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Linear modeling in Transportation problem: Need of reliable Public transportation system in Madhya Pradesh with special reference to Gwalior division"

[1]Dr. R.K. Shrivastava, [2]Dr.Neeta Saxena
Professor, Govt. Science College. Gwalior
Assistant Professor, ITM Gwalior

Abstract: *The public transportation industry is facing significant problems in all size cities in India. This study is concerned of assessment of public transport demand for Gwalior Division and identifies the major factors for poor ridership with estimation of the probable shift of personal vehicle users to public transport due to the increase in its level of service also identifies ways to account for qualitative factors in the public transport project evaluation by adjusting travel time values to reflect comfort and convenience. For this Data Envelopment Analysis is used, it is a non-parametric method of efficiency measurement. To calculate Efficiency of Madhya Pradesh State Transport undertaking there are three input variables and one output variable are considered. Input variables include total number of employees, total number of buses, and total Bus-km per year and the output includes total revenue. Results from DEA indicate that there is a need in improvement of public transport system. A serious effort should be made to improve the productivity efficiency of public transport operators so that they can enhance both quality as well as quantity of public transport service. In order to improve traffic conditions the relation between socio-economic feature and the mobility of the people is very important issue. To analyze some socio-economic features of study area Discrete Choice Modeling is applied. The utility function, derived out of the choice sets help to observe the attractiveness of each alternative, for a given trip. In order to assess and reduce air pollution due to road transportation two approaches are considered - (i)Macroscopic (ii) Microscopic.*
Key Words: *Data Envelopment Analysis (DEA), production efficiency, Socio-economic features, Discrete Choice Modeling, Utility function, Bus Rapid Transits system (BRTS), Air pollution Modeling.*

I. Introduction:

The public transportation industry is facing significant problems in all size cities in India. Due to high vehicle ownership and poor supporting public transport facilities especially in the cities where the population is between 1 to 2 million. The major factor is very low ridership in public transport due to poor service quality and more traveling time. This study is concerned of assessment of public transport demand for Gwalior Division and identifies the major factors for poor ridership with estimation of the probable shift of personal vehicle users to public transport due to the increase in its level of service also identifies ways to account for qualitative factors in the public transport project evaluation by adjusting travel time values to reflect comfort and convenience. This can help to find innovative solutions to the current problems such as increasing traffic congestion, energy-consumption etc. and can increase the efficiencies as well as support for alternative modes of public transport, making them more acceptable by the people & achieving their equity objectives and increased economic efficiency both also a new approach is required to estimate the actual public transport demand so that most feasible and reliable system can be selected to optimize the public transport demand. Public transport must become more productive, attractive and reliable especially if it is to meet society's expectations for helping address environmental problems and social needs. Productivity measures compare levels of output to inputs. Inputs include labor, capital and other goods. Effectiveness measures how efficiently these inputs are used in producing a given output. Measuring productivity or effectiveness in businesses that operate outside the market economy (like public transport) is complicated, and, without clear performance measures it is difficult to improve effectiveness. In this study the method Data Envelopment Analysis (DEA) is used to perform an efficiency analysis.

Data Envelopment Analysis as a performance measure: *Data envelopment analysis is a Linear Programming Problem that provides a means of calculating apparent efficiency levels within a group of organizations. The efficiency of an organization is calculated relative to the group's observed best practice*[6] It is a non-parametric method of efficiency measurement, which measures the relative efficiency of decision making units by comparing them to similar units (Charnes, Cooper and Rhodes 1978). The method calculates an agency's efficiency based on the maximum outputs that a decision making unit is able to produce with a given set of inputs or based on its ability to produce a given set of outputs using the least amount of inputs. The method is useful in assessing the performance of decision making units such as transit systems, schools, and hospitals for whom performance may not be measured only in terms of financial performance or profits earned. Efficiency is defined as the ratio of output to input.

