ABSTRACT:

Demand – supply – system are the three core clusters of transportation research in policy making for addressing mobility problems, infrastructure and functionality issues in urban areas. This study explored the development of strategic approach to supply system planning that provides a quantitative method to support decision making in urban transportation development planning. An attempt is made to address the urban transportation problems caused due to land use insensitivities, network dissimilarities, demand concentration, non warrant view from supply utility etc.

The policies in developing countries are framed to fit the urban form in a hostile environment to meet mobility, accessibility and connectivity needs whereas policies in developed countries emphasize sustainable transport solutions, recognizing the environment with integrated planning approaches. The policies however, are designed to balance the pace of economic development. India is in the pace of transformation from developing to developed nation and all Indian cities face a crisis of urban transport with the suboptimal use of existing infrastructure. Indian urban transport policy addresses an integrated transport landuse planning to solve urban mobility problems. But the policy guidelines in developed / developing nations indicate a clear gap in the scientific approaches / planning guidelines on the supply system development with respect to functionality, utility and similarity which are the key control points for enhancing the system capacity. Academic research on supply system planning focuses on attaining the demand – supply equilibrium with supply system enhancement to reach the demand or demand management to meet the supply system.
An approach for demand deconcentration and consolidation with existing supply system design and reorientation have been developed to achieve homogeneity in travel with uniform landuse dissemination.
This study attempts to orient the supply system considering the demand that makes the supply system subjected to an optimal use and can also promote demand deconcentration, landuse dissemination with the attainment of demand-supply equilibrium over a time frame. The basic objective of the study is to develop a strategic approach to urban transport policy framework for supply system planning and orientation by development of a fractal supply environment that facilitates uniformity and similarity in demand orientation. This has been formulated by development of a functional network that suits the fractal view, thus generating a congenial urban environment.

Fractal supply system derives an inherent hierarchy embedded in it that is critical to system efficiency. Existing non effective and non regularised hierarchy of supply system emerged with government policies and user knowledge which are the key existing control entities in the operational performance of the network are considered critical and hence are to be improved considering system wide impacts. Hence an approach to prioritise these critical entities is required as a supportive tool to supply system planning and its capacity enhancement. With these multiobjective tasks, the study is attempted with characterization, evaluation and design of supply system. The analysis assumes a spatial evaluation as a proxy to the operational performance of network without considering the real time dynamics of travel. The existing supply system is analysed assuming a non hierarchial system at the present time with demand loaded on the shortest paths that are considered as user preferred paths. The functional network is assumed to represent the traffic demand network which is designated on the basis of outward representation of travel demand identified.
The analytical framework is attempted through characterization and topological formulations of demand and supply analysers, static supply evaluation to give a lead to the design of supply system. The tools for characterization of demand and supply that are dynamic and static in nature are derived through graph theoretical approach of network generalisation by nodes, links and paths converging in a common platform for analysis. The normalization of demand over supply is made by trip orientation over path, trip intensity over node, link and path and trip length over path in a network. This is attempted with static and dynamic analysis of network through road user concepts. A static evaluation is also made to determine the state of the existing system based on the shape / morphology criterion as a proxy to measure the connectivity, accessibility and hierarchy of the supply system. The tools used for static evaluation are fractal geometry, standard deviation ellipse and coverage index that measure similarity, Centrality and spatial dispersion of supply entities. An ideal configuration of the evaluation parameters is often observed in a planned urban areas and in the core CBD areas which are policy driven and structured over a time frame. Transitional urban areas which need planning intervention often show signs of non-ideal configurations of evaluation parameters. Hence transitional urban areas which are victims of urbanization are selected for the study. The evaluation of the transitional urban areas identifies the type of design required for the area. Design is formulated with node similarity, link/path similarity and development of integrated network with a supportive planning tool for path prioritization. Modeling tools attempted for the design phase included p-Median conceptualization, development of spatial decision support system with subset analysis and multi criteria analysis. Conceptualization included
system wide analysis with neighbourhood concepts, road user concepts, supply utility concepts to analyse in a modeling framework. The data requirements included road network characterization studies and traffic characterization studies for urban form and travel pattern characterization. GIS is used as a supportive tool which could accommodate complex network analysis through graphical interfacing and module addition in VB/VC++. The analytical framework is validated and evaluated with real world resources and comparison of the existing and proposed conditions to generalize the design approach.

