

The Application of Mathematical Models for the Choice of Variables in Modeling Interurban Trips



Engineering

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ABSTRACT

The process of “building” of a mathematical model requires an accurate assessment of the variables that will participate in this model. Referring to the specific conditions of Albania, the data necessary for the construction of a model for interurban trips is not easy. Visible changes in the socio-economic and administrative plan shown in Albania during the years 1989-90 up to now, have had a great influence on the manners, forms of organization and functioning of the institutions involved in the collection of statistical data in the transport field and therefore the information dispose is no homogeneous. Without an extensive information of “data base” of variables is not possible to build models to assess the demand for travel, and even more for the provision of travel requirements for medium and long term periods, especially for countries with non stable economic development. [1,5].

INTRODUCTION.

In the last decades the application of mathematical models in the field of transportation has become quite friendly. Urban and interurban trips are difficult to define consistently in a precise way. Furthermore the differences between urban and interurban trips are not clearly separated by determining parameters such as economic, demographic or territorial, especially when the distances between the cities are small.

But undoubtedly variables analysis techniques are available to assist in determining the amount of risk and uncertainty. Not only that but they have to be very flexible and should allow for the intervention of a simulation for a reliable prediction of the evolution of their reference time period.

MATERIALS AND METHODS.

Despite the existing difficulties for a proper database necessary for modeling of interurban trips in Albania, to make the selection of a group of variables are based on three basic factors, demographic economic and territorial which directly affect community trips whose dependencies are known.

Based on the analysis of the three above mentioned factors and launched from statistical data situation collected and processed, as a first step we have concluded in the selection and grouping of variables that will be used as follows, resident population, the composition of the population by professional and non-professional activities, age group, economic activity, GDP, industrial units, commercial, agricultural, tourism, public administration sectors, the number of hotel beds-tourism, passenger cars per 1000 inhabitants, the resident population km2, etc. [9,4]

By a second analysis of this group of variables based on the similarity between some of them, not availability of data to many of the variables proposed by three basic factors above, and some small impact in terms of our country, we chose the following 5 variables, the resident population in the cities, “Xp”, motorization rate for passenger vehicles “Xmj” active work power “Xfa”, enterprises economically active “Xnd”, the number of employees “Xpu”.

To obtain a quantitative relation between the variables “X” and trips “Y”, it is necessary to specify the model to be applied or mathematical form of the relationship. Based on regression models used simple regression especially as,

$$\text{Linear.....} Y = a + bX \quad (1)$$

Form used to express relationships between dependent vari-

ables and independent variables is the power regression model.

$$Y = c_1 X^{c_2} \quad (1.0)$$

where:

“Y” = demand for trips (actual or anticipated) “X” = variables, c_1, c_2 = calibration coefficients of the model. [6]. Given the above analysis of existing models, the comparison between their advantages and disadvantages, for the “production” of a suitable model, aiming at the selection of independent variables classified by weight occupied by each of them, we applied mathematical model power form, (1.0)

In this mathematical model function values “Y” represent the matrix O/D travel current national road network which we possess full. [7]. The objective of the paper is to modify model parameters in order to achieve a better fit ensuring optimal convergence. The result of the model describes a relationship between two variables average variables.

The application of this model has some limitations; the number of parameters to be identified shall not exceed 20 and not less than 1. ratio of the number of variables and the number of areas (cities) should not be less than 1/8. [12]

Matrix O/D for all couples “i, j” origin and destination in fact represents the values of the function “Y”, we can apply mathematical model 1.0 finding parameters values c_1 and c_2 , but also assessing the correlation of each variable “X” and “Y”. To apply mathematical model 1.0 and draw legitimacy of travel in function variables “Xi” selected are concentrated in 8 major cities like Tirana, Durrës, Vlora, Elbasan, Fier, Korce, Berat, Shkodra, Lezha, as the centroid of the which represent about 96% of the population and economic activities. (Table 1).

Table 1.

Destination cities.	Means of transport for passengers	Cities of origin.				
		Tirana	Durrësi	Fieri	Elbasani	Vlora
Number of trips						
Durrës	19721	15230	xxxx	1155	1225	626
Elbasan	14594	4224	1150	640	xxxx	681
Fier	122449	3850	1100	xxxx	1050	3560
Tiranë	72925	xxxx	14097	4191	4583	3694
Vlorë	12143	4377	565	2045	404	xxxx

Journeys O/D dependent to variable “Xmj”. Source INSTAT, ANTP

For selecting the most important variables in this “package” of 5 variables we are based on the application of power model, and simulation of these variables by 10%, for trips originating only from 5 cities Elbasan, Durres, Fier, Vlora, Tirana and 8 destination cities taken in the analysis.

We received the results of travel laws O/D. For simplicity we give only the results for the city of Durres.

Legality on travel in the function of the vehicles of transport of passengers

RESULTS.

Origin from Durres.

