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REGRESSION SHARING MODEL DEVELOPMENT TO ESTIMATE THE IRAQI LOCAL AIRPORTS FUTURE DEMAND

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ABSTRACT: The market share technique has long been used in forecasting air travel demand. It usually necessitates very good awareness of each airport within the group encompassed by the airport system which is intended to be analyzed. It requires a good comprehension of each airport's demand history and the perfect distinction of its market area. In this paper, an econometric model has been developed to estimate the local Iraqi airports shares of the national aggregate air passengers' demand. Each airport market area was assigned according to the airport vicinity and the local authority jurisdictions. The model depended on the socio-economic characteristics of these market areas in estimating their shares, provided that these characteristics are reliable and the market area borders are well defined. The model provided the capability of estimating the shares of newly established airports like Najaf International Airport despite the fact that it does not have historical data. , it was found that the most influential socio-economic factor affecting the market share of air passengers are the urban labor force and the population density factor.

Keywords: Econometric analyses, aviation system, share analyses, airport market area, air travel passengers.

1- INTRODUCTION

In this paper, the future aviation activities are estimated using the market share method. It is a widely used method; sometimes named top-down, ratio, or base forecast method. It necessitates that the high level aggregate demand is used to derive those of smaller areas [1, 2]. It is a simple method in which the historical trend of local or small parts of the transportation system is consulted to forecast its future demand values. This method requires either constant shares for local parts or they endure regular or steady variation in percentage what make them easily foreseen. It also requires that the local areas in which demand is being estimated are very well defined in terms of the borders of the market area of the local facility. Sometimes it is executed in two steps; the first includes sharing the total aggregate demand into regional shares, while the second includes the application of another ratio that distributes the regional shares among local airports in that region. [3, 4]

The sharing method can sometimes give better results than any complex method, at the same time, it has its own weaknesses such as the fact that it requires accurate high level aggregate demand estimates, if this data is not available or the available data is unreliable, this method cannot be applied [5]. Another disadvantage of this method represented in the precision required in the borders between adjacent market areas which often overlap each other mainly due to the competition between acting airports to attract air travel passengers. It also should be mentioned that the outcomes of this method is highly affected when there is a high percentage of charters in the total traffic. [6]

A model was developed in early eighties of the last century in which two approaches were used, the first includes time series that analyze air traffic demand over time and the second

used cross-section data depending on the variation in air travel demand among number of cities simultaneously. It was found that air charges, population, and per capita income, are the most important factors that affect air travel demand. It was also proven that a single model could represent the complete study period [7].

A three stage model was developed by Ni Shen to predict the annual international aircraft landings and takeoffs at 66 airports in the United States of America. Regression models were utilized in the first stage to predict passenger enplanements per year in all airports in the study, then the outcome of this process is distributed over the airports using sharing analysis. In the third stage, passenger enplanements in each airport are converted to aircraft landing and takeoffs. It was concluded that the socio-economics of the market area and the level of service at the airport have minimal effect on market share, while the airline business is a very important factor influencing it [8].

2- IRAQI AIRPORT SYSTEM CONFIGURATION

After the war in 2003, the aviation system in Iraq endured dramatic variation. At first; the Baghdad International Airport was acting alone from 2003 to 2005, i.e. no viable airport system was present at this period. The Iraqi national aviation system started to exist in 2006 and expanded gradually thereafter. The overall configuration of the system can be classified into two stages. The first included four airports in the cities of Baghdad, Basra, Erbil, and Sulaymania. This stage lasted from 2006 to 2009. The second stage included six airports by adding the airports in Najaf and Mosul to those included in the first stage, this stage started from 2010 ahead [9]. The structure of the system could be illustrated as in Table 1.

2-1 – AVIATION MARKETS

Each airport has its own market area in which it dominates the air traffic market in terms of passengers or aircraft operations. In the case of Iraqi airports, and due to the nature of the local authority's jurisdictions, it was clearly recognized that each airport serves a group of certain governorates in its vicinity. This may help in specifying the peripheral borders for each market in light of the borders of the governorates served by local airport. Local aviation markets are listed in Table 2 for the two stages with their correspondent governorates.

The socio-economic factors in each market area are to be analyzed especially those that influencing the propensity to fly in a community.

2-2: MARKET SOCIO-ECONOMIC FACTORS

In this research, the socio-economic factors to be considered are the population and their densities in major metropolitans, the per capita gross domestic production, and the urban labor force. The configuration of each airport market area requires special treatment to these factors to determine the forms in which they are considered [10].

