Ideal Mode Share for Indian Cities

Nidhishree N Kumar, Prof. Rohini N, Prof. Vidyadhar S Wodeyar

Abstract— In today's world, due to rapid urbanization and increase in population, many cities have high urban pressures to withstand. This is impacting on the transportation system which is highly evident in metropolitan cities. It has resulted in high private vehicle dependency and thus, planning for transportation has shifted its focus from people to motors. The solution for this ultimately aims towards increased modal shares of sustainable transport options such as walking, non-motorised transport (NMT) and public transport. The level of transportation service surrounds around the choice of modes of transport by the people of that city, and thus the existing mode shares are taken into consideration for the analysis of the transportation system of the city. However, to begin to think about solutions for the overall problem of traffic congestion, there first needs to be an analysis that must clearly give an idea of how much improvement is needed. To know this, there must be a comparable quantity that the real figures of mode-share can be compared to, to know how bad or well the transportation system is or how much needs to be improved to make the city with good transportation. This quantity is termed as 'ideal mode share,' which acts as a benchmark for mode shares of all Indian cities. This paper shows the series of steps involved in the calculation of how we have achieved the figures of ideal mode share. Any city that has its mode share equal to or more than the ideal, has priority for NMT and pedestrians along with public transport in their transport systems, i.e., a good transport system.

Index Terms— Ideal mode share, Indian cities, non-motorized transport, pedestrians, priority, sustainable modes, transportation.

1 Introduction

IN the midst of development and urbanization, cities have grown in population around various centres and poles of growth. While development is an important quotient of the city, it is also affecting the comfort of people in commuting with ease in multiple ways. A good transport system allows people to reach/ get their services through means of access from their residences. Today, due to surrounding developments and availability and closeness to better facilities, population has increased, resulting in congestion on the streets. This has diverted planning from people to motors.

The most affected urban space in terms of ease of transportation is in Metropolitan cities. The Indian metro cities like Delhi, Mumbai and Bangalore have high levels of traffic congestion. High private vehicle dependency is one of the major reasons for heavy traffic in Indian cities. Building more roads for an unrelenting growth of vehicles is not a solution for the problems like congestion and pollution. India is still experiencing exponential growth in ownership and use of cars owing to various reasons [1]. 57% of the country's population own private vehicles with highest traffic congestion recorded in metro cities of Bengaluru, Mumbai and Delhi [2]. According to TomTom Traffic Index 2019, Bengaluru (71%), Mumbai (65%), Pune (59%) and New Delhi (56%) ranks 1st, 4th, 5th and 8th respectively among top 10 cities globally [2].These cities parallelly have growing levels of urbanization, population and influx of migrants. To withstand such urban pressures, it is important to give priority to pedestrians and non-motorised transport (NMT) along with public transport, that follows the motto, 'People first, Motor next.'

To establish a pathway to solve this major problem of traffic congestion and discomfort in mobility, the crucial step as a precursor is to determine how bad the current scenario is, or how much improvement is needed. To know this, there must be a comparable quantity that the real figures of mode-share can be compared to. This quantity is termed as 'ideal mode share' which acts as a benchmark for mode shares of all Indian cities. This paper shows the series of steps involved in the calculation of how we have achieved the figures of ideal mode share. Any city that has its mode share equal to or more than the ideal, has priority for NMT and pedestrians along with public transport in their transport systems, i.e., a good transport system.

2 Goal and Methodology

The goal here is to come up with figures for ideal mode share that acts as a benchmark for all Indian cities. This follows a methodology which is nothing but the series of steps taken to calculate what must be the percentage of sustainable transport options, private and semi-private vehicles. The methodology for the study is as follows:

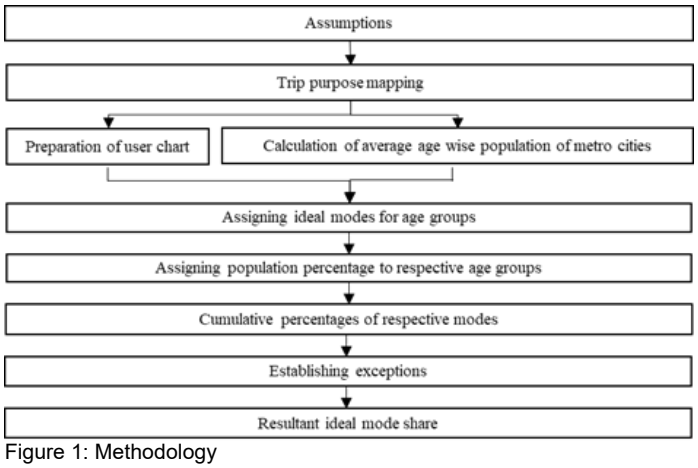

Figure 1: Methodology

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3 Calculation of Ideal Mode Share

