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# Influential Variables Inducing Aeronautical Revenues At Regional Airports

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**Graphical abstract**

**Abstract**

Maximising revenues is one of the main objectives for regional airports to achieve in order to sustain their business, especially after the introduction of deregulation and privatisation of airports. Optimising aeronautical revenues has always been considered as a straightforward method and airport managers generally overlooked on the importance of daily operational factors that could influence the generation of aeronautical revenues. Thus, the objective of this paper is to validate whether the identified influential factors such as type of flight services offered, type of aircraft that airlines utilised, time of the day, day of the week the flights arrives or departs, and the number of passenger the airlines ferry in and out of the airport have an effect on the generation of aeronautical revenues. This study has adopted a quantitative approach using regression analysis to investigate the influence of these selected variables on the generation of aeronautical revenues. The findings indicate that the selected variables have positive and negative significant influence on the generation of aeronautical revenues at regional airports.

*Keywords*: Aeronautical revenues, regional airport, regression analysis



## 1.0 INTRODUCTION

In this competitive environment, regional airports are expected to be financially stable in order to sustain their operations. Meanwhile, at the same time, regional airports need to fulfil various stakeholders' requirements. The main objective of most regional airports is to maximise their revenues and minimise operational cost in order to sustain their business. Airport revenues mainly stemmed from Aeronautical Revenues (AR) and Commercial Revenues (CR). AR are generated from the airside operations activities, which are directly related to the number of traffic and passengers' movements. CR are derived from terminal concessions, airport car parking, rental car, advertising, commercial development, land use etc. Currently, most researchers focus more in finding new strategy and solutions to maximise commercial revenues [1-8]. On the other hand, less emphasis are given in searching for solution to maximise AR since it is considered as a straightforward problem. However, it is important to study the factors that influence the generation of AR since it is still the main source of revenues for regional airports [9-10].

## 2.0 METHODOLOGY

Based on interviews and case study conducted at Rotterdam the Hague Airport in the Netherlands, the external parameters that have been discovered to have influence on the generation of aeronautical revenues in regionals airports are operational modes, traffic types, time of day, day of week, engine type and aircraft MTOW (maximum take-off weight) category [11-12]. There were 29,269 traffic movements at Rotterdam the Hague Airport in 2009.

In this study, Pearson correlation and regression analysis were carried out using SPSS version 20 software to measure the relationship between the independent variables and the dependent variable (output variable). The type of traffic, the time of day, day of week, engine type and MTOW category were classified as the input or independent variables, as shown in Table 1. Meanwhile, AR (*Total_Rev*) generated per flight was regarded as the output or dependent variable. MTOW was classified into three groups in accordance to Rotterdam the Hague Airport landing charges rate.

**Table 1** Independent variables

| Variables | Descriptions |
|---|---|
| Traffic types | Type of flights arrive and depart which includes Schedule flights, Business flights ($B_1$), Charter flights ($C_1$), Training flights ($T_1$) and Others flights ($O_1$). |
| Time of day | Day time where flights arrive or depart between 07:00 hrs to 23:00 hrs.<br>Night time ($N_1$) is between 23:00 hrs to 07:00 hrs. |
| Day of week | Weekdays are from Monday to Friday.<br>Weekends ($W_1$) are Saturday and Sunday. |
| Engine type | Jet engine and Propeller engine ($P_1$). |
| MTOW category | Light category is for MTOW below 6,000kg, Medium category is for MTOW between 6,000kg to 20,000kg and Heavy category is for MTOW above 20,000kg |