The methodological framework is attempted with the following folds:

- **Fold 1:** Data collection using road network characterization and traffic characterization studies involving Differential Global Positioning System survey, Road inventory survey, Classified Volume count survey, Videography survey, Origin destination survey, speed studies, delay studies and headway studies

- **Fold 2:** Selection of study locations based on the explicit and implicit characteristics defined as scope of elements for location choice. The explicit characteristics of urban form include urban shape and transportation network whereas implicit characteristics include demographic, socio-economic, node, link, network, impedance, landuse, travel pattern characteristics that are varied in nature.

- **Fold 3:** Development of generalization patterns for network representation through node, link and path
Fold 4: Urban form characterization through development of GIS base map

Fold 5: Development of static supply analysers by identification of node, link, path and network characteristics

Fold 6: Travel pattern characterization through development of demand analysers using intensity, load and orientation of trips

Fold 7: Static and dynamic analysis of road network for normalization of demand analysers over static supply elements i.e.; on node, link / path, network through node / link trip intensity (dynamic), node/ link overlap size (static and dynamic), user preferred path trip assignment and overlap size

Fold 8: Evaluation of static supply system to measure the topological spatial structure with reference to shape / morphology as a proxy to measure connectivity, hierarchy and accessibility. The evaluation is made to measure similarity, centrality and spatial dispersion characteristics of existing functional supply elements through fractal dimension, standard deviation ellipse and coverage index.

Fold 9: Development of node similarity by identification of nodes to be developed which are critical components in the network performance and are highly functional in demand transition through conceptualization of p-median method (Facility location problem). Conceptualisation includes node
and neighbourhood characteristics of a node considered for determination of node potential and distance as impedance parameter analysed through a grid topology analysis in a iterative process

- **Fold 10**: Development of link/path similarity by a modeling framework of subset analysis in a spatial decision support system framework. The demand and static analysers developed in urban form characterization with priority to links/path promoting external based movements, high dynamic and static intensity in terms of trip intensity and overlap size are considered in the modeling framework.

- **Fold 11**: Integration of paths in a network with the neighbourhood network to develop a coordinated network and a fractal environment in urban form.

- **Fold 12**: Prioritisation of existing major paths in a network to provide a supportive tool for spatial planning with system wide analysis. The functional behavior of the path is analysed in light of its functional attributes such as geometric, traffic and landuse characteristics in a multicriteria evaluation framework conceptualised with five phases – input phase, design phase, analysis phase, evaluation and validation phase, choice phase.

- **Fold 13**: Evaluation and Validation of the fractal supply system with the comparison of proposed and existing supply system.
Fold 14: Evaluation and Validation of path prioritization with comparison of prioritized rank with the input characteristics.

Fold 15: Development of policy framework, strategies and implementation requisites for supply system planning and its enhancement.

The study is applied to the transitional urban fabric of Hyderabad city comprising 10 municipalities of Cyberabad region. Functional road network with critical nodes and links/paths have been developed in the study locations and are integrated with the neighbourhood network that formed a beltway around the CBD area. The fractal network obtained from the analysis is shown in the figure below. Major corridors in all the 10 locations were prioritized using Multi criteria analysis. The approach is useful in developing policy guidelines for supply system planning.

Supply system enhancement can be further operationalised with new infrastructure development and identification of missing links with the three dimensional spatial planning perspective through engineering face life. Road utility assessment and functionality allocation can be viewed from activity based road utility rather than landuse/location/ accessibility based criterions.