Efficiency = output/input

However, since different outputs and inputs may not be equally important, so that appropriate weight may be assigned to the various output and input variables. In DEA, the assessment of efficiency is done by maximizing the sum of weighted outputs for a given sum of weighted inputs.

$$\text{Max}\sum_{i=1}^{m} A_i * Y_{ij} \qquad (1) \qquad \text{Such that}$$

$$\sum_{k=1}^{n} Bk * X_{jk} = 1 \qquad (2)$$

$$\sum_{i=1}^{m} Ai * Yji - \sum_{k=1}^{n} Bk * X_{jk} \leq 0 \qquad (3)$$

$$B_{k,} A_i \geq \theta \qquad (4)$$

Where, θ is a very small positive number

A_i is the Weight of the i^{th} output;

B_k is the weight of the k^{th} input;

Y_{ji} is the quantity of the i^{th} output of the j^{th} agency;

X_{jk} is the quantity of the k^{th} input of the j^{th} agency;

m is the total number of outputs; and n is the total number if inputs used in the analysis.

Equation (1) maximizes the weighted output of company j, such that its weighted input is 1 (as constrained by equation 2). This constraint is added under the assumption that the resources available to a transit agency are limited and that the objective of the transit agency is to maximize its output given the limited resources. Equation (3) is added as a constraint to ensure that the efficiency is a number between 0 and 1. If output is always smaller than or equal to the input, the efficiency is always between 0 and 1.[11]

Equation (4) ensures that all inputs and outputs have at least a small positive weight. This is essential because an agency j is allowed to manipulate the weights such that its efficiency indicator is maximized. For example, if equation (4) is not used in the DEA calculation, then an input such as fuel may be assigned a weight of zero while the number of MPSRTC buses is assigned the maximum weight. So equation (4) ensures that an unfavorable variable is not completely ignored.

The concept of efficiency in the DEA model: Efficiency in the DEA model is the concept of technical efficiency, which is the concept of relative efficiency that is determined through comparison with the most efficient frontier. In other words, since it is impossible to measure absolute efficiency that is evaluated according to ideational data point, it measures the degree of efficiency through comparison with reference set that has similar input and output structure. Efficiency is fairly simple to calculate when a production organization produces only one output by using only one input element but most of the organizations use a number of input elements and produces a multitude of outputs. In order to calculate these organizations's efficiency, a process to calculate aggregated input that sums up by adding weights to many input elements and aggregated output that is calculated by using many output weights.[8]

Technical efficiency shows the relations between output and input that are used to produce the output and means the capacity to produce the maximum output within the range of given input. Therefore, technically, the word efficient means that when the input reduces, output has to be reduced and the word inefficient means that although input is reduced, we can maintain the existing output. In other words, technical inefficiency occurs because input elements are overused. Price efficiency is related to optimizing compounding of input elements that can be produced output with minimum expenses and inefficiency in terms of price means that input elements are overused compared to the optimized compounding amount and it also occurs when they are used much less than that. Overall efficiency is a multiple of technical and price efficiency, which means that in order to provide overall economic efficiency, technical and price efficiency has to be considered at the same time.[11]

The efficiency derived for each unit is on a scale of 0-1, where 0 denotes an extremely inefficient unit and 1 represents an efficient unit. Efficiency scores are relative and are derived by comparison between the units in the data set are being analyzed, according to Charnes- Cooper and Rhodes 100% efficiency is attained for a unit only when: (A.) None of its output can be increased without either (i) Increasing one or more of its input or (ii) Decreasing some of its other outputs. (B.) None of its input can be decreased without either (i) Decreasing some of its other outputs or (ii) Increasing one or more of its inputs.