City	TT (vehicles)	UP (O/D)	YP (legality)
BR	8318	721	388
EL	14594	1150	983
FR	12449	1100	756
KO	11016	427	617
LE	4085	171	119
SH	13972	532	915
TR	72925	14097	14095
VL	12143	556	725

where;

TT(vehicles)- is variable “Xmj” for cities Berat, Elbasan, Fier, Korce, Lezhë, Shkodra, Tirana and Vlora (which are marked by the indices according to vehicle license plates of respective cities).

UP(O/D)- are current travels between the town of Durres travel origin and 8 other destination cities. (Which in fact is the value of the function “Y”).

YP(legality)- is the result of travel laws “Y”.

From the model results we taking;

$$Fopt = 2.327195728038741E-003$$

$$Copt(1) = 1.259623947904718E-004$$

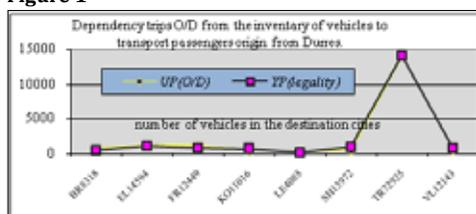
$$Copt(2) = 1.655156003774128$$

where;

Fopt- the value of the function (Ylegality), Copt (1) and Copt (2) - the values of the model coefficients. So the function has the form,

$$Y = 0.0001259X_{mi}^{1.655}$$

Figure 1



In the same way are implemented the applications of power model for 5 variables and to 8 other cities taken as the origin. But on the other hand by applying only power model which is only one variable, we cannot judge precisely the role that each variable on the trip, as the latter are dependent on a multiple of several variables. But also connected with the difficulties of the application of a regression model for more than three variables we select only three major ones. To recognize the impact that is caused by a unit of variables “Xp, Xmj, Xnd, Xfa, Xpu” in interurban trips according to travel O/D datas, for the five variables we find the coefficient “kO/D/Xi” [trip/ variable unit] for Tirana, Elbasan, Fier and Vlora cities. Table 2.

Increased travel to increase a variable unit Origin from Tirana					
Destination	k _{UP(Xp)}	k _{UP(Xmj)}	k _{UP(Xnd)}	k _{UP(Xfa)}	k _{UP(Xpu)}
BR	0.02	0.33	1.12	0.04	0.38
DR	0.08	0.77	2.34	0.22	0.37

EL	0.02	0.29	1.11	0.03	0.34
FR	0.02	0.31	0.64	0.03	0.17
KO	0.03	0.37	0.82	0.05	0.29
LE	0.03	0.52	2.06	0.04	0.38
SH	0.01	0.16	1.42	0.03	0.25
VL	0.03	0.36	1.00	0.09	0.33

Besides the evaluation of the kO/DXi we have done and simulation of variables “Xp, Xmj, Xnd, Xfa, Xpu” with 10%. Estimated elasticity coefficients for 4 cities origins and 8 cities destinations. For simplicity we give only the results of the simulation to “Xmj” with 10% of where we got the results of increasing the “X” in Table 3.

Table 3

Simulation with 10% of “X _{mi} ”				
Cities of travel destination	Cities of travel destination			
	TIRANE	ELBASAN	FIER	VLORE
	Increase by % of Y			
	BR 27.1	BR 12.2	BR 10.3	BR 7.8
	DR 27.1	DR 12.2	DR 10.3	DR 7.8
	EL 27.1	FR 12.2	EL 10.3	EL 7.8
	FR 27.1	KO 12.2	KO10.3	FR 7.8
	KO 27.1	LE 12.2	LE 10.3	KO 7.8
	LE 27.1	SH 12.2	SH 10.3	LE 7.8
	SH 27.1	TR 12.2	TR 10.3	SH 7.8
	VL 27.1	VL 12.2	VL 10.3	TR 7.8

From tabular data clearly is distinguished the effect of simulation with 10% of transport vehicles variable for passenger and the measure of the impact of this variable simulation in O/D of various cities.

STATISTICAL METHODS

Descriptive statistics, mean and standard deviation were tabulated using SPSS 16.0 software.

RESULT.

However the results obtained applying the model almost all variables have given results which show displayed multicollinear with “Y”. Table 4 presents the results of the correlation for 5 of 8 cities in the study.

$$R = \frac{\sum X/n - (\sum X \sum Y)/n^2}{\sqrt{(\sum (X^2)/n - (\sum X/n)^2) (\sum (Y^2)/n - (\sum Y/n)^2)}} \quad (2.0)$$

Table 4

City of origine	VARIABLE				
	X _n	X _{mi}	X _{nd}	X _{fa}	X _{pu}
The correlation coefficient “R”					
Elbasan	0.94	0.95	0.98	0.91	0.98
Durrës	0.98	0.99	0.99	0.94	0.99
Fier	0.77	0.80	0.83	0.67	0.79
Vlorë	0.52	0.44	0.58	0.66	0.50
Tiranë	0.95	0.80	0.59	0.99	0.89

In this way from 200 travel directions between 8 cities included in the study to express the relationship between travel O/D and variables (XP, Xmj, Xnd, Xfa, Xpu).

