

# Prioritization of Urban Transport system for Madurai City

G.Sathya

Civil Engineering Department  
Thiagarajar College of Engineering

Dr.R.Velkennedy

Civil Engineering Department  
Thiagarajar College of Engineering

Prof.D.Srividya

Civil Engineering Department  
Thiagarajar College of Engineering

**Abstract**— India is one of the world's fastest growing economies today, which increased thrust on development of transportation infrastructure in the country to reduce the traffic congestion due to increased traffic demand. Now a day, various mode of transportation is being used for metro cities such as Chennai, Mumbai, Delhi, etc. The Madurai city is under tier 2 city has narrow roads along with densely packed building. This city facing, massive traffic congestion is required effective alternative mode of transport to compliance with the existing situation. Transportation modes are available in a large number but not one can be decided as the best suitable for every scenario. Numerous factors that are changing according to the place, population, its needs and its growth dominantly influence the selection/Implementation of a particular transportation mode. Hence consideration of the requirement and objectives influence the decision. Prioritization in response to these considerations is vital to reap the maximum benefits. This paper examines these factors and considers available transport options suiting the city's needs and characteristics resulting in a stage where prioritization of these options.

**Keywords**— Urban transports, Prioritization, Factors consideration, Site scenario, Traffic congestion.

## I. INTRODUCTION

Madurai is located in the south west part of Tamil Nadu. The district is bounded by the Dindigul, Pudukottai, Sivagangai, Virudunagar and Theni districts. Madurai city is about 100 meters above mean sea level. Geographically the city is located on  $9^{\circ}55'$  north latitude and  $78^{\circ}7'$  east longitude. It is well connected by road, rail and air. Figure 1 shows the location of the project town. Madurai Municipal Corporation, covering 51.96 sq.kms, comprises of a total population of 928,869 persons, whereas the Madurai Urban Agglomeration comprising the city and surrounding settlements accommodates a population of 11,94,665 persons.