Common Efficiency Measures for Transport Agency

The common efficiency measures for a transport agency can be differentiated in following manner: [12]

Efficiency Measures	Efficiency Indicator
Cost Efficiency	Cost/km/mi Cost/hour Cost/vehicle Cost/passenger trip
Cost-effectiveness	Revenue/passenger trip Ridership/expense Passenger trip/km//mi
Service utilization Efficiency	Passenger trip/hour Passenger trip/capital Km/mi/vehicle
Vehicle utilization Efficiency	Passenger trip/employee
Labor productivity	Vehicle miles/employee Vehicle km/mi/capital
coverage	Total vehicle km//mi Service areas

Efficiency of Madhya Pradesh State Transport Corporation: Public transport is an important part of overall development of the country and affects in some way nearly all aspects of mobility in general. This study deals with the problem caused due to a decline in the performance of the MPSRTC (Madhya Pradesh State Road Transport Corporation.)A Linear Programming based on DEA is used to measure the efficiency of various decision-making units. The analysis on this study is sought to provide a way to obtain a valid efficiency measure for MPSRTC. The first step in a DEA is to identify the inputs and outputs that can be potentially used to define the efficiency of a transport system. The output of a transport agency in general is service that may or may not be actually used by the consumers—transport users. For example, the seating capacity of a transport vehicle assigned to a route may not be fully utilized (i.e., not all seats are used), which means the service produced is not the same as the service that is actually utilized. Production processes involve the use of inputs to produce outputs. In the case of bus transit, the inputs are generally in the three categories of labor, capital and energy. The most commonly used inputs are number of employees (proxy for labor). Number of MPSRTCs buses (**Proxy for capital**) and quantity of fuel used annually (proxy for energy used). The outputs used to measure efficiency in the transit industry are usually MPSRTC buses -kilometers (produced output) and passenger-km or passenger boarding consumed output. In this study, three input variables and one output variable are considered for efficiency measurement. Input variables include total number of employees, total number of buses, and total Bus-km per year and the output includes total revenue. On examination of data it was observe that the production efficiency is increasing for the year 1981-2001 and extremely decreased in 2002-03. (Table-1) For the years 2000, 2001 and 2002, MPSRTC buses had load factors that were above 100%. Load factors is calculated as the ratio of passenger-km to place-km where place-km is obtained by multiplying the total capacity of a bus including seating and standing capacity, by the total number of kilometers operated per year. This indicates that buses in MPSRTC buses were overcrowded during those years. If occupancy is analyzed using seating capacity of buses as the capacity and having standees as indicative of crowding decreases quality of service, increases waiting times and implies that the system is not offering sufficient quantity of service to meet the demand. It may also discourage passengers for using the bus, decreasing the effectiveness of service.

Table-1: Production efficiency of MPSRTC (1981-2003)

Year	No. of Division	Depots	No. of Buses	No. of employee	Bus-km/year	Total Revenue (in Lakhs)	Efficiency
1962-63	2	12	702	400	328	NA	---
1971-72	5	31	1852	11161	817	NA	---
1981-82	11	44	2510	19438	1415	5301.62	22.6%
1984-85	11	47	2821	21739	1553	6990.04	26.9%
1991-92	11	53	3097	23386	2071	16942.66	59.35
2000-01	11	53	2525	19260	2120	20426.50	85.4%
2002-03	11	53	2146	11204	1760	17180	11.3%

Table-2: Financial Performance of Gwalior Division (Rupees Lakh)

Parameters/Year	2000-2001	2001-2002	2002-2003
Total Cost	123392	123805	115385
Staff Cost	66533	73733	66413
Fuel Cost	30076	27111	24401
Taxes	5125	5136	5131
Total revenue	94753	89224	91062
Profit/Loss	-28638	-34581	-24323
Profit/Loss (net of taxes.)	-23513	-29445	-19192

(Source RTO Gwalior 2005)

Factors affecting the Efficiency of MPSRTC:

Drop in occupancy ratio- (i.e. average percentage of seats in a bus taken by passengers):The occupancy ratio of MPSRTC has come down significantly from 71% in 1995-96 to 46% in 2002-03. This is because of the competition from other modes which have gained importance due to decreasing fleet size of MPSRTC. Also the buses available were of poor quality (often being transferred after the buses are deemed not fit for inter-city operations), unreliable and in some ways do not provide the level of service which are offered by competing modes.

Fleet Utilization - Although fleet utilization has improved from 1962-63 to 3times in 2002-03.

There is considerable variation in fleet utilization across SRTUs as can be seen which points towards scope for improvement, for e.g. fleet utilization was as high as 99.5% in case of APSRTC and a low of 42.5% in case of Bihar SRTU.