2-2-1: POPULATION FACTORS

Two factors are to be studied in this research both related to the population in the market area. The first is the total population in the market (P) which is represented by the algebraic sum of the population of the governorates encompassed by the market area. The available historical data of this factor is very well defined that enables good future estimations [11]. The second is the population density in these governorates (D). The density represents an important factor on aviation due to the fact that big cities with vast urban communities usually generate higher percentage of air passengers than low density areas. The density factor, unlike other factors, is considered to be constant over time following its historical trend in the areas under consideration. Population and density factors are listed in Table 3 for all markets in the study.

2-2-2: Gross domestic production factor (G)

This factor is very influential on the air travel demand for it explains the capability of people to sustain the airline charges. The available data is given for each governorate. Since every market consists of many governorates, it was found that the mean value would not be representative enough, instead; the weighted average of the GDP for all governorates in the

market is adopted, i.e. the average GDP is weighted in terms of the population in each governorate as shown in Eq. 1.

$$G = \frac{\sum GDP_i.P_i}{P_m} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where:
G = gross domestic production market factor
GDP_i = gross domestic production per capita in governorate i
P_i = population in governorate i
P_m = total population in the marker area

2-2-3: **urban labor force factor (U)**

This factor is adopted due to the high percentage of air passengers in the urban community, especially among working class, compared to other communities in rural areas. This factor represents the summation of the labor force in all governorates in the market. A reliable data is available for all governorates along the study period and their extrapolated value are also easy to predict. Table 3 contains the (U) factor for each market.

3- MODEL CREATION

The core effort in this research is represented in utilizing the aviation market socio-economic data to create a regression model that predicts the market share of the total national aviation activity in question. Once the aviation shares of group of markets are explained by their explanatory socio-economic factors, then the share of any new market can be predicted depending on its own factors even if it does not have any aviation historical data.

The available data for the Iraqi airport system is as listed in Table 3 which shows the socio-economic factors and the terminal area passengers for all markets (M1 through M4) and their percentage of the total national aggregate. The data is limited to the duration of stage I which lasted from 2006 to 2009. This arrangement of data provides some 16 data point for regression analyses. All factors were transformed to the logarithmic form in the regression analyses in order to minimize the effect of multi-collinearity between variables.

The Data Analyses tool in the Microsoft Excel software was used to analyze the available data statistically. Many trails were made to come up with the best fit model. The explanatory variables were analyzed all together at first and then re-entered by omitting one variable at a time, and finally dealing with each variable separately. This process yielded many models; the one with the highest statistics is the one that depends on urban labor force factor (U) and Population Density factor (D) as explanatory variables, while the percentage of passenger (% PAX) as the dependent variable. The outstanding statistics of this model are shown in Tables 4, 5 and 6 which reflect the excellence of this model.

The standard form of the developed model is as in Eq. 2. The transformation of variables from the standard form into logarithmic one may cause a little distortion to the process, what may require another check after derivation in which the model is tested in its standard form for the regression statistics. This model yielded an adjusted R^2 of 0.98 which means that the independent variables U and D in their standard form described a bigger portion of the unexplained error.

$$\%PAX = 0.12U^{0.256}\,D^{0.66} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where:
%PAX: the share of air passengers in a market out of the total national passengers
U: the urban labor force factor in a market
D: the population density factor in a market

4- MODEL EXPLOITATION

The model in this research was developed to estimate the airport market shares of the total national air passenger demand depending on their socio-economic characteristics'. This approach may provide the capability to estimating the share to any newly established market launched due to the construction of new airport or developing an old one, provided that the market borders are well defined and the socio-economics of the area are available. The estimated shares by this model, unlike traditional sharing analyses, are changing overtime following the changes of the market characteristics.

This type of model usually yields a slight error due to the unexplained variation. In most cases, this small error is quit acceptable, but in the case of sharing estimation it is not. The total shares should always be 100% for any given year in the study. Hence; a correction measure is in order to correct this error by considering the summation of the estimated market shares in any given year is a unity and re-adjust the proportions accordingly.

The regression model which has been econometrically derived through stage I of the Iraqi national airport system is to be applied to stage II. Since stage II has two additional markets, M5 and M6 in Najaf and Mosul respectively. The predicted share values must be dependent on the socio-economic variables rather than the historical trend of air passenger demand, due to the fact that the new markets have no history and their presence affected the old markets from which they occupied considerable trip generation communities, as shown in Table 2. Accordingly; the historical data of the old markets are distorted and the new markets have no viable history and the only guide is the socio-economic characteristics of each market which are defined properly and highly reliable.