To begin with the calculations, we must first define the situation of what we call the "ideal" scenario. For the same, a set of assumptions are made which are made keeping in mind its relevance in the real scenario, in order to ensure that the resulting numbers of the "ideal" are useful for the comparison of real scenario. The following are the assumptions:

1. All activities with respect to travel are happening at the same time
2. Infrastructure for all modes is at 100% bench mark
3. Modes of transport available in plenty
4. All people of their respective age groups are healthy according to their age
5. Homogenous terrain

Through these assumptions, we have defined what "ideal" means. The results of the calculation would mean in such a way that, taking the first assumption as an example, even if all activities of travel happen at the same time, minimum mode share as the result is considered good. For this defined scenario, the calculation is done in a series of steps shown below.

3.1 Step 1 - Trip Purpose Mapping

An ideal city will have its process to calculate its traffic composition, which begins with mapping out the various purpose of trips. It deals with a simple mechanism, where only a single origin is taken as the individual's residence and his/her multiple destinations is listed with respect to their purpose. This step is termed as trip purpose mapping, which will deal with two sections: preparation of user chart and calculation of average age-wise population.

User chart is a mapped-out trip purpose chart along with most attracted age groups for each of these purposes.

TABLE 1
TRIP PURPOSE OF ATTRACTED AGE GROUPS (USER CHART)

Land use	Purpose	First attracted age group	Second attracted age group	Third attracted age group	Fourth attracted age group
Commercial	Grocery	30 to 50	19 to 30	10 to 18	50 to 60
	Malls	19 to 30	10 to 18	30 to 50	50 to 60
	Small retail	19 to 30	10 to 18	30 to 50	50 to 60
	Eateries	19 to 30	30 to 50	10 to 18	50 to 60
Institutional	School	5 to 18			
	College	18-25			
	Work	25-65			
Recreation	Parks	10 to 18	30 to 50	50 to 60	
	Playgrounds	10 to 18	18-30		
	Gym	18 to 30	30 to 40		
	Shows	18 to 30	30 to 50		
	Functions	All			
Public semi-public	Banks/ATM	25 to 65			
	Post office	50 to 60			
	Hospital	60 above	50 to 60		
	Other govt offices	50 to 60	30 to 50	60 above	

Once this chart is prepared, it needs to be meaningful to the context of Indian cities. Hence, we now calculate average age-wise population composition in order to substitute the age-groups in the user chart with the Indian city's average of age-wise population. The cities considered for average age-wise population calculation are Delhi, Mumbai, Kolkata, Bangalore and Chennai, as they are the 5 largest metropolitan cities in India (among top ranked 30 cities of the world, by World Urbanization Prospects 2018 [3].)

The age wise average composition (based on the projected population of census, 2021 of each of the 5 cities [4]) is given in table 2.

TABLE 2
AVERAGE AGE WISE POPULATION COMPOSITION IN INDIAN CITIES

Age	Population composition
0-10	14.94%
10 to 20	15.35%
20 to 30	17.51%
30 to 50	30.42%
50 to 60	10.47%
60 above	11.31%

3.2 Step 2 – Assigning Ideal Modes for each age group

Following our fourth assumption of all people of their respective age groups being healthy according to their age, we shall dedicate a particular mode for each age group. This means that, any person belonging to that age will use our assigned mode in an ideal city. There are three different categories we would be assigning which are sustainable modes like walk/cycle/public transport (PT), semi-private modes which include auto-rikshaws, taxis and cabs, and the final one being private modes which include cars and bikes. The assigned modes for age-groups are as follows:

1. 5-18: Semi-private
2. 19-30: Walk/Cycle/PT
3. 30-50: Walk/Cycle/PT
4. 50-60: Semi-private
5. Above 60: Private

(The assigned mode for each of these age groups follows an analysis of their fitness to the modes which is shown in table 4.)