Bus Staff Ratio - The staff bus ratio has dropped from 1991-92 to 2002- 2003 and is in the optimum range of 5.5 to 6.

Fuel efficiency - Fuel efficiency is a function of age of bus fleet, maintenance, and competence of drivers and terrain. Although over all fuel efficiency in terms of km per liter has improved from around 4.4% in 1995-96 to 4.91% in 2002-03, there still seems to be a lot of scope for improvement.

Absence of fare revision mechanism-Fuel cost and man power cost accounted for 32and 40 percent respectively of the total cost in 2002-03. Though the cost of manpower has come down during the last few years, the cost of fuel has been increasing which in the absence of a suitable fare revision mechanism is adding to the losses of the MPSRTC.

Burden of Concessions/exemptions - MPSRTC not fully compensated for various concessional fares/exemptions and universal service obligation rendered in the form ofbus connectivity to remote areas. [3]

Above all, there remains an overarching problem of lack of accountability of losses occurring due to operational inefficiencies and those occurring due to operations on unviable but socially desirable routes. Absence of a system of accountability in this manner eliminates the possibility of having a rational system for deciding the amount of subsidy to be given to MPSRTC.

Financial Challenges Faced by MPSRTC and Gwalior Division:

Lack of funds is perhaps the biggest challenge faced by the MPSRTC. Starting 1992, the central government stopped providing funds to the State Road Transport Corporations. In 1992 and 1993, the legislature also passed the 74th and 75th Amendments to the constitution which decentralized government and gave more power to municipal and village governments. One of the negative effects of such policies of devolution was that M.P. State Road Transport Corporations as well as Gwalior Division no longer had access to central government funds to improve or augment their transport supply.(Table-2) However, since M.P.State Transport Corporations no longer had access to sufficient funds, it was unable to expand their services. The quality of service suffered. Many State Road Transport Corporations did increase their supply of buses with the help of borrowings. But, these increases were not proportional to the increase in population and were not sufficient to meet the growth in demand. Almost all cities suffered a decline in per capita provision of bus services. [1]

Insufficient supply of buses led to increased waiting times and crowding on buses. In 1992, buses in M.P. had an occupancy ratio of about 120%. The insufficient supply led to a decline in the quality of buses which in turn led to a decline in the modal share of buses (Ministry of Urban Development, 2008). Many middle-class Indians responded to the insufficient public transport supply by choosing private modes of travel.

Result from DEA: DEA is a useful method to calculate relative efficiencies of transport systems. The use of *level of comfort* as an indicator of crowding while analyzing the efficiency of transport systems is also a new application. Several factors affect efficiency of bus services. Some of those can be controlled by the STU while others may be controlled through overall planning. The factors that can be controlled by the STU are fare per km and the average age of buses. Higher fares do not seem to affect ridership negatively, probably because the increased revenue can be used to improve services. Factors that cannot be controlled directly by the STU are

population density and average traffic speed. High population density can be encouraged through land use and zoning regulations. Average traffic speed is affected by the nature of traffic.[8]
Above analysis reveals that there is a need in improvement of public transport system. Improvement of public transport is one of the highlighted measures when it comes to the reduction of negative impact of traffic and the improvement of the energy efficiency of a transport system. A serious effort should be made to improve the productivity efficiency of public transport operators so that they can enhance both quality as well as quantity of public transport service. It is recognized that some form of competitive pressure is needed to ensure that a serious effort is made towards product efficiency. This competitive pressure may be obtained either through direct competition for the market or through some form of systematic comparison with similar operators.
City character is also effects efficiency. There is a close relationship between the socio-economic feature and the mobility of the people. The more mobile a person is, the wider the circle of socio-economic interaction that would be available to them. In term, both mobility and socio-economic status influence the type, frequency and intensity of their participation in activities. Individual income is the indicator of socioeconomic status. Undertaking MPRTD buses accessibility is the indicators of mobility. Trip purpose is the indicator of activity participation. Travel time and travel mode are the indicators of travel behavior.

