Research Paper

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Study of Congestion Contributors of Traffic Mobility in Urban Areas: A Case Study of Gaddiannaram Municipality Area Hyderabad, A.P., India

Engineering

KEYWORDS : Congestion generation; Road networks; contributos;Travel demand analysis; ; User preferred paths; Principal component analysis.

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ABSTRACT

Urban congestion is one of the major issues which is influencing road user. This influence is effecting on economic travel, non-substance of environment, psychological strains and a travel imbalance on traffic mobility. Congestion priority for major corridors of traffic mobility was done with the objective of knowing links which lead to congestion. The Gaddiannaram municipality of Ranga Reddy district, Andhra Pradesh, INDIA has been delineated as the study area. Identifying congestion in the links of the network is an important task in integrated planning. The performance and functionality of a link can be attributed to many characteristics including the neighborhood characteristics of the link and there is a research gap in finding the exact criterions which are the real factors of congestion generation . So the link has to be evaluated based on these conflicting multi attributes at one point of time.

Introduction

Urbanization is closely linked to upgrading, industrialization, and the sociological process of validation. Rapid Urbanization causes disorganized and unplanned growth of urban centers which becomes more complex with the fact that it must take place within the built up area. This pressure of continuously growing population results in congestion and becomes trouble to limited public sequence facilities which forces the middle class as well as builders to move to outlying periphery, phenomenon called Urban spread out or development. Urbanization operating in the fringe brings a number of Transportation problems of safety, congestion, accidents, parking, management and enforcement. [1]

The study is attempted, with reference to the geometric, traffic, utility and land use characteristics of the study area, to identify the major corridors with traffic characteristics as independent characteristics congestion generation, distribution and to identify the links leading to congestion. A mathematical model, namely Principle Component Analysis is used to find congestion links. In this analysis Speed is considered as major contributor.

Principal component analysis

The central idea of principal component analysis (PCA) is to decrease the dimensionality of a data set consisting of a large number of interconnected variables, while retaining as much as possible of the variation present in the data set. This is achieved by transforming to a new set of variables, the principal components (PCs), which are uncorrelated, and which are ordered so that the first few retain most of the variation present in all of the original variables. **[4]**

In PCA, the extractions of PC can be made using either original multivariate data set or using the covariance matrix if the original data set is not available. In deriving PC, the correlation matrix may be used, instead of the covariance matrix, when different variables in the data set are measured using different units or if different variables have different variances. Using the correlation matrix is equivalent to standardizing the variables to zero mean and unit standard deviation.

The PCA model can be represented by:

$$U_{mx1} = W_{mxd} X_{dx1} \text{--------} (1)$$

Where *U*, an m-dimensional vector, is a projection of *X* - the original d-dimensional data vector (*m* << *d*). It can be shown that the m projection vectors that maximize the variance of *U*, called the principal axes, are given by the eigenvectors e1, e2, ..., em of the data set's covariance matrix S, corresponding to the m largest non-zero eigenvalues ë1, ë2, ... ëm.

The data set's covariance matrix S can be found from:

$$S = \frac{1}{n-1} \sum_{t=1}^{n} (x_t - \mu)(x_t - \mu)^T \text{---------} (2)$$

Where μ is the mean vector of *x*. The eigenvectors e_i can be found by solving

The set of equations:

$$(S - \lambda_i I) e_i = 0 \; for \; i = 1,2, \ldots \ldots d \text{---------} (3)$$

Where e_i are the eigen values of *S*. After calculating the eigenvectors, they are sorted by the magnitude of the corresponding eigen values. Then the m vectors with the largest eigen values are chosen. The PCA projection matrix is then calculated as:

$W = E^T$ ------ (4)

Where *E* has the m eigenvectors as its columns. Here *W* is an mxd matrix.

