Planning of interurban travel through modeling

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ABSTRACT.
For a more harmonious development between economy and transport and for a close relation supply and demand for travel, proper scientific studies should be conducted to determine operational instruments for resolving the contradictions between this report and especially those technical instruments should provide recommendations on permanent and long-term planning that preceded the decision and policy-makers [1-3]. One of these instruments that are in use with much interest and after 50 years are mathematical models in transportation. They are based on the assumption that a linear equation could represent the relationship between a dependent variable "Y" that represents a pointer or economic phenomenon and one or more independent variables "$X_1, X_2 .... X_p$" and that each of them taken separately can satisfy the assumption of Linearity that is expressed in mathematical form as follows, [6]

$$y = F_G = a_0 + a_1 x_1 + ... + a_n x_n + e \qquad (1.0)$$

It is important that we have implemented practical use of information which is part of a database system for collection and data management of travel and road traffic in our country. In particular and very carefully, we have also defined specific requirements for input data analysis and have made their selection for the purpose of constructing the model. Despite the statistical information that looks like the exuberant view, is to be stressed that in the above information has no high level credibility as a result of, [3]

a. informality to the reporting of statistical data binding,
b. a considerable number of activities non registered (licensed).

INTRODUCTION.

Theoretical treatment and research on our part has been extended by examining all transport's components, taking into account the current information system that forms the basis of existing data, and providing other forms of data impossible to ensure up to now but that are indispensable. On the other hand referred to the specific conditions of Albania's research and collection of appropriate data is not easy mainly because of the fragmented characteristics of existing statistical data and lack of time series. Basic variables which we are supported affect the quantity and quality of travels and we have grouped into three categories as follows, [8]
demographic factors, economic factors, territorial factors. Based on three categories of the above variables from an analysis of their grouping and also based on:

a. *similarity between some of the variables of the relevant package that proposes each treating category (resident population, the composition of the population, resident population per km²)*
b. *because of non disposal of data availability to many of proposed variables by the above three categories (average per capita product, the composition of the population by occupations and economic sectors, etc.)*
c. *small impact of some of them in terms of our country (resident population/km², age distribution, etc.)*

have deemed to representation and application of the travel modeling, the following variables as, resident population in cities, the number of passenger vehicles, and the active forces able to work, economically active enterprises, number of employees. With travel ensuring *O/D* (origin-destination) [7] between the cities of the country and variables expressed above we have ensured the necessary database for the travel modeling through the application of selected mathematical model. To derive the travel legality in the function of variables *"Xi"* selected according to the recommendations and analysis made by us, we were focused on some of the country's main towns which make up about 96% of the population and economic activities, of variables *"Xi"* taken into consideration.

Starting from the given travel data *O/D* and for the 5 selected variables we have draw 5 tables, as an example only one of them
a. travels O/D depending on the population variable.(X_p)
b. travels O/D variable depending on the number of economically active enterprises.(X_{nd})
c. travels O/D depending on the variable means of transportation for passengers.(X_{mj})
d. travels O/D depending on the variable active work force.(X_{ap})
e. travels O/D depending on the variable number of employees.(X_{np})

Destination cities	population "X_p"	The cities of origin				
		Tirana	Durresi	Fieri	Elbasani	Vlora
		Travels O/D				
Berat	127837	2768	721	450	62	827
Durrës	181662	15230	-	1155	1225	626
Elbasan	221635	4224	1150	640	-	681
Fier	199082	3850	1100	-	1050	3560
Korcë	142909	4046	427	73	583	177
Lezhë	67734	2118	171	75	15	50
Shkodër	185395	2247	532	82	54	79
Tiranë	519720	-	14097	4191	4583	3694
Vlorë	147128	4377	565	2045	404	-

Tabela 1. Travels O/D depending on the population variable.(X_p)

for,
a) selection of independent variables classifying by weight occupied by each of them, and to make a second selection of the 5 variables in the three we have applied the mathematical model of the shape force, [5]

$$Y = c_1 X^{c_2} \tag{1.1}$$

and for,

b) modeling and forecasting of interurban trips we shall apply the mathematical model of linear form

$$Y = a + bX + cX_2 + dX_3 + ...nX_n + e \tag{1.2}$$

Mathematical model of the selected form $Y = c_1X^{c2}$ is based on comparing of the process conduct and this of the model, especially when the dependence between the *"Y"* and *"X_i"* is not linear and more so when there is no identity of conduct.