Socio-economic & household features:

Socioeconomic and household features such as sex, age, profession household size, household income, Vehicle ownerships, play an important role in the travel features. In order to obtain relevant socio-economic data and trip information a household survey was carried out in study area. A travel time survey was conducted for different types of vehicles moving through the study area. Public views and opinions about the problems and solutions relating to traffic movements have been gathered through questionnaire survey. Respondents were selected on random basis. Out of the total responses, 76% of the respondents are workers and 24% are students. Majority of the workers in a house hold are males (80%) and accordingly they have higher percentage in the target group. As per age, most of the individuals are belonging to the category of 14 -30 and 31 – 50 years of age. Overall, most of the households belong to the middle income group having monthly income in the range of Rs. 10,000 to 15,000 months. The average household size of the sample comes around 4.5 members per household.

Modal Split

The model split expose the highest share of bike overall. The bus is contributing only 13% of the total share. This shows that people are more interested towards private modes use, especially motor scooter and less attracted to bus for their daily trips.

When studying the modal split by the trip purpose for work trips, majority of the people are using private modes and only minority group are using buses and bicycles. For educational trips, the share of private bus and bicycle is comparatively higher as compared to work trips. On comparing the Private Vehicle ownership users with their household Private Vehicle availability, about 29% of them can be considered as captive travelers of bus with no Private Vehicle owning. As Private Vehicle ownership increases, the chances of using bus also decrease. The Private Vehicle owned in a household is used by the head of the household in most of the cases while remaining members are relying on the public transport.

Attitude towards public Transportation

As per the opinion of the people towards the public transport buses, the list of attributes was presented to the respondent. First the person is asked to tick all the attributes which he/she thinks are relevant and following that is a question where the respondent has to select the one most significant attribute from the earlier selected list. It shows that most of the people voted for frequent service and low cost Bus fare as the most significant attribute. People are not much concerned about the comfort level as only about 6% opted for the clean and good quality of bus. The following graph shows the result of the second part, indicating the most significant attribute selected by the people.

Analysis of the willingness to shift to proposed public transport: To analyze the choice making behavior of sample population, the choice set data is used to develop the random utility models and to estimate the potential model shift, based on a binary logit model developed out of it. The analysis first explains the shift in general statistical terms and later utility functions are derived for each choice combination.

When studying the willingness to shift as per the current mode category, 73.8% of the MPSRTC (undertaking) buses and 12.4% of the car users said that they will use public transport buses for their trips. Some shift is shown from bicycle as well, around 12%. The highest shift is from the bus as these are considered mostly captive travelers. It is assumed that all the users of MPSRTC buses will be shifted to public transport buses system will be completely replacing the existing public transport system.

Discrete Choice Modeling

The stated preference and Revealed Preference data have been used to calculate the mode choice parameters. Sp data presents the hypothetical situation which is the proposed public transport may be BRT system and the RP data contains the observed behavior of the people. The basis for the comparison between the RP and SP is the daily trip occurring in the AM peak period from their home to the destination.

Overview of the model structure

Discrete choice model postulates that the probability of individual and BRT system given option is a function of their socioeconomic characteristics and the relative attractiveness of the option. For the study, a binary choice model was considered, where an individual has two choices, the current modes and the BRT system. The choice set is denoted as C_a and C_b alternate C_a is the current mode and alternate C_b is the BRT system. The utility function for an alternative can be written as :

$$U_{cn} = V_{cn} + \varepsilon$$

V_{cn} is the systematic or representative utility and εis reflecting unobserved individual idiosyncrasies of taste. The later part is also termed as ASC (Alternative specific constant)

The probability of alternative b being chosen will be determined by:

$$P(b) = \frac{\exp(\beta U_{bn})}{\exp(\beta U_{bn}) + \exp(\beta U_{cn})}$$

Empirical structure of the utility function is critical to modeling individual choice, and represents the process by which attributes of alternatives and individuals' socioeconomic environments combine to influence choice probabilities, and in turn the predictive capability of the choice model.[10]

Mode choice study variables

The main variables, used for random utility models are the income, profession, trip length, travel time and travel cost. The utility functions derived, helps to identify, the role of these variables in determining the utility for each alternative.[11]

The variables such as income profession and trip length, representing individual attribute, which have same values for both options, are put into only one of the utility equation. The variables dependent on the alternative mode, such as travel time and travel cost appear in both equations. The(ASC) alternative specific constant, accounted for the un-observable part in utility determination, is linear model for only one option as it is not possible to have it for every option, due to the way the model works.