Location details of Madurai

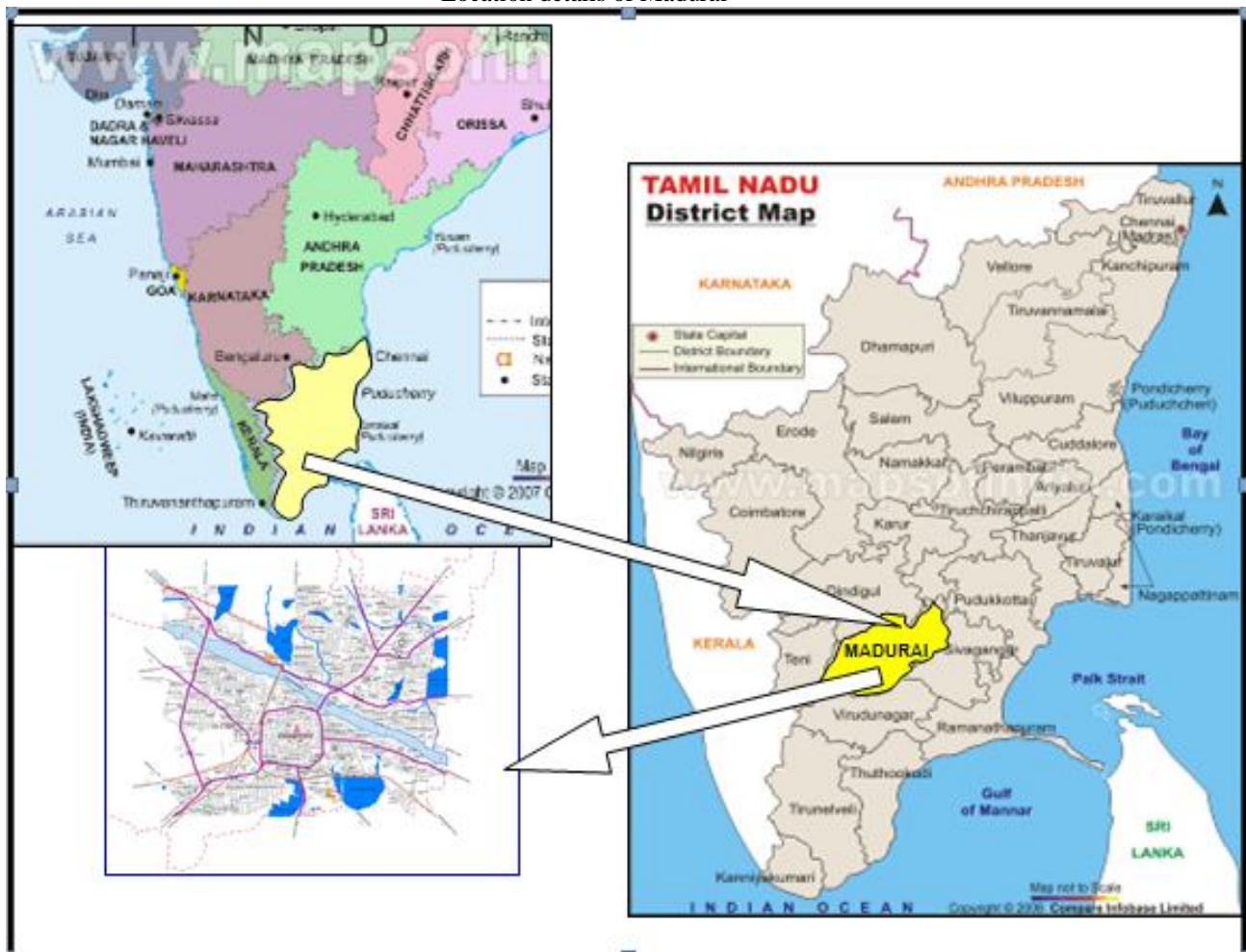


Figure 1

The objectives of the present study are to specifically analyze the existing traffic scenario, the pattern of growth of the town in all its aspects and the traffic and transportation requirements identify the causative factors for the traffic impediments and to suggest relief and improvement measures, both from technical and traffic management perspective, keeping in view the increase in population and resultant increase in the travel demand considering the environmental, ecological, archaeological and religious issues and green city concepts.

## II. PROBLEM IDENTIFICATION

### General

Origin and destination survey reveals that about the goods traffic is destined traffic which is a serious issue needs to be addressed immediately on priority basis. Market area inventory reveals that there are about 8 types of whole sale markets and goods transport offices present within the CBD area. These markets are mainly concentrated on the northern side. Presence of such whole sale markets within the CBD area not only attracts goods vehicles in the city but also degrade the environment because of the market waste disposed.

### Existing road network

Some of the outstanding problems related to the road network are:

- Absence of functional hierarchy of road network as a result of which there is an intermixing of local traffic with long distance through traffic.
- Narrow road network with restricted capacity, particularly in the CBD results in congestion.
- Intense development along major arterial corridors without adequate provision for its transport demand is affecting the level of service on these corridors. (e.g. Veli streets, Thirupparankundram road, Melur Road etc.)
- Absence of access control measures and inconsistent carriageway width along the arterial roads is affecting the speeds.
- Poor road geometrics along majority of the roads are making them accident-prone.

From the study, the major key issue associated with Madurai roads is that the available carriageway width is not sufficient to meet the traffic demand. It means that roads having narrow width. So the factors should be fixed by considering the existing situation and present need.

## III. CONGESTED ROUTE IDENTIFICATION

Congested route in Madurai can be identified by conducting traffic survey along the various routes in Madurai. By using these data, find Traffic to capacity ratio. Which means the ratio of existing traffic to the actual traffic capacity of the road.

If traffic to capacity ratio is less than 1 which means no congestion,

If traffic to capacity ratio is greater than 1 which means congested route.

After done the above procedure, the following 3 routes are identified as the most congested route in Madurai.