3.3 Step 3 – Input of Average Values of Age-groups in User Chart

The user chart will now have all the age-groups sorted out of their trip purpose. They will also have the assigned ideal modes for each age group. Now comes the crucial step to begin our calculations where we substitute the average population values of respective age-groups in the user chart as shown in table 3. This table summarizes our entire process until now, which displays all the ideal characteristics of a city.

TABLE 3

SUBSTITUTED VALUES OF POPULATION COMPOSITION OF RESPECTIVE AGE GROUPS AND MODE IN THE USER CHART

Land use	Category	First age group	Avg. Comp	Ideal mode	Second age group	Avg. Comp	Ideal mode	Third age group	Avg. Comp	Ideal Mode	Fourth age group	Avg. Comp	Ideal mode
Commercial	Grocery	30 to 50	30.42%	Walk/ cycle/ PT	19 to 30	17.51%	Walk/ cycle/ PT	10 to 18	15.35%	Walk/ cycle/ PT	50 to 60	10.47%	Semi-private
	Malls	19 to 30	17.51%	Walk/ cycle/ PT	10 to 18	15.35%	Walk/ cycle/ PT	30 to 50	30.42%	Walk/ cycle/ PT	50 to 60	10.47%	Semi-private
	Small retail	19 to 30	17.51%	Walk/ cycle/ PT	10 to 18	15.35%	Walk/ cycle/ PT	30 to 50	30.42%	Walk/ cycle/ PT	50 to 60	10.47%	Semi-private
	Eateries	19 to 30	17.51%	Walk/ cycle/ PT	30 to 50	30.42%	Walk/ cycle/ PT	10 to 18	15.35%	Walk/ cycle/ PT	50 to 60	10.47%	Semi-private
Institutional	School	5 to 18	10.46%	Semi-private		4.48%	Walk/ cycle/ PT						
	College	18-25	8.76%	Semi-private		8.76%	Walk/ cycle/ PT						
	Work	25-65	47.93%	Walk/ cycle/ PT		10.47%	Semi-private						
Recreation	Parks	10 to 18	15.35%	Walk/ cycle/ PT	30 to 50	30.42%	Walk/ cycle/ PT	50 to 60	10.47%	Walk/ cycle/ PT			
	Playgrounds	10 to 18	15.35%	Walk/ cycle/ PT	18-30	17.51%	Walk/ cycle/ PT						
	Gym	18 to 30	17.51%	Walk/ cycle/ PT	30 to 40	30.42%	Walk/ cycle/ PT						
	Shows	18 to 30	17.51%	Walk/ cycle/ PT	30 to 50	30.42%	Semi-private						
	Functions	All	100%	Private									
Public semi-public	Banks/ATM	25 to 65	47.93%	Walk/ cycle/ PT		10.47%	Semi-private						
	Post office	50 to 60	10.47%	Walk/ cycle/ PT			Semi-private						
	Hospital	60 above	11.31%	Private	50 to 60	10.47%	Semi-private						
	Other govt. Offices	50 to 60	10.47%	Semi-private	30 to 50	30.42%	Walk/ cycle/ PT	60 above	11.31%	Semi Private			

3.4 CUMULATIVE VALUES OF RESPECTIVE MODES

We now calculate the sum of all values of each mode to get a cumulative value of how much percentage of the population must ideally use that mode. The formula used for the calculation is as follows:

$$M.S = \frac{\sum_n^1 M}{\sum V} \quad (1)$$

Where, M. S = Mode share
M = Mode considered for calculation
n = Total number of values of respective mode
V = Composition values of all modes

For instance, if we consider the mode of walk/cycle/public transport (M), n would be equal to 25 which is assigned across different trip purpose and age-groups. V is 41 values, cumulative of which would be equal to 783. The $\sum V$ equal to 783 is the same for calculation of all the three mode categories.

With the above equation, the mode share values of the three categories of modes are:

- Walk/ cycle/ PT: 71.20%
- Semi-private: 14.59%
- Private: 14.21%

However, these values have arrived under purely unexceptional conditions. We must consider the fact that, a society is diverse with a section of people who are dependent and cannot choose a mode that is ideal to their age-group which include pregnant women or even disabled. To establish such exceptions and reflect them in our final figures of mode share, a suitability chart is made keeping our focus to sustainable modes of walk and cycle.