Continuous variables such as travel time, travel cost, trip length and income, are multiplied by their respective coefficients which reflect the disutility per unit of that variable. Other coefficients are applied to categorical variables, which respective coefficients which reflect the disutility per unit of that variable. Other coefficients are applied to categorical variables, which reflect the total utility increase or decrease for that variable relative to a base situation.[4]

Formulation of the model structure:

The discrete choice model is developed as a binary logit model between the current modes and BRT buses. The bus users are not included because, after the implementation of the public transport system the existing public transport system will be completely replaced by the new system and as such, it is not possible to have alternatives buses and BRT for the route. Also the mode individual is also included, as the number of observations for it is very few.

The inclusion and exclusion of the variables is dependent on their significance test. If the parameter of a variable is giving very low significance test results,. It's are excluded. The best fit equation is used, by comparing log-likelihood ratio value and Rho-square, among other possible forms. As a result, the functions derived for each mode are different from each other in the attribute selection and their interaction.

Utility equation derivation

The utility function, derived out of the choice sets help to observe the attractiveness of each alternative, for a given trip. The contribution of each attribute to a utility of an alternative is indicated by the sign of its coefficients. A positive value indicates a positive impact on the utility and opposite applies to a negative value. Three models are considered which are described below: [5]

Model 1: 2-wheeler and BRTS

Utility equations

$$U_{ms} = \beta_{TT} \times Travel\,Time_{ms} + \beta_{TC} \times \left(\frac{Travel\,cost_{ms}}{Income}\right) + \beta_0 \times Occupation + \beta_1 \times income$$

$$U_{BRT} = \beta_{TT} \times Travel\,Time_{BRT} + \beta_{TC/1} \times \left(\frac{Travel\,cost_{BRT}}{Income}\right)$$

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Description of utility of 2-wheeler and BRTS

Travel time and travel cost have negative coefficients which suggest that the utility of an alternative decreases as the values of these terms increases. The higher income group has less value on cost as compared to lower income group. In terms of occupation, the positive coefficient value indicates that workers are more likely to use the 2-wheeler than the student and accordingly it is expected to have fewer shifts to the BRT from the workers side. As per the income groups, higher income groups are more likely to use as suggested by the positive coefficient and thus less likely to shift towards BRT Rho-square in coming close to 0.2, which suggests that it is representing a fairly good model.

Model 2: Car and BRTS

Utility Equations

$$U_{Car} = ASC + \beta_{TC/car} \times \left(\frac{Travel\,Time_{car}}{Income}\right) + \beta_1 \times income$$

$$U_{BRT} = \beta_{TT} \times Travel\,Time_{BRT} + \beta_{TC/1(BRT)} \times \left(\frac{Travel\,cost_{BRT}}{Income}\right)$$

Description of utility of Car and BRTS

Travel time and travel cost have negative coefficients which suggest that the utility of an alternative decreases as the values of these terms increases. The results shows that value of travel cost have a different marginal utility for car and BRT. Travel time is not at all coming significant for under alternative and so it is not included in the equation. So according to it, travel time is playing no role in the utility of car, which is somehow, an unclear result. Also, in contrary to the expectation, the coefficient of income is negative, which is an indication that as income level increases, the utility of the car decreases.