The objective of the method is to modify the model parameters in order to achieve a better fit by assuring a very fast convergence and adjacent to the redevelopment status and optimal.
The result of the model describes a relationship between average variables of the two variables. The results given by the model are tabular and in graphical form, showing except of the parameters values (coefficients before variables *"X_i"*), and some important indicators that show the reliability of the model and extent of links between the two sizes *"X and Y"* such as, R, R^2 (or R^2, correlation coefficients, an indication that express the value of the model), adjusted R^2 (or Adjuster R) is useful in comparing this model with other models, F (value of the coefficient of reliability, P-value (probability value of reliability of coefficients before variables *"X_i",* etc.

Based on the selected mathematical model we have applied software of this model (6.1) for nine main cities like Tirana, Durres, Vlora, Elbasan, Fieri, Korca, Berat, Shkodra, Lezha, representing cities centers of the county towns that constitute the major economic, social and cultural potentials, taking as the origin one city and destination eight other cities and so changing the positions of origin of travels to eight cities in an order we have received the following results which express the legality of dependency between variables *"X_i"* and function *"Y"*. In here we are providing only one of the results of application of software.
Journeys in the function of the population originating from Elbasan.

	TT (pop)	*UP (O/D)*	*YP (legality)*
BR	127837	62	371
DR	181662	1225	696
FR	199082	1050	820
KO	142909	583	453
LE	67734	15	119
SH	185395	54	722
TR	519720	4583	4573
VL	147128	404	477

where;
TT(pop)-is variable *"X_p"* that gives the number of population for cities Berat, Durres, Fier, Korca, Lezha, Shkodra, Tirana and Vlora (which are marked with the indices according to the vehicles number plates of the respective cities).
UP(O/D)-are current journeys originating travel between the city of Elbasan and 8 other cities of destination, (which in fact is the value of the function of *"Y"* mathematical model that we implemented).
YP(legality)-is the result of the travel legality *"Y"* according to the application of mathematical model. From the results of model we are taking,

Fopt = 3.762306016217445E-002
Copt(1) = 2.658623009781310E-007
Copt(2) = 1.790759920467837

where;
Fopt- function value (*Y* legality) *Copt* (1) and *Copt* (2)-values of model parameters.
In that way the function has the form,

$$Y = 0.0000002658 X_p^{1.790} \tag{1.3}$$

In the same way we extracted the results and for eight other cities taken by order as the origin of travels. In this way the characteristics of transport in urban areas reflect in a broad way, the social, economic, physical conditions at a given point in a given time. In Table 2 are given the variables and the correlation's coefficient.

Tabela 2. Variabel and corelation's coefficient.

City of origin	V A R I A B E L AND CORRELATION'S COEFFICIENT				
	Xp	*Xmj*	*Xnd*	*Xfa*	*Xpu*
	Correlation coefficients				
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
Tirane	0.95	0.80	0.59	0.99	0.89

Thus from the 200 directions of travel between 8 cities in the study,
about 80-85% of them express a reliable correlation between the curve of *O/D* and that of legality of the *O/D* found by modeling, the remaining 15-20% displays a correlation not very satisfactory. To select which of the variables "*Xi*" influence more on trips *O/D,* it was applied their simulation "X_p, X_{mj}, X_{nd}, X_{fa}, X_{pu}" by increasing them to the extent of 10%. From the application of mathematical model of the type power

$$Y = c_1 X^{c_2} \tag{1.4}$$

we obtained 200 values of trips *O/D* between the couples of cities and we get the following results. Specifically for simulation with 10% of "X_p" we get the results as table 3.

Table 3. Travel increase by simulation 10 % of " X_p*"*

Cities of Travel Origine			
TIRANA	ELBASAN	FIER	VLORE
Travel increase in %	Travel increase in %	Travel increase in %	Travel increase in %
Cities of Travel Destinations			
BR 21	BR 18.6	BR 16.3	BR 12.6
DR 21	DR 18.6	DR 16.3	DR 12.6
EL 21	FR 18.6	EL 16.3	EL 12.6
FR 21	KO 18.6	KO 16.3	FR 12.6
KO 21	LE 18.6	LE 16.3	KO12.6
LE 21	SH 18.6	SH 16.3	LE 12.6
SH 21	TR 18.6	TR 16.3	SH 12.6
VL 21	VL 18.6	VL 16.3	TR 12.6

As a conclusion based on the above two assessments therefore;

1) to the extent of influence after the simulation with 10% of variables
2) and coefficient *"$k_{O/D/Xi}$"* [travel/unit variable]
have made their classification from which we selected three of variables that have significant impact on the generation and attraction of trips which are,

- ✓ population *(X_p),*
- ✓ transportation of passengers *(X_{mj}),* and
- ✓ economic enterprises *(X_{nd})*

Based on these three selected variables "construct" the modeling of trips generated or attracted in nationally rate, using the linear form which is as follows,

$$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + e \quad (1.5)$$

where,
e-error term,
for, $X_1=X_p$, $X_2=X_{nd}$ *and* $X_3=X_{mj}$
Then our function will have the following form,

$$Y = a_0 + a_1X_p + a_2X_{nd} + a_3X_{mj} + e \quad (1.6)$$

Based on official data of INSTAT [8], and the values of travel [7] according to the matrix *O/D* we have benefited Table 4.