The output estimation of the model to the shares for the years 2010, 2015, 2020, 2025 with their correction factors and the corrected estimates are listed in Table 7. The corrected shares for the stage II are shown next to those of stage I in Table 8 in order to reveal the change that is taking place in the old airport market shares. The drop in market shares of all airports is noticeable and it is quite justified due to the emergence of new markets that attracted considerable portion of air passengers used to be generated in old markets. This change can be recognized easily in the graphical representation illustrated in Fig 1 in which the shares of all markets in stage I are dropped immediately when the stage II start functioning. The main market M-1 of Baghdad suffered a reduction in its passenger share about 15%, M-2 of Basra dropped some 2.1%, M-3 of Erbil dropped 3.9%, and M-4 of Sulaymania dropped 2.9%. The newly established markets M-5 in Najaf and M-6 in Mosul gained immediately the shares 14.4% and 10% respectively.

The model predicts continuous changing in shares during the same stage; some markets lose portions of their demand for the benefit of other markets. The model suggest that until 2025 M-1, M-2 and M-6 will keep losing demand about 0.2%, 0.1% and 0.1% respectively, while M-3 in Erbil, M-4 in Sulaymania, M-5 in Najaf, will keep gaining at the rate of 0.1% each. Fig. 2 (a & b) shows the share change behavior for M-6 in Mosul and M-3 in Erbil.

5- CONCLUSIONS:

The most evident conclusions that could be drawn from this study are as follows:

- The market share method is simple and practical way to estimate the future demand of any aviation activity especially when the high level aggregate demand is available and local markets are well defined.
- The share analyses could be developed econometrically depending on the socio-economic factors of the market areas as explanatory variables and the aviation activity in question as dependent variable, provided that the markets boundaries are determined and the socio-economic characteristics are reliably available.

- The econometric model that developed this way can provide the capability to estimate the share of any new market even if it does not have any aviation historical data. This kind of models may represent the most applicable solution for predicting the future demand for local facilities after any distortion in the aviation system due to either introducing new airports or shutting down old airports and the historical trend of these portions of the system will no longer be viable data.
- In the case of Iraqi aviation system, it was found that the most influential socio-economic factor affecting the market share of air passengers are the urban labor force and the population density factor.

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Table 1: Iraqi airport system stages

Stage	I	II
Duration	2006-2009	2010 ahead
Airports	Baghdad	Baghdad
	Basra	Basra
	Sulaymania	Sulaymania
	Erbil	Erbil
		Najaf
		Mosul

Table 2: Aviation markets and correspondent governorates

Stage	**Market**	**Governorate**							
I	**M-1**	Baghdad	Diyala	Sala Addin	Anbar	Najaf	Karbala	Babil	Wasit
	M-2	Basra	Muthanna	Dhi Qar	Maysan	Qadisiyah			
	M-3	Erbil	Duhok	Mosul					
	M-4	Sulaymania	Taamim						
II	**M-1**	Baghdad	Diyala	Sala Addin	Anbar				
	M-2	Basra	Muthanna	Dhi Qar	Maysan				
	M-3	Erbil	Duhok						
	M-4	Sulaymania							
	M-5	Najaf	Karbala	Babil	Qadisiyah	Wasit			
	M-6	Mosul	Taamim						

Table 3: Market factors

Year	Market	Airport	GDP Factor **G**	Urban Labor Force **U**	Population Density Factor **D**	Population in (1000) **P**	Passengers **PAX**	Passengers Percentage **%PAX**
2006	M-1	Baghdad	2969	2426	0.53	14942	442017	0.608
	M-2	Basra	2627	220	0.15	5224	81975	0.113
	M-3	Erbil	2581	280	0.13	4537	80304	0.110
	M-4	Sulaymania	2619	122	0.19	2700	122553	0.169
2007	M-1	Baghdad	3072	2482	0.53	15311	461749	0.569
	M-2	Basra	2719	225	0.15	5334	111270	0.137
	M-3	Erbil	2672	287	0.13	4653	113970	0.141
	M-4	Sulaymania	2709	125	0.19	2762	124050	0.153
2008	M-1	Baghdad	3920	2537	0.53	15685	537721	0.548
	M-2	Basra	3468	229	0.15	5443	138759	0.141
	M-3	Erbil	3409	294	0.13	4770	178219	0.182
	M-4	Sulaymania	3455	128	0.19	2825	126782	0.129
2009	M-1	Baghdad	3706	2594	0.53	16065	681337	0.620
	M-2	Basra	3280	234	0.15	5557	148634	0.135
	M-3	Erbil	3225	301	0.13	4891	139965	0.127
	M-4	Sulaymania	3265	131	0.19	2889	129119	0.117