Model 3:- Shared Auto and BRTS

Utility Equations:

$$U_{SA} = ASC + \beta_{TT} \times Travel\,Time_{SA} + \beta_{TC/1(SA)} \times \left(\frac{Travel\,cost_{SA}}{Income}\right)$$

$$U_{BRT} = \beta_{TT} \times Travel\,Time_{BRT} + \beta_{TC/1(BRT)} \times \left(\frac{Travel\,cost_{BRT}}{Income}\right)$$

Description of utility of Shared Auto and BRTS:

The parameter of cost and income are significant and its value is different for each option, indicates that the perceived value of cost for each option is different. For a given cost, BRT option is more attractive to the people than shared Auto which is shown by higher negative coefficient for Shared Auto in the cost term.

Air pollution Modeling: The approaches in the field of modeling air pollution from road traffic can be categorized in two categories-[2]

(i) Macroscopic

(ii) Microscopic.

Macroscopic: In a macroscopic model the traffic is represented as a compressible fluid and the movement of each vehicle cannot be monitored. Emission is usually determined depending on total traffic volume and average speed of traffic flow. In the macroscopic representation road traffic is associated with compressible fluid, so can be applied the fluid mechanics theories. The road traffic is characterized by three variables:

Traffic flow (Volume), Speed of vehicle and traffic congestion (density).
Supporting this theory is the relationship between these three parameters has the from

$$Q = D^* V\text{----------------------- (i)}$$

Where Q [vehicle/hour] is the traffic volume.
D [vehicle/km] is the traffic density.
V [km/hour] is the speed.

With Q=1/h, D=1/s where h [hours] in succession interval, s [km] is the distance between successive vehicle.
Now total traffic volume in (vehicle*km)

$\mathbf{Q_T = \sum M_i}$ ($\mathbf{M_i}$ – Mileage of i type vehicle)
$= \sum \mathbf{A(M_i)}$ ($\mathbf{A(M_i)}$ – Average Mileage of i type vehicle)
$= \mathbf{A(M_i)} * \mathbf{N}$ (**N-** total no of vehicles.)

And $Q_{total} = \sum \mathbf{Q_T}$ on a road link.
$= \sum$ Q on a road link* $Tp*R_l$

Where Q- Traffic volume (in vehicle/time unit), Tp- Time period, R_l- Length of road link.

Since in the macroscopic approach the traffic is treated as a continuous flow, there is not possible a detailed representation of travel speed variation associated with individual or categories of motor vehicle type, which compose the traffic flows. This issue creates limitation on the traffic modeling of macroscopic level.

Microscopic: Since the speed fluctuation shows a considerable importance in modeling air pollution from road transport therefore an alternative to the macroscopic representation of traffic flow is the microscopic models take in to account the individual behavior of vehicles and are used to forecast the likely impact of changes in traffic conditions, these models quantify the emission at the level of each vehicle in the structure of traffic flow, being taken in to account the parameter that characterized the movement of the vehicle such as – instantaneous speed, acceleration, motorization category(types of vehicle), the total emission associated with traffic flow are obtained by aggregating the specific emission for each motor vehicle.

Estimation of emission: Air quality modeling is very important as it helps to predict the impact of any proposed project on environment. It is also an important tool and play major role in attempt to protect air quality. Modeling tools are needed to predict road side air quality and to analyze travel behavior strategies to mitigate possible negative impacts.[6]

Emission from road traffic was estimated based on the number of vehicles and distance travelled in a year per different types of vehicle. This is given by:

$$E_i=\sum (V_j*D_j)*E_{ij,km}$$

Where E_i =Emission of compound (i)
V_j = Number of vehicle/type (j)
D_j = Distance traveled in a year per different vehicle type (j)
$E_{ij,km}$ = Emission of compound (i) from vehicle type (j) per driven km.

II. Summary and conclusions:

In the study DEA analysis reveals that there is a need in improvement of public transport system. Improvement of public transport is one of the highlighted measures when it comes to the reduction of negative impact of traffic and the improvement of the efficiency of a transport system. A positive step towards to find a RTS in Gwalior division the choice analysis experiment done and

Mode choice experiments help us to investigate the propensity of the commuters to change their travel behavior in relation to the choice of a particular mode for their trips. The statistical figure shows overall 37% of the commuters are willing to shift BRTS. When analyzing the shift in terms of the categories of income, sex, occupation and current travel mode. It reveals that low income group, females, students and bus users respectively are more likely to use the BRTS.