1. about 80-85% of them express a reliable correlation between the curve of the O/D and legality O/D.
2. the remaining 15-20% displayed a correlation not very satisfactory,

As seen in Table 2, three main variables that have the greatest impact are “Xnd, Xmj, Xpu” where their values range from 0.16 to 2.34 [trip/variable unit]. The two variables other “Xp, Xfa,” have not very significant impact and their values fluctuate 0.01 to 0.09 borders [trip/variable unit]. In the same manner and the estimates have been made for 8 other cities. From the results obtained in Table 3, noted that with simulation 10% of “Xmj”

most influential travel growth is made in Tirana with 27.4%, followed in Elbasan with 12.2% and Fieri with 10.3% [3]

So a 10% increase in variable "Xmj" nationally we have an average increase of 14.4% of trips. The analysis of five variables noted that cities with high socio-economic developments, represented by stable variables, their interaction is at high levels of correlation and mutual between cities, regardless of origin or destination city pairs. The result for some variables is still tense not only for specific parameters, but also for specific urban areas where it is impossible to accept the risk of multicollinearity and not the eventual appearance of variables. Especially it is distinct in several cities originated trips Tirana, Durres, Fier, Vlora, Elbasan and destination cities Lezhë, Shkodra, Korca and vice versa.

This is because we do not have matches in travel time between measurements of O/D and the variables "Xi". Corridors also relatively short length of less than 50 km, with two or more urban areas manifested journey different proportions. These areas are known as Metropolitan Statistical Zone (MSA) and non MSA area. This for Albania is most notable in the central area of the country covered by the geographical triangle Tirana-Durres-Elbasan and for southern area in territorial space Vlore-Fier. [10]

Based on the principal theory of opportunity to say that they would rather travel to the nearest town who have goods and services necessary for them, then tend towards MSA, where smaller cities serve as a market area "satellite" to larger urban areas. Areas (MSA) regarded as areas with high levels of GDP growth have a bearing of approximately 20 percent, in addition likewise travel and an increase in the scope of travel for work around 25 percent. The above arguments also in view of the relations or not the relations between O/D factual law O/D for different pairs of cities are explained by Gravitational theory as follows:

By MG (gravity model) it has to do with the interaction strength between areas "i" and "j" and the distance "dij". On the other hand for the same power interoperable "Pi, Pj" between two areas, but with great "dij" mainly above 50 km we will have a no phase coefficient (kO/D).

To enable the selection of variables according to their importance and the impact they have on trips O/D, according to the tables of kO/D/Xi, R, and the coefficient of elasticity for 5 towns origins, we have made grouping and ranking according to their role classified into five categories, where category 1 shows the first or most influential variable occupies among the 5 variables, and so on up to the number 5 categories showing little impact.

Table 5

Variable ranking by Category					
Cities Origin	categories				
	1	2	3	4	5
Tirana	X _{1d}	X _{2d}	X _{3d}	X _{4d}	X _{5d}
Elbasani	X _{1d}	X _{2d}	X _{3d}	X _{4d}	X _{5d}
Fieri	X _{1d}	X _{2d}	X _{3d}	X _{4d}	X _{5d}
Vlora	X _{1d}	X _{2d}	X _{3d}	X _{4d}	X _{5d}
Durresi	X _{1d}	X _{2d}	X _{3d}	X _{4d}	X _{5d}

From the above table (Table 5) shows that three of the variables that affect more interurban trips are; "Xp, Xmj, Xnd".

DISCUSSION.

Based on the application of the model and its simulation power see no correlation to the appropriate level for some pairs "i,j" departure cities. Besides the evaluation of the correlation to achieve a high reliability assessment of the value of the function and the variables we studied the coefficients (kO/D/Xi) of several pairs of cities that have a fairly good correlation of about 80%. But among the 200 directions O/D trips there nonphase analyzed this correlation, which can be mentioned, couples Fier-Vlora, Vlora-Fier, Vlora and Shkodra, Vlora,Lezhë, Vlora-Korca, Fier-Korca, Fier-Shkoder, Elbasan-Lezhë, Tirana and Shkodra etc, however (kO/D/Xi) has maintained almost the same for both directions in each variable analyzed. This deviation of the correlation of the fact that, among several cities taken as origin or destination, Tirana, Durres, Fier, Vlora, Elbasan and some other cities like Berat, Lezha, Korca, Shkodra have no connection or depending on economic, social and tourism between them.

CONCLUSION.

In conclusion, given the above two evaluations before, on the extent of the influence of the coefficient of elasticity and coefficient "kO/D/Xi," we have made their classification, where we have selected three variables that have significant impact on interurban trips which are (Xp), (Xmj), and (Xnd). From the results obtained, and analyzes of their arguments conclude that the results are reliable and satisfactory in over 80% of applications that can be launched for practical use to assist policy Modeling, Planning and Transport Management in the field of travel and investment in services and infrastructure. On the basis of these 3 variables selected as the most important influencing community movement is now entirely possible to "build" mathematical model of interurban travel nationally. [9,10]

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