Freight Transport needs are to be assessed and systematic planning techniques have to be evolved for achieving the economy and protect the environment in our cities.

Last but not the least is the need to set up Traffic and Transportation divisions in all the cities with established local administrations. The responsibility of these divisions would be to identify the problems from time to time and evolve TMS actions to ease the problems. Besides this they will have to prepare future transportation plans, may be with the help of specialist and consultants. This point of having inhouse expertise of Traffic and Transportation in the city administration is very essential to make the traffic move smoothly on our urban roads.

Mr. Reddy emphasised that Transport Management System (TSM) actions acts as a mean to optimise the use of infrastructure as infrastructural development is the need of the hour because of rapid urbanisation. He suggested to identify different alternatives (TSM actions) keeping in view the coordination of various modes of transportation and the relevant issues concerned with transport to make the mobility smooth and confortable.

All the view points considered above may be summed up as follows:

Most of the authors advocated the integration and coordination of different modes of transportation to achieve balanced approach and to avoid delay, wasteful use of resources and unnecessary competition. Dr. Khan considers them the subsystems of a master system. David Steward David has identified the way, terminals, the carrying units and motive power as the physical elements of a transport system. According to Dr. Desari Panduranga Rao, the transportation system is the culmination of all technical instruments and organisations designed to enable persons, commodities and news to master space. He studied it from the grass root level and studied it from the grass root level and studied
Visakhapatnam district as a unit. Dr. Patankar's emphasis was road passenger transport, he identified operator, user, society and government, four vital elements of road passenger transport, system and its environment. S.Sriraman considered that transport activity is not performed in isolation, the transport planning process is to be holistic, based on system approach and to be conducted within an integral part of the overall planning strategy. R.K. Arora and Som Dutt Dadheech, highlighted the consideration of electronic and information technology towards the formulation of Intelligent Road Transport System. Last but not the least T.S. Reddy suggested to identify different alternatives (Transport System Management actions) under the system perspective.

The foregoing review of research and literature an transport or transportation system (The term 'Transport' and 'Transportation' have the same meaning, the latter being used more frequently by the American authors of the subject) suggests that the subject is wider in scope and in depth in study and has interdisciplinary character. Therefore, continuing and sincere efforts are required for comprehension. Though the efforts made towards this cannot be claimed to be exhaustive but may be sufficient to draw a framework to study a transport organisation.

Although, the most important aspect of system approach is its holistic nature i.e., to take into account the totality of factors relevant in a situation. Secondly, this approach tries to locate a system or order behind every existing social phenomena as it is based on the assumptions that different elements of a social setting are not interacting in a haphazard manner but systematically related with each other. Thirdly, a system may be open
or closed depending upon the interaction with its surroundings. However, most of the social system are open as they continuously interact with the environment. In other words, they affect their surroundings and get affected in turn. Fourthly, the demands made on the system along with its resources constitute its input which is processed by the central processing mechanism of the system. Fifthly, the processed demands are expressed in the form of outputs which are directly related to the objectives and goals of a system. Sixthly, the gap between output and input is further communicated back to the system through a feedback mechanism.⁴⁹

Therefore, with this perspective this study titled as "Organisation And Management Of Road Transport In Himachal Pradesh-- A Study of Himachal Road Transport Corporation" is to be made. For this purpose Himachal Road Transport Corporation (HRTC) is to be considered an organisational system rather an open system. Hence, the system approach is to be applied to HRTC with its specific and distinct characteristics studied and derived above.
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