Utility function derived out of the choice sets, helps to assess the relative attractiveness of the option, indicated by the sign of the coefficient of the attributes. In overall study travel time and travel cost has a negative sign indicating that an increased value of these terms will have a negative effect on the utility of the option. The model for two wheeler and BRTS combination shows a good fit model as compared to other modes as it has over observations and all its parameters are significant at 90% confidence interval. Other combinations have comparatively few observations and accordingly their parameter estimates are not very significant. The models derived here are used for predicting the model shift for estimating a new model split for the BRTS scenario. As per the objective of the study the comparison is done only between the current mode and the BRTS offering a binary logic model. The possibility to shift within the available current modes in presence of a new mode is not studied which requires the use of multi-nomial logic model.

The general process of modeling air pollution generated by road traffic consists of the following steps: (i) Collecting data and information under laying the Microscopic approach.(ii)Estimating the transport demand

and the affecting of the traffic flow on the entire analyzed network.(iii)The inventory of the emission from road vehicles which compose the traffic flow. In this study traffic flow estimation is a key issue in the modeling of air pollution due to road traffic. The emissions associated with traffic flow are evaluated by aggregating the specific vehicle emission at the individual level. Technical measures alone are insufficient to ensure the desired reduction of air pollution; they are necessary component of any effective strategy for limiting vehicular emission. Employed as part of an integrated transport and environmental program, these measures can buy the time necessary to bring about the needed behavioral changes in transport demand and the development of environmentally substantial transport system. In addition, use of alternative fuels and effective public transport system and management can ensure a substantial improvement in environmental conditions, despite continuing increases in vehicle fleets and their utilization.

After deceleration to close the Madhya Pradesh state road transport corporation (MPSRTC) in May 2008 the undertaking buses run under the Madhya Pradesh transport Department (MPTD.)

References:

[1]. Report of the Sub-Group On State Road Transport Undertakings formed under the Working Group on Road Transport Constituted by Planning Commission. Twelfth Five Year Plan **(2012 – 2017).**

[2]. Mitran G.,Ilie S.: 'Air pollution from road traffic by transport modeling.*'Ph.D Scientific Report No1University of Pitesti.Romania* **(2011)**

[3]. Review of the Performance of State Road Transport Undertakings(**2010-11**)

[4]. Mintesnot Gebeyehu and Shin-ei :Diagnostic Evaluation of Public Transportation Mode choice in Addis Ababa(*Journal of Urban Transportation*) *Takano Hokkaido University, Sapporo, Japan.* (**2010)**

[5]. Ashim Ratna Bajracharya: The Impact of model shift on the transport ecological foot print; A case study of the proposed BRT in Ahmedabad.**(2008)**

[6]. T.V. Ramachandra and Shwetmala: 'Emission from India's transport sector: State wise synthesis.*'Journal of Atmospheric Environment,Elesvier***(2009)**

[7]. Ciegis, R,: Gineitiena, D.: Participatory aspects of strategic sustainable development planning in local communities: Experience of Lithuana, Technological and Economic: Development of Economy 2008.

[8]. Punita Saxena, K.K. Diwan, M. Mastafa: Data envelopment analysis: An application in the transport sector *journal of inter-disciplinary mathematics* **(2006)**

[9]. Daniel McFadden: Computing Willingness to pay in Random Utility Models, Department of Economics, University of California, Berkeley. **(2006).**

[10]. Sanjay kumar Singh: State Road transport undertakings, 1983-84to 1997-98; a Multilateral comparison of Total Factor Productivity. *Indian Journal of transport Management* **(2005)**

[11]. Venkatesh Bhagavath: Technical Efficiency Measurement by Data Envelopment Analysis:

[12]. An Application in Transportation. *Alliance Journal of Business Research*. **(2003)**

[13]. Enhancing Discrete Choice Demand Modeling for Decision- based Design. *ASME 2003 Design Engineering Technical Conferences on Computers and Information in Engineering Conference Chicago, USA,***(2003)**