**Table 2** Pearson correlation

| | *Tot_Rev* | $B_1$ | $C_1$ | $T_1$ | $O_1$ | $N_1$ | $W_1$ | $P_1$ | *MTOW* |
|---|---|---|---|---|---|---|---|---|---|
| *Tot_Rev* | 1 | -.192** | .030** | -.237** | -.342** | .012* | .035** | -.518** | .733** |
| $B_1$ | | 1 | -.035** | -.148** | -.233** | .091** | -.058** | -.234** | -.197** |
| $C_1$ | | | 1 | -.035** | -.054** | -.003 | .009 | -.001 | .024** |
| $T_1$ | | | | 1 | -.230** | -.050** | .076** | .314** | -.347** |
| $O_1$ | | | | | 1 | .025** | .080** | .277** | -.415** |
| $N_1$ | | | | | | 1 | .021** | -.111** | .037** |
| $W_1$ | | | | | | | | -.034** | .019** |
| $P_1$ | | | | | | | | 1 | -.743** |
| *MTOW* | | | | | | | | | 1 |

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

## 3.0 CORRELATION ANALYSIS RESULT

From Pearson correlation analysis in Table 2, it could be seen that only MTOW has strong positive linear relationship with the total AR where the Pearson correlation coefficient ($r$) has the value of $r$ = 0.733. Business ($B_1$), Training ($T_1$) and Others ($O_1$) flights indicate weak negative correlation with the total AR due to the $r$ values which are small negative values and below 0.6 (weak correlation occurs if $0 \leq r \leq 0.6$). Charter flights ($C_1$) has weak positive linear relationship with generation of total AR. Similarly, night flights ($N_1$) and weekends flights ($W_1$) also indicated weak positive relationship with the generation of total AR. However, the engine propeller type aircraft ($P_1$) indicates moderate negative relationship with the generation of AR ($r$ = - 0.518).

## 4.0 REGRESSION ANALYSIS RESULTS

As for regression analysis, the data was split into two groups which are arrival and departure since arrival and departure movements were derived from different sources for AR generation. When a dummy coding is used in regression analysis, the overall results will indicate whether there is a relationship between dummy variables and dependent variables. The values of the intercept and regression coefficients of the resulted regression model can be obtained using least squares estimation procedure.

Results for arrival model of the regression analysis, with a sample size of 14,637, is shown in Table 3. As $r$ = 0.990 ($r$ is denoted as $R$ in Table 3), it indicates that there is a very strong linear relationship between independent variables and dependent variable. In addition, $r^2$ = 0.981 (*R-squared*) means that 98.1% of the variance in the total AR can be predicted from the independent variables. The prediction is supported by the adjusted $r^2$ (Adjusted *R-squared*), which is a corrected goodness-of-fit (model accuracy) measure for linear models. The value of $r^2$ = 0.981, which is very close to 1, indicates that the model almost perfectly predicts values in the target field. The variable constant represents the *y*-intercept or the intercept of the regression equation and it is equal to the expected value of the dependent variable whenever the values of the independent variables are equal to zero. The resulted estimated regression equation for the above result is as follows:

$$\hat{Y} = 64.606 - 55.606B_1 - 16.823C_1 - 92.839T_1 - 82.159O_1 + 378.409N_1 - 4.359W_1 + 30.666P_1 + 10.750MTOW \quad (1)$$

**Table 3** Regression statistics for arrival

| | Un-standardised Coefficients | | Standardised Coefficients | T | Sig. |
|---|---|---|---|---|---|
| | *β* | Std.Error | *Beta* | | |
| (Constant) | 64.606 | 2.482 | | 26.027 | 0.000 |
| $B_1$ | -55.606 | 1.969 | -.055 | -28.242 | 0.000 |
| $C_1$ | -16.823 | 4.283 | -.005 | -3.928 | 0.000 |
| $T_1$ | -92.839 | 1.672 | -.092 | -55.514 | 0.000 |
| $O_1$ | -82.159 | 1.440 | -.107 | -57.058 | 0.000 |
| $N_1$ | 378.409 | 2.489 | .177 | 152.061 | 0.000 |
| $W_1$ | -4.359 | .926 | -.005 | -4.706 | 0.000 |
| $P_1$ | 30.666 | 1.630 | .045 | 18.813 | 0.000 |
| *MTOW* | 10.750 | .037 | .905 | 292.952 | 0.000 |
| R | .990 | | | | |
| R-squared | .981 | | | | |
| Adjusted R-squared | .981 | | | | |
| Std. Error of the Estimate | 46.90734 | | | | |

