African Journal of Business Management Vol. 6(15), pp. 5268-5280, 18 April, 2012
Available online at http://www.academicjournals.org/AJBM
DOI: 10.5897/AJBM10.1435
ISSN 1993-8233 ©2012 Academic Journals

Full Length Research Paper

Brazilian airport infrastructure: Analysis using the Monte Carlo simulation and multiple regressions

Hugo Ferreira Braga Tadeu[1], Jersone Tasso Moreira Silva[2]*, Guilherme Cunha Malafaia[3], and Denise Barros de Azevedo[3]

[1]Business Administration, Centro Universitário UNA and Fundação Dom Cabral, Brazil.
[2]Business Administration, Fumec University, Brazil.
[3]Business Administration, Universidade de Caxias do Sul, Brazil.

Accepted 25 February, 2011

The airport infrastructure is a polemic and controversial theme with innumerous opportunities to be explored. The study between the GDP, demands growth and costs is a Brazilian national interest. Studies about the airport infrastructure have been conducted worldly, as well as qualitative and quantitative methods. After a literature review it is possible to determinate an inexistence texts correlation airport infrastructure with Monte Carlo Simulation and Multiple Regressions, the stimulus for this text. The methodology presented is quantitative, using data and the respective treatment with Monte Carlo simulation, Multiple Regressions and specialized systems. Brazilian airport infrastructure are the focus of this paper, with a generate results for the long term simulation, considering the period of 2010-2017, the same as the strategic Brazilian government plan to the airport sector.

Key words: Brazilian airport infrastructure, Monte Carlo simulation, multiple regressions.

INTRODUCTION

The airport infrastructure is a polemic and controversial theme, with serious functional bottlenecks and with innumerous opportunities to be explored, Tadeu (2009). The study that is being analyzed is of national interest, when the demand's growth is observed, in consonance with the restriction of terminals and air traffic supervision. At the same time, there is a growing interest for the operations within the Brazilian territory, which is one of the markets with the highest expansion rates in the world (10% per year), according to the IATA (2010).

Studies about the airport infrastructure have been conducted worldly, with analysis involving new distinct operational and metric conceptions, being possible to quote an isolated performance or in partnership by private companies and government, in the management of passengers' terminals, according to Tadeu et al. (2010), as well as the studies of qualitative nature that were elaborated by Gillen (2009: 2006) and Button (2003) and also the quantitative studies of specific aspects, quoting Charnes et al. (2007), Prodifillidis (2000) and Vreeker et al. (2002). The technical elegance of these studies is quite evident, which use recent data, being a combination of estimates and advanced modeling.

Due to the importance of the theme, it is possible to notice the growing relevance of modern management, as basic functions for the airport sector's growth. However, to reach excellence in airport management, the special interest of this study is in the analysis of data that involves economical and infrastructure data. In a recent paper, Tadeu (2009) presents a strategic analysis of the sector, focusing the International Airport Tancredo Neves, with the basic requirements to explore this knowledge in national scale.

Therefore, this study has as objectives to present and analyze references about (1) economic performance, (2) airport infrastructure, (3) Monte Carlo Simulation, (4) Multiple Regressions and (5) mathematical modeling to adopt a quantitative methodology, viewing the development of a long term scenario and identifying the critical knowledge for airport management.

*Corresponding author. E-mail. tasso@fumec.br.

LITERATURE REVIEW

Tadeu (2010) proposed a quantitative and integrated mapping about the airport infrastructure, based on studies that were concluded about the economical development and the transport matrix, involving passengers and cargo, using long term scenarios through the Monte Carlo simulation and Multiple Regressions. This mathematical modeling has been improved through studies that are directed to the airport sector, as an open and comprehensive mathematical form, starting from the data collection, its interpretation and solution proposals. Hence it is a dynamic model, for a unifying action between the economical performance and the transport sector.

As quoted before, the proposed mathematical modeling is "integrated" and it is formed by the following phases:

(i) the economical performance`s analysis, as a strategic conception about the national performance; (ii) analysis of the airport infrastructure's, as a capacitating condition; (iii) the use of mathematical modeling, expressed by the Monte Carlo simulation and (iv) multiple regressions to identify the most important criteria decision. All the phases are described as follows.

Analysis of the economical performance

For Mankiw (1999), the GDP is a value generated in a geo-economic space, due to a time interval. This is the most important economical data to evaluate the growth or not of a country. Consequently, estimating the participation of several different segments in the GDP will determine their contribution in generating wealth, like the infrastructure airport. To measure its performance, there is the need to take into consideration the wealth generated by all of the economical agents and participants in the productive process, or evaluate the general population's consumption, in search of goods and services that are offered by the market.