1. Thirupparankundram- Kalavasal- Yanaikkal- Goripalayam- Mattuthavani- Mellur
2. Mellur- Mattuthavani- Goripalayam- Yanaikkal- East Veli Street- South Veli Street- Thirupparankundram
3. Thirupparankundram- periyar- yanaikkal- Goripalayam- Mattuthavani- Mellur

Location details for congested routes in Madurai



Figure 2

## IV. PRIORITIZATION

It is the process of finding out the best alternative from the number of available alternative by considering various factors related to the needs that fulfilled by alternative. There are number of prioritization tools are available, from which TOPSIS (Technique of Order Preference by Similarity to Ideal Solution) is the simple and easily understandable tool for prioritization.

### TOPSIS (Technique of Order Preference by Similarity to Ideal Solution)

The technique called TOPSIS can be used to evaluate multiple alternatives against the selected factors. In the TOPSIS approach an alternative that is nearest to the Positive Ideal Solution (NPIS) and farthest from the Negative Ideal Solution (FNIS) is chosen as optimal.

- Ideal alternative: the one which has the best level for all attributes considered.
- Negative ideal alternative: the one which has the worst attribute values.

TOPSIS selects the alternative that is the closest to the ideal solution and farthest from negative ideal alternative.

### Steps involved in TOPSIS

TOPSIS assumes that “m” alternatives (options) and “n” attributes/criteria and have to score of each option with respect to each criterion by expert system

- Attribute weight by expert
- Decision matrix
- Standardized decision matrix
- Weighted standardized decision matrix
- Ideal solution
- Negative ideal solution
- Result

## V. STUDY METHODOLOGY

First step of this study is to fix the important factors that influence the best transportation system by considering existing situation and need of transportation. After that the various urban transports are set as alternatives for solution. Then experts from transportation field should give weightage value out of 10 to the each factor for each alternative. These input values are used in TOPSIS technique for prioritization

### 1. Factors considered according to the need of transport

Following factors are considered to fulfill the basic requirement of transport

- Safety
- Tariff
- Capacity
- Pollution
- Integration
- On time
- Regular
- Speed
- Space occupation
- Cost

### 2. Alternative mode of urban transports

Madurai city has more space constraint (narrow road) that result from study. By taking this as a major issue, The following alternative mode of urban transport are considered for this study

- Metro rail
- Mono rail
- Bus transport

### 3. Processing with TOPSIS

1. Standardize the decision matrix.

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}}, \quad i = 1, 2, \dots, m, j = 1, 2, \dots, n$$

2. Calculate the weighted Standardize decision matrix.

$$r_{ij} = w_j z_{ij}, \quad i = 1, 2, \dots, m, j = 1, 2, \dots, n$$

3. Identify the positive ideal solution  $A^*$  and the negative ideal solution  $A^-$

$$A^* = \left\{ \left( \max_i r_{ij} | j \in J \right), \left( \min_i r_{ij} | j \in \hat{J} \right) | i = 1, 2, \dots, m \right\} = \{x_1^*, x_2^*, \dots, x_n^*\}$$

$$A^- = \left\{ \left( \min_i r_{ij} | j \in J \right), \left( \max_i r_{ij} | j \in \hat{J} \right) | i = 1, 2, \dots, m \right\} = \{x_1^-, x_2^-, \dots, x_n^-\}$$

4. Calculate the distance for each alternative to the positive ideal solution and the negative ideal solution, respectively.

$$S_i^+ = \sqrt{\sum_{j=1}^k (r_{ij} - x_j^+)^2}, \quad i = 1, 2, \dots, m$$

$$S_i^- = \sqrt{\sum_{j=1}^k (r_{ij} - x_j^-)^2}, \quad i = 1, 2, \dots, m$$

5. Calculate the relative closeness for each alternative to the ideal solutions.

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^+}, \quad i = 1, 2, \dots, m$$

6. Rank the alternatives according to the value of  $C_i^*$

TOPSIS suggests the best alternative which has the furthest distance from the negative ideal solution (biggest value of  $S_i^-$ ) and shortest distance to the positive ideal solution (smallest value of  $S_i^+$ ). Thus, the increase of numerator and the decrease of denominator will lead to a bigger value of  $C_i^*$  in final Equation. In other words, the alternative which maximizes the value of  $C_i^*$  ranks first.