For $B_1$ variable, the *t*-test is significant, and the value of *β* (*Beta* for un-standardized coefficient) is -55.606, which means that the AR generation decreased significantly more for accepting Business flights than Schedule flights. For $C_1$, the *β* value also has a negative value but the AR generation by Charter flights is 16 times less compared to schedule flights. $T_1$. $O_1$ also has negative value of *β*, which indicate that Training flights, generate 92 times less AR than Schedule flights and Others flights generate 82 times less AR compared to Schedule flights. The *t*-test shows all are significant. $N_1$ gives a positive beta value, which indicates that night flights can earn 378 times more AR compared to day time flights due to the additional landing charges received from night surcharge penalty. However, weekends have negative *β*, which means that it contributes less 4.359 of AR compared to weekdays flights because there are more flights during weekdays. $P_1$, has positive *β* value of 30.666, which means that propeller engine aircraft generate more AR than jet engine aircraft. *MTOW* is the only continuous data in this analysis *and it also* indicates a positive *β* value. It shows that there is a direct relationship between the AR and *MTOW*.

As for departure flights results with sample data size *N* = 14,632 in 2009, Table 4 confirms that, by having R-squared of 0.745, there is a strong linear relationship between the selected variables and the generation of AR. The resulted estimated regression equation for the above result is as given in equation (2) below:

$$\hat{Y} = 371.419 - 632.442B_1 + 134.893C_1 - 272.018T_1 - 466.607O_1 - 197.417N_1 + 133.506W_1 - 180.239P_1 + 29.648MTOW \quad (2)$$

**Table 4** Regression statistics for departure

| | Un-standardised Coefficients, | | Standardised Coefficients, | T | Sig. |
|---|---|---|---|---|---|
| | **B** | **Std.Error** | **Beta** | | |
| (Constant) | 371.419 | 33.386 | | 11.125 | 0.000 |
| $B_1$ | -632.442 | 26.363 | -.169 | -23.990 | 0.000 |
| $C_1$ | 134.893 | 60.329 | .009 | 2.236 | 0.025 |
| $T_1$ | -272.018 | 22.578 | -.072 | -12.048 | 0.000 |
| $O_1$ | -466.607 | 19.374 | -.164 | -24.085 | 0.000 |
| $N_1$ | -197.417 | 58.846 | -.014 | -3.355 | 0.001 |
| $W_1$ | 133.506 | 12.666 | .045 | 10.540 | 0.000 |
| $P_1$ | -180.239 | 21.891 | -.071 | -8.233 | 0.000 |
| *MTOW* | 29.648 | .493 | .672 | 60.099 | 0.000 |
| R | .863 | | | | |
| R-squared | .745 | | | | |
| Adjusted R-squared | .745 | | | | |
| Std. Error of the Estimate | 633.70996 | | | | |

The intercept value for the least square equation is 371.419 for departure, which is of higher value than arrival. This means that airport receive more AR generated by departure activities. The charges received from departing passengers are more subtantial than aircraft landing charges. Business flights ($B_1$) has negative value which indicates that for every movement of Business flight, it loses €632.442 per flight because it has lower load factor compared to Schedule flights. Charter flights ($C_1$) gives a positive value which means that every Charter flight earns additional AR of €134.893 per flight as compared to Schedule flights. Charter flights have higher load factor compared to Schedule flights. Training and Others flights ($T_1$ and $O_1$) also give negative $\beta$ value which indicates that they lose €272.02 and €466.61 per each flight respectively compared to Schedule flights. Night time flights ($N_1$) are unfavourable than day time because passenger do not prefer to depart at late hours except for business executives, where they choose to arrive at their destination early morning. Weekends ($W_1$) gives positive indication because leisure passengers and travellers prefer to visit friends and relatives or go for holidays during the weekends. Schedule and Charter traffics prefer to depart during weekends and business passengers using schedule services also probably prefer to depart on weekends so they would arrive at their destination before Monday morning. Departing passengers seem to prefer flying in a jet engine aircraft compared to propeller engine aircraft and most jet engine aircrafts have higher seat capacity to carry more passenger per flight. The *MTOW* of the aircraft definitely has a positive significant on the generation of passenger departing fees since most large aircrfat has higher searing capacity which can carry more passenger per flight.