Table 4. Real travels according to 3 variables.

No.	Cities	*Xp*	*Xnd*	*Xmj*	*O/D Real travels*
1)	Tirana	519720	19363	72925	63922
2)	Durres	181662	6058	19721	25222
3)	Kavaje	78179	1683	4430	6296
4)	Kruje	63517	455	5641	5837
5)	Elbasan	221635	3422	14594	8390
6)	Peqin	32964	267	1170	534
7)	Fier	199082	3906	12449	9423
8)	Vlore	147128	3947	12143	11574
9)	Lushnje	143933	2120	5611	4069
10)	Shkoder	185395	1582	13972	4964
11)	Sarande	35089	433	3221	1809
12)	Lezhe	67734	550	4085	3236
13)	Lac	54392	480	3706	3562
14)	Korce	124870	3245	11016	5367
15)	Pogradec	70471	578	2846	1359
16)	Librazhd	72387	131	1081	870
17)	Erseke	17161	224	682	393
18)	Kukes	102037	344	2443	1287
19)	Gjirokaster	54647	1327	4713	1756
20)	Tepelene	32404	141	1241	1077
21)	Permet	25780	168	924	429
22)	Diber	132546	723	4039	1048

To obtain the mathematical form of the model for interurban travel in national scale have applied software-in *SPSS,* where we have the following results and linear form of

mathematical model of interurban travel. According to the results of software and the taken coefficients interurban travel modeling has the form of general equation as follows,

$$Y = 1003.578 - 0.029\,X_p + 1.68\,X_{nd} + 0.632\,X_{mj} \quad (1.7)$$

Based on the above model we calculated the values of the function "*Y*" for 22 centroidat (cities) and the results are given in Table 5.

Table 5. The values of the function for legality of travels "Y'and real travels "Y"

a_0	a_1	X_p	b_1	X_{nd}	c_1	X_{mj}	Legality of travels (Y) O/D	Real travels O/D (Y)	City
1003.578	0.029	519720	1.68	19363	0.632	72925	64550	63922	TR
1003.578	0.029	181662	1.68	6058	0.632	19721	18376	25222	DR
1003.578	0.029	78179	1.68	1683	0.632	4430	4363	6296	KJ
1003.578	0.029	63517	1.68	455	0.632	5641	3491	5837	KR
1003.578	0.029	221635	1.68	3422	0.632	14594	9548	8390	EL
1003.578	0.029	32964	1.68	267	0.632	1170	1235	534	PE
1003.578	0.029	199082	1.68	3906	0.632	12449	9660	9423	FR
1003.578	0.029	147128	1.68	3947	0.632	12143	11042	11574	VL
1003.578	0.029	143933	1.68	2120	0.632	5611	3937	4069	LU
1003.578	0.029	185395	1.68	1582	0.632	13972	7115	4964	SH
1003.578	0.029	35089	1.68	433	0.632	3221	2749	1809	SR
1003.578	0.029	67734	1.68	550	0.632	4085	2545	3236	LE
1003.578	0.029	54392	1.68	480	0.632	3706	2574	3562	LA
1003.578	0.029	124870	1.68	3245	0.632	11016	9796	5367	KO
1003.578	0.029	70471	1.68	578	0.632	2846	1729	1359	PG
1003.578	0.029	61234	1.68	131	0.632	1081	131	870	LB
1003.578	0.029	17161	1.68	224	0.632	682	1313	393	ER
1003.578	0.029	102037	1.68	344	0.632	2443	166	1287	KU
1003.578	0.029	54647	1.68	1327	0.632	4713	4626	1756	GJ
1003.578	0.029	32404	1.68	141	0.632	1241	1085	1077	TP
1003.578	0.029	25780	1.68	168	0.632	924	1122	429	PR
1003.578	0.029	132546	1.68	723	0.632	4039	927	1048	DI

Graphic presentation shows a high consistent of both values above. Figure 2.