Table 4: regression statistics

Multiple R	0.979620432
R Square	0.95965619
Adjusted R Square	0.95344945
Standard Error	0.143438882
Observations	16

Table 5: analyses of variation

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	6.36232565	3.181162825	154.6151745	8.66064E-10
Residual	13	0.267471268	0.020574713		
Total	15	6.629796918			

Table 6: model coefficients

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-2.120270087	0.568707377	-3.72822681	0.002530221
LinU. L.F	0.255919691	0.064023468	3.997279435	0.001519846
Lin D	0.659761874	0.131530827	5.016024657	0.000236176

Table 7: Estimated shares with correction factors and corrected shares in stage II

	2010			2015			2020			2025		
	A	b	c	a	b	c	a	b	c	a	b	c
M1	0.483	0.97	0.470	0.496	0.95	0.469	0.509	0.92	0.469	0.521	0.90	0.468
M2	0.117	0.97	0.114	0.120	0.95	0.114	0.123	0.92	0.113	0.126	0.90	0.113
M3	0.090	0.97	0.088	0.093	0.95	0.088	0.096	0.92	0.089	0.099	0.90	0.089
M4	0.090	0.97	0.088	0.093	0.95	0.088	0.096	0.92	0.089	0.099	0.90	0.089
M5	0.145	0.97	0.141	0.149	0.95	0.141	0.153	0.92	0.141	0.158	0.90	0.142
M6	0.102	0.97	0.100	0.105	0.95	0.099	0.108	0.92	0.099	0.110	0.90	0.099
	1.027		1.00	1.056		1.00	1.085		1.00	1.113		1.00

a: predicted market share, b: correction factor, c: corrected market share

Table 8: Observed shares in stage I and estimated shares in stage II

Market	Airport	%PAX							
		Stage I				Stage II			
		2006	2007	2008	2009	2010	2015	2020	2025
M-1	Baghdad	0.608	0.569	0.548	0.620	0.470	0.469	0.469	0.468
M-2	Basra	0.113	0.137	0.141	0.135	0.114	0.114	0.113	0.113
M-3	Erbil	0.110	0.141	0.182	0.127	0.088	0.088	0.089	0.089
M-4	Sulaymania	0.169	0.153	0.129	0.117	0.088	0.088	0.089	0.089
M-5	Najaf					0.141	0.141	0.141	0.142
M-6	Mosul					0.100	0.099	0.099	0.099