Study area

The Gaddiannaram municipality of Ranga Reddy district has been delineated as the study area (Fig.1). The study area comprises of 21 wards. Based on the survey, 5 major corridors have been identified. The map shows the major corridors and major intersections in the study area. The map showing the major intersections can be viewed in Fig.2

Figure 1

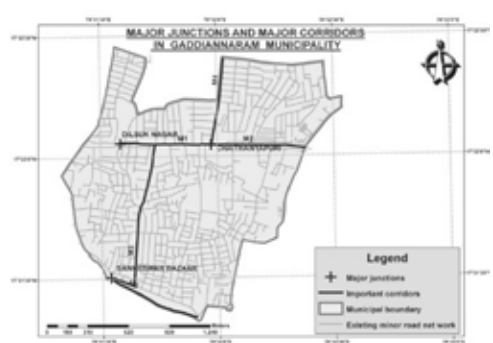

Figure 2

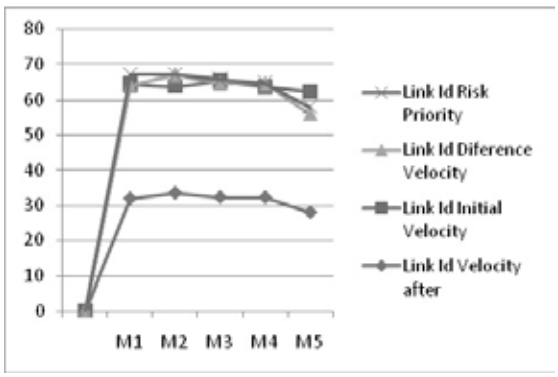

Figure 3: Congestion priority graphs for velocity criterion.

Data collection and Processing

The field surveys that were carried out to collect the data in the study area have been grouped. They are Road network characterization studies and Traffic characterization studies. The data collected from these surveys has been analyzed to evaluate the network characteristics of the study area.

The broad criterions are categorized in four groups – Geometric characteristics, Traffic characteristics, Land use or road side characteristics and Utility characteristics. The attributes considered under each criterion are as follows.

Geometric characteristics

Roadway width in meters (RW), Carriageway width in meters (CW), Stopping sight distance in metres (SSD), Number of curves on the link (NC), Pavement Condition index determined from the rating of the pavement based on the pavement condition and riding comfort experienced by the user to the scale of 1 to 5, 5 being an excellent pavement and 0 being an impassable pavement. – (PCI), Number of access points on the link (NA).

Traffic characteristics

Headway in seconds (H), V/C Ratio (VCR),Speed in kmph (V), Delay in seconds (D)Land use or road side characteristics and Utility characteristics Commercial area along the road side of the link in sq .km (CA), Residential area along the road side of the link in sq.km (RA), Semi Residential area along the road side of the link in sq .km (SRA), Industrial area along the road side of the link in sq .km (IA), Intensity Parking, business activities and road side activities in a point scale(PBE)

Utility characteristics

Overlap size of the link from static analysis (OS), Trip intensity on the link (TI) in trips / day

All the geometric, traffic, land use and utility characteristics are taken into consideration for the analysis.

Step-2: Standardization of input values

The objective function is optimized to identify the links in the network which are leading to congestion and the factors which are responsible for congestion in the network evaluation criteria for attending the objective function are the path characteristics that influence more in related to the congestion or risk occurrence. A

lead is identification of functional characteristics is obtained from (Nesamani K.S. et

al 2005) and Stephen r. Alderson & Yorgsos Stepharedes 1986 which evaluates the links based on the geometrics, traffic, land use and utility characteristics and showed a strong influence on the overall performance of the network. The main criterions with their objective functions which provide ideal values for congestion are linked below.

Geometric	Traffic	Land Use	Utility
Carriage way width (Min)	Headway (Min)	CA (Max)	Trip intensity (Max)
Roadway width (Min)	V/C ration (Min)	RA (Max)	Overlap Size (Max)
Shopping right distance (Min)	Speed (Min)	SRA (Max)	
Number of curves (Max)	Delay (Max)	IA (Max)	
PCI (Min)		PBC (Max)	
Number of access points (Max)			

As per the above table, input values are standardized by subtracting either the minimum value or maximum value from the respective characteristic vector and dividing it with the difference between maximum and minimum value.