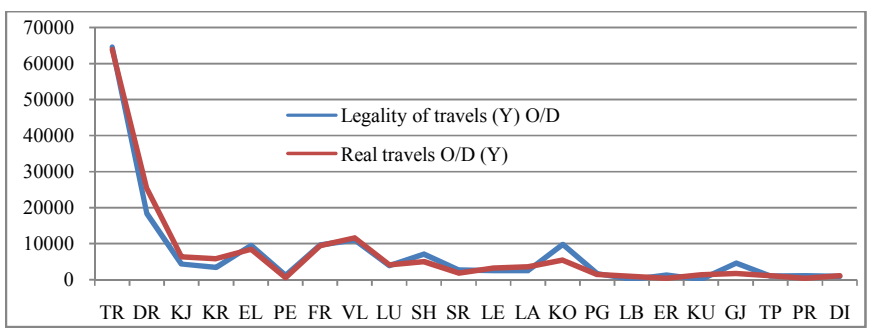

Figure 2. Comparison of values between the actual results of real travel and the function legality "Y"

Notwithstanding that out;

- ✓ *comparison of values between the actual results of travel O/D and the function legality "Y" i.e. the travel legality O/D, looks like a reliability modeling,*
- ✓ *Evaluation parameters of the model such as correlation coefficient " R " and "R^2" which are in very high levels and specifically according to table 6, they are 0.986 and 0.972,*
- ✓ *value of validity coefficient "α" is smaller than $\alpha = 0.05$ according to the table I (Statistics Book) [6]*

model rejected by the negative value of coefficient "$a_1 = -0.029$" variable that is before " X_p " which is impossible, because it is in confrontation to the generation theory and trips attraction which estimate that the population is the community of variables that affect positively in increasing the travel. This discrepancy is due to multicorelation among the selected variables by our side with the desire to include as many variables in the modeling of travel. To continue to the realization of the goal of our work we shall exclude the variable " X_p " from the table 5 above and would appreciate the dependence of travels with two other variables "X_{mj}, *dhe* X_{nd}" to "construct" travel model.

Data collected for software application are given in the table below where besides the elimination of population variables we have increased the number of zones (cities) to have an even greater representation of spatial interaction. To obtain the mathematical form of model for generation interurban trips (Table 5) in nationally scale we have applied again software SPSS, where we get the following results and linear form of mathematical model of generating interurban travel.

Table 6

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.9888221
R Square	0.97776914
Adjusted R Square	0.97591657
Standard Error	1959.44908
Observations	27

Table 7

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	4052837796	2026418898	527.79013	1.45705E-20
Residual	24	92146576.44	3839440.68		
Total	26	4144984373			
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*
Intercept -	**329.4979926**	429.6622815	-0.7668767	0.4506332	1216.277351
X_{nd}	**1.31581788**	0.677392307	1.94247538	0.0639025	0.082251118
X_{mj}	**0.535742204**	0.183371013	2.92162973	0.0074701	0.157283036

CONCLUSION

According to the results of software and coefficients of Table 7, are,

$$a_0 = -329.479;\ a_1 = 1.315;\ a_2 = 0.535; \tag{1.8}$$

and interurban travel modeling generation has the form of general equation as follows;

$$Y_{gj} = - 329.4 + 1.315 * X_{nd} + 0.535 * X_{mj} \quad (1.9)$$

Regarding the reliability of function (1.9) we halted in the analysis of some parameters that are evaluated by software through *ANOVA* (analysis of variation). From the results of tables 6 and 7 we see that the coefficient of determination is $R^2 = 0.97$ or *97 %,* which highlights the extent of variation of the "*Y*" from two variables "X_{mj},X_{nd}*"* and from statistical theory is considered as a criterion to judge objectively on the quality of the model because it is the indicator of the degree of approximation of "*Y*" and X_i. Likewise, *"R*" corrected (adjusted R Square) and "R" Multiple (Multiple R) have very high values that attests to a strong correlation between independent variables and dependent variable.

The data results of Table *ANOVA* according the table *OUTPUT SUMMARY* results that Significance *F* = 1.45705E-20 is less than then $\alpha = 0.05$ so we are within a specified condition, while the validity coefficient (importance) to the $\alpha = 0.05$ According [6] the values of table I The book of Statistics) we have that probability of regression coefficient at the variable "X_{nd}" is 90% as the P-value = 0:06, while the probability of the coefficient of regression at the variable "Xmj" is 95% as the P-*value* = 0007 so many good values which estimate the model of "construction". Above model parameters carry a significant meaning, so the regression parameter a_1 = 1.315 before variable "X_{nd}" indicates that when the number of enterprises increased by 1% the number of trips generated will increase by 1.31% while for the regression parameter a_2 = 0.535 before variable "X_{mj}" it shows that when the number of vehicles increased by 1% the number of trips generated will be increased by 0535%.
Regarding the parameter a_0 = - 329.479 in generall have no much sense and requires great care in interpretation.

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