For the IPEA (2010), the form that is used to evaluate the GDP, is the result of the real GDP concept, being an evaluation of current prices, deflated from the economy's price index, in order to find ideal values. However, other than the GDP's data, it is recommended to evaluate for this study, the data from the airport infrastructure. It is through the inter-relation between the economic performance and the airport infrastructure that the mathematical modeling proposed previously emerges.

Graph 1 presents the GDP's evolution as an economical activity in the last years, which will be the first entry data for the modeling.

It is possible to understand that historically, the national GDP had a vigorous behavior starting at the 90s, observing 1994, the year that Real Plan was implemented. So, with the GDP raise, more airport infrastructure will be usage (ANAC, 2010). But how is the correlation between the GDP and airport infrastructure sector?

As an inducer of investments that were done in the last years, the government and private sectors have been allocating resources in infrastructure, according to Graph 2, but with low rates of investment in transport, and especially for airports, BNDES (2010).

Analysis of airport infrastructure

The airport infrastructure's evaluation takes into consideration the national, international demand and operational costs, according to Lacerda and Ribeiro (2003). It is possible to verify the increase demand and that the cost related to the airport modal are the largest in the Brazilian transport matrix, due to the expenditure with fuel, airport charges and the availability of cubature for the outflow of cargo, having also to take into account, the speed, consistency, availability and frequency.

However, the choice for a transport modal should be related to the infrastructure's availability, observing the aggregated value to the national economy (Barat, 2007). In this case, Figuereiro (2003) observes that:

"The transport activity, the most important among the several logistic components, has increased its participation in the GDP, having grown from 3.7 to 4.3% between 1985 and 1999. In 30 years, or in other words, between 1970 and 2000, the transport sector has grown about 400%, while the GDP growth was of 250%. This growth was strongly influenced by the Brazilian economy's geographic decentralization in the last decades, especially in the direction of the Center-West, North and Northeast of the country."

In this case, the growth of the airport transport was not followed by the necessary investments to maintain the infrastructure, being possible to verify stagnation, especially in the Graph 2.

Brazil is in a worrying situation, taking into account the operational conditions of its airports, comparatively to countries like Holland, Germany, China and the United States, especially due to the inefficiency of the government expenditure (WORLD BANK, 2010). A solution would be to adopt a Government-Private Partnership and the concession model, according to the law 8,987/95 and 11,079/04, considering a technical and prioritized evaluation for short and long term investments.

Graph 3 shows larger demand passenger traffic considering national and international routes for 2001 to 2009.

Graph 4 presents the airport sector's costs with a larger participation of expenditure with fuel, reaching a level of 30% of the sector's companies' revenue. The data series that are now presented in the Analysis of the economical performance and analysis of airport infrastructure are used in Mathematical modeling, being composed by the

Mathematical Modeling and quantitative analysis associated in complementation.

Monte Carlo simulation

After the economical performance and airport infrastructure data presentation it is important to show the evidence of how to develop the scenario analyses with Monte Carlo simulation. According to Chwif (2006), a simulation is a process by means of another, being a test, an experience and a rehearsal. In particular, the adopted simulation is classified as computational, with the help of specialized systems.

The objective of the simulation that is being studied is to find out which will be the airport infrastructure's behavior in the long term, working with discreet events, that is, with a series of finite histories, but taking into consideration its mutation in the long term.

It is important to elucidate that the simulation has as its objective to foresee the system's behavior and its variables, respecting the possibilities of error, possible adaptations, which should not be mistaken with the term "optimization", for its focus is not in a single response, but in the analysis of scenarios and hypothesizes. Especially the Monte Carlo Simulation, which is originated from the operational research, corresponding to the execution of numerical and experimental analysis, with the realization of the first studies that originate from the Second World War, to create the atomic bomb (Saliby, 1989).

For this study, the Monte Carlo Simulation is executed with the use of the RiskSim computational system, according to what was proposed by Hiller and Lieberman (1995), helping in the construction and decision making of the statistic models to elaborate the scenarios. Hence, the simulation is a structured process, with the intention of understanding the behavior of an experiment, according to the following steps: (i) describe the variables' behavior that are being studied; (ii) build hypothesizes; (iii) use theories that have been published, especially, for the Monte Carlo simulation and (iv) to do the necessary calculus, obtaining the distribution of probabilities and frequency graphics.

Some evidences about quantitative studies involving Monte Carlo simulations and economic decision were develop by Boda et al. (2000), Dempster and Scott (2000), Fu et al. (2001), Castillo-Ramírez (2001), Tsitsiklis and van Roy (2001), Sun et al. (2004), Suslick and Schiozer (2004), Walls (2004), Barraquand and Martineau (2005), Liu (2005), Broadie et al. (2007), Peterson et al. (2007), Siddiqui et al. (2007) and Chakarvartula et al. (2008). The decision observed by making existing tests was made by Kleijnen (2004), Fichthorn and Weinberg