Step-3: Calculation of the covariance matrix

The covariance of the above matrix is found using the software MATLAB.

Step-4: Calculation of the eigenvectors and Eigen values of the covariance Matrix

Step-5: Calculation of the Principal components

Step 6: Deriving new Dataset

The Final values are obtained by multiplication of the one transposed matrix i.e

Principal components matrix and Standardized matrix. The final values obtained are the standardized values.

Step-7: Finding the congestion

After finding the final values of speed are compared with actual values. Therefore the congestion generated links are found out

Findings and Recommendations

The study links the complexity of the road systems with the land use and demand profiles. Identifying the congestion generated in the major links is the crucial task in the integrated planning. The performance and functionality of a link can be attributed to many characteristics including the neighborhood characteristics of the link.

With speed as major criterion, it is found that the congestion is generated in the links and distributed in the following order

S.No.	Link id	Name of Link id
1)	M3	Dilsuknagar – Sankeswar Bazaar
2)	M5	Sankeswar Bazaar - Saroornagar
3)	M1	Dilsuknagar - Chaithanyapuri

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Table 1: Link Input attributes of the characteristics in each.

S.No	Link name	Link Id	Geometric characteristics					Traffic characteristics					Land use or Road side Characteristics					Utility characteristics	
			RW in m	CW in m	SSD in m	NC	PCI	H in sec	VCR	PBE	V in kmph	D in sec	NA	CA in sq.km	RA in sq.km	SRA in sq. km	IA in sq.km	TI in trips / day	OS
1.	Dilsuknagar - Chaithanyapuri	M1	21.6	18.8	50.52	0	3	2.93	2.37	9	32.59	12.5	15	0	0.052	0	0	31109	44
2.	Chaithanyapuri - Kothapet	M2	21.55	18.4	45.85	0	3	2.56	2.27	9	30.6	7	10	0	0.036	0	0	35797	38
3.	Dilsuknagar – Sankeswar Bazaar	M3	10	7	52.19	2	1	2.11	1.64	6	33.28	7.5	21	0.0042	0.088	0	0	4442	34
4.	Chaithanyapuri – P& T	M4	9.5	7	48.07	1	3.5	5.1	1.46	3	31.56	4	14	0	0.044	0	0	8566	10
5.	Sankeswar Bazaar - Saroornagar	M5	10	8	55.49	2	4	4.5	1.81	1	34.61	0	9	0	0.0196	0	0	663	14

Table 2: New data sheet.

RW in m	CW in m	SSD in m	NC	PCI	H in sec	VCR	PBE	V in kmph	D in sec	NA	CA in sq.km	RA in sq.km	SRA in sq. km	IA in sq.km	OS	TI in trips / day
5.832498	8.212774	49.10931	3.079491	5.547589	5.720395	2.406574	7.049126	32.00684	17.00932	31.20499	0.002423	0.060719	5.33E-05	7.22E-05	56.93021	6978.943
12.33555	9.406062	50.52279	3.262433	5.788319	5.793951	2.265068	10.99358	33.54173	11.23669	32.18355	0.004865	0.051419	7.78E-05	7.78E-05	49.77691	6283.346
14.77182	1.809574	41.61591	4.012948	3.683106	4.48226	3.452079	7.748508	32.36854	8.725838	29.14443	0.002876	0.061293	2.97E-06	0.000129	44.43398	37507.73
5.20298	5.613724	44.42382	3.213834	5.112166	4.688635	3.602188	19.86392	32.31442	9.565714	28.53534	0.002229	0.03995	3.57E-05	0.000145	63.98206	24561.29
13.30786	1.239404	40.06176	5.903565	4.793642	6.482675	3.205974	21.83918	28.00714	19.73673	28.58558	0.003327	0.051333	3.60E-05	0.000177	18.79004	27556.71

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