3.5 Establishing Exceptions

The suitability table considers two main factors, the common dependency or responsibilities of the age groups and their fitness to choose sustainable modes. This is further classified based on gender, thus making our purpose highly inclusive. Table 4 shows the suitability chart that helps us establish exceptions for choosing the sustainable modes of walk and cycle.

TABLE 4
SUITABILITY CHART FOR SUSTAINABLE MODES

Age	Men	Women	Health	Suitability for cycle	Suitability for walking	Exceptions	
0-10	Dependant	Dependant	Developing	Nil	Nil	All	Disabled
10 to 18	School	School	Fit	Highly suitable	Highly suitable	-	
18-25	College	College	Fit	Highly suitable	Highly suitable	-	
25-35	Work, marriage, family	Work, fertility, family	Fit	Highly suitable	Highly suitable	Pregnant women	
35-50	Work, family	Work, family	Moderately fit	Moderately suitable	Suitable	-	
50-65	Work	Work	Moderate to poorly fit	Unsuitable	Moderately suitable	-	
65 above	Retired, dependant	Retired, dependant	Unfit	Unsuitable	Unsuitable	All unsuitable	

3.6 Resultant Mode Share

Considering the exceptions of pregnant women and disabled, there would be a decrease in the mode share of sustainable transport (walk/cycle/PT). Here we have considered a buffer of 10% in the mode shares. Thus, a decrease in 10% from the sustainable modes will mean that, those who must ideally choose walk/cycle/PT will choose either semi-private or private modes to commute. Hence, the 10% deduction from walk/cycle/PT would be transferred to semi-private and private modes. Considering the equal probability of choosing these modes, the following table shows the final mode share that an ideal city will follow.

TABLE 5
RESULTANT MODE SHARE

Mode	Ideal Mode Share	With exceptions (+/- 10%)
Walk, cycle, PT	71.20%	**61.20%**
Semi Private	14.59%	**19.59%**
Private	14.21%	**19.21%**

Inference: Based on calculated results, the ideal mode share is as shown in column 2. The exceptions deduct a 10% from walk/cycle/PT and equally add to semi private and private modes. Hence, any city that meets the final mode share values of the ideal is considered to give good priority to pedestrians and NMT.

3.7 Limitations

The mode share compositions are calculated based on the population census data of 2021. The validity of these ideal mode share values would exist if the age-wise composition remains the same each year. The average composition of population projected to 2031 (as per [4]) are as follows:

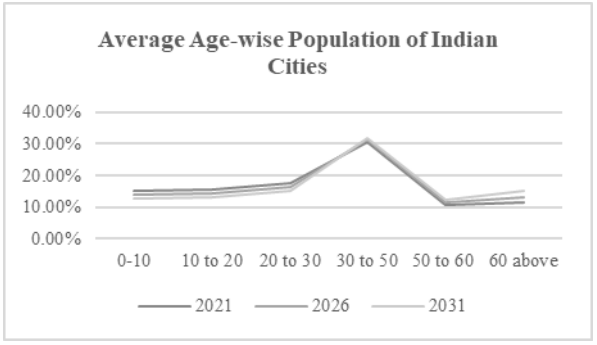

Figure 2: Trend of average age-wise composition of population of Indian cities

We observe from the figure that, the projected average age-wise composition of population of Indian cities until 2031 follows a similar trend. Hence, the ideal mode share can act as a benchmark until at least 2031. However, for more accuracy of the ideal

values, the population values for the current or recent year, specific to the city or project area, can be used for computing age-wise composition.

4 Conclusions

The final result shows that the modal choice of 61.2% of the people in our ideal scenario should be sustainable mode of walking, cycling and public transport combined. This means that 39.8% of population only must use private and semi-private modes. These modal shares act as benchmarks for the real cities or towns, where the real mode shares can be compared to this to know its status i.e., any city that has its mode share equal to or more that the ideal, has priority for NMT and pedestrians in their transport systems. Additionally, the ideal mode share makes it easier for those cities, which have a lower sustainable mode share than the ideal, to set a goal or target. As goal forms an essential part of the process to take a right path for a project to set off, the ideal mode share as a goal would direct the project progress towards bringing priority to pedestrians and NMT users in transportation.

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