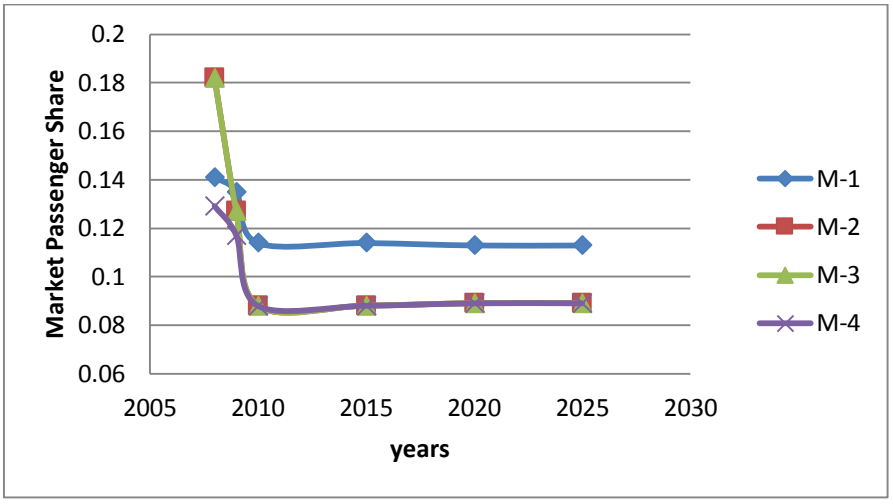
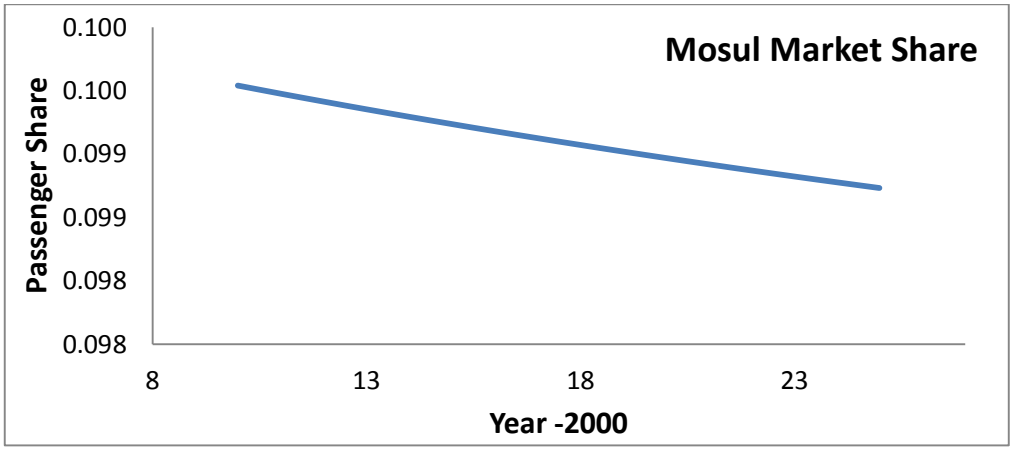
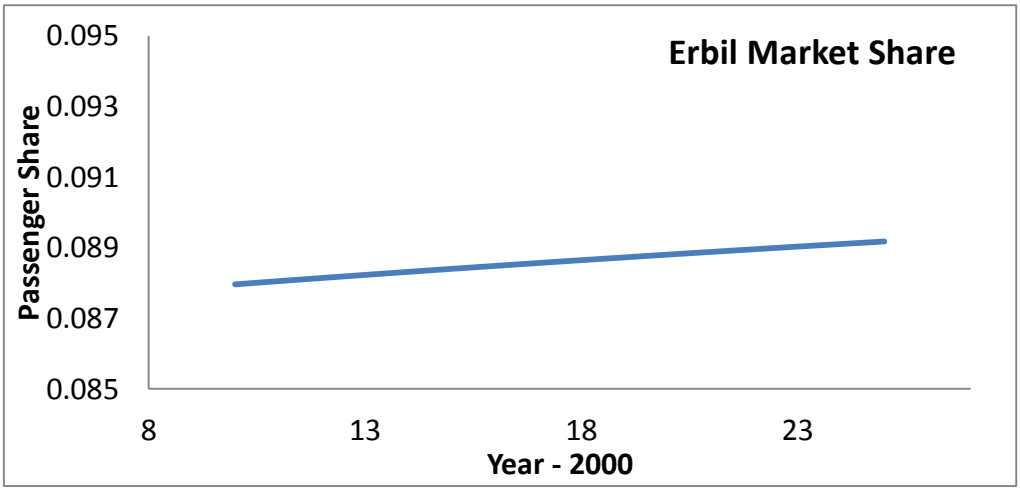


Fig. 1: Change of market shares between stages



a



b

Fig. 2: Market share changing during stage II

تطوير نموذج استقراء بطريقة الانحدار الاحصائي لتخمين حصص المطارات العراقية من الطلب الكلي المستقبلي

الخلاصة:

لطالما تم استخدام طريقة تحديد حصة المطار من الطلب الكلي في اعمال التنبؤ والتخمين المستقبلي. وهي غالبا تتطلب المعرفة الدقيقة بخصائص كل مطار من المطارات المكونة للمنظومة المزمع دراستها. فهذه الطريقة تستلزم الماما شاملا لتاريخ الطلب على كل مطار وكذلك تستوجب تحديد منطقة عملياته. تم في هذه الدراسة تطوير موديل احصائي لتخمين حصص المطارات العراقية من الركاب. وقد تم تحديد منطقة عمليات كل مطار اعتمادا على جغراقية المحافظات العراقية وحسب قربها من المطارات، واعتمادا على توفر المعلومات الاجتماعية والاقتصادية لكل منطقة وبصورة تفصيلية. لقد وفر هذا الموديل امكانية تخمين حصة المطارات التي ليس لها تاريخ من النشاط الجوي اعتمادا على خصائص المنطقة مثل مطار النجف الاشرف. ولقد تبين نتيجة هذا البحث بان من اهم العوامل المؤثرة على تحديد حصة كل مطار من الركاب هي كثافة السكان في المناطق القريبة من المطار وكذلك القوى العاملة في التجمعات الحضرية.