## 5.0 CONCLUSION

Airports revenues are derived from aeronautical and commercial revenues. Although currently regional airports seem to focus more in finding new resources of generating commercial revenues, aeronautical revenues still remain the core income for regional airports. The generation of aeronautical revenues of regional airports are highly dependent on the number of flights landed and the number of passenger departs at and from their airports, thus it is important for airport management to analyse in detail the variables that contribute to the generation of aeronautical revenues for better planning and managing the airside operations and flights scheduling. Based on the correlation analysis conducted in this study, it was found that all the selected variables (traffic types, time of day, day of week, engine type and MTOW category) are correlated with the generation of aeronautical revenue, either positively or negatively. The correlation results are also in line with regression results, where all the selected variables are found to be significance predictors of the generation of aeronautical revenues. By confirming these influential variables, it provides useful insights that can assist airport management in becoming more aware on which traffics types, the time of day, day of week, and type of aircraft that would attract more passengers, thus, they could plan and manage better their business operations and scheduling which would generate more aeronautical revenues for regional airports.

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## References

[1] Graham, A. 2009. How Important Are Commercial Revenues To Today's Airports?. *Journal of Air Transport Management*. 15: 106–111.

[2] Castillo-Manzano, J. I. 2010. Determinants Of Commercial Revenues At Airports: Lesson Learned From Spanish Regional Airports. *Tourism Management*. 31(6).

[3] Freathy, P. and O'Connell, F. 1999. Planning For Profit: The Commercialization Of European Airports. *Long Range Planning*. 32(6): 587–597.

[4] Fuerst, F. and Gross, S. 2011. The Sky Is The Limit? The Determinants And Constraints Of European Airports Commercial Revenues. *Journal of Air Transport Management*. (17): 278–283.

[5] Gitto, S. and Mancuso, P. 2012. Two Faces Of Airport Business: A Non-Parametric Analysis Of The Italian Airport Industry. *Journal of Air Transport Management*. 20: 39–42.

[6] Tovar, B. and Martin-Cejas, R. R. 2009. Are Outsourcing And Non-Aeronautical Revenues Important Drivers In The Efficiency Of Spanish Airports?. *Journal of Air Transport Management*. 15: 217–220.

[7] Van-Dender, K. 2006. Determinants Of Fares And Operating Revenues At US Airports. *Journal of Urban Economics*. 62: 317–336.

[8] Appold, S. J. and Kasarda, J. D. 2006. *The Appropriate Scale Of US Airport Retail Activities*."

[9] Doganis, R. 2000. The Airport Business. *Routledge*.

[10] Graham, A. 2008. *Managing Airports - An International Perspective*. 3rd Ed. Butterworth-Heinemann,

[11] Wan Mohamed, W. M., Curran, R., Van Der Zwan, F. and Van Der Kleij S. 2009. *Evaluating The Impact Of Noise Constraints On Regional Airport Capacity And Economics. GARS Conference 2009*. - Airports and the Environment

[12] Wan Mohamed, W. M., Curran,R., Van Der Zwan, F. and Roling, P. Modeling the Effect of Night Time Penalties on Commercial and Business Flights for Regional Airport Noise and Economics: Rotterdam Airport Case Study. *AIAA ATIO/ANERS Conference*. Hilton Head, S.C, U.S.A, 2009.