The following are the tables obtained by above mentioned steps.

Attribute weight (Common)

Experts Attribute	E1	E2	E3, E4...	E10	Attribute Weight
Safety	9	10		10	9
Integration	8	9		9	8
Arrival on time	7	8		8	7
Capacity	5	6		5	7
Speed	8	9		7	8
Delay in Travel time	8	9		8	9
Environmental Pollution	9	8		8	9
Tariff	9	8		6	7
Total Cost for Transport Facility	8	9		9	7
Space Required for Construction	8	9		9	8

Standardized decision Matrix

Attribute	Alternatives		
	Metro	Mono	Bus
Safety	0.68	0.6	0.43
Integration	0.5	0.57	0.65
Arrival on time	0.66	0.66	0.37
Capacity	0.67	0.59	0.45
Speed	0.72	0.56	0.4
Delay in Travel time	0.66	0.66	0.37
Environmental Pollution	0.67	0.67	0.3
Tariff	0.53	0.6	0.6
Total Cost for Transport Facility	0.45	0.59	0.67
Space Required for Construction	0.5	0.65	0.57

Weighted standardized decision Matrix

Attribute	Alternatives		
	Metro	Mono	Bus
Safety	6.12	5.4	3.87
Integration	4	4.56	5.2
Arrival on time	4.62	4.62	2.59
Capacity	4.69	4.13	3.15
Speed	5.76	4.48	3.2
Delay in Travel time	5.94	5.94	3.33
Environmental Pollution	6.03	6.03	2.7
Tariff	3.71	4.2	4.2
Total Cost for Transport Facility	3.6	4.72	5.36
Space Required for Construction	4	5.2	4.56

- **Ideal Solution**  $A^*$  = {6.12, 5.2, 4.62, 4.69, 5.76, 5.94, 6.03, 4.2, 5.36, 5.2}
- **Negative Ideal solution**  $A^-$  = {3.87, 4, 2.59, 3.15, 3.2, 3.33, 2.7, 3.71, 3.6, 4}
- **Separation from Ideal Solution  $S_i^*$**  = {2.49<sub>(Metro)</sub>, 1.8<sub>(Mono)</sub>, 5.14<sub>(Bus)</sub>}
- **Separation from Negative ideal solution  $S_i^-$**  = {6.06<sub>(Metro)</sub>, 5.56<sub>(Mono)</sub>, 2.26<sub>(Bus)</sub>}

Relative closeness to the Ideal solution ( $C_i^*$ )

Steps	Alternatives		
	Metro	Mono	Bus
$S_i^*$	2.49	1.8	5.14
$S_i'$	6.06	5.56	2.26
$S_i^*+S_i'$	8.55	7.36	7.4
$C_i^* = \frac{S_i'}{S_i^*+S_i'}$	<b>0.71</b>	<b>0.76</b>	<b>0.31</b>
<b>Rank</b>	<b>2</b>	<b>1</b>	<b>3</b>

#### 4. RESULT

The **Monorail** is the best transport system for Madurai, which fulfills the requirement of transport and compliance with the existing situation in Madurai.

#### VI. CONCLUSIONS

Urban Transport modes are available in a large number but not one can be decided as the best suitable for every scenario. Numerous factors that are changing according to the place, population, its needs and its growth dominantly influence the selection/Implementation of a particular transportation mode. Hence consideration of the requirement and objectives influence the decision. Prioritization in response to these considerations is vital to reap the maximum benefits. For which TOPSIS tool used to identify the best mode of urban transport system in Madurai.

Madurai has three main route facing traffic congested problems and having narrow roads, it will emerge the implementation of best transportation system. By kept this scenario in this study, there are various factors are set such as space occupation, safety, speed, capacity, etc. then the possible alternative mode of transport system are fixed such as Metro rail, Monorail, Bus transport system, Which are involved in TOPSIS evaluation technique to obtain the best mode of transport System. The final result shows the **MONORAIL TRANSPORT** is the best mode of transport system that compliance with the existing situation in Madurai. Because it full fill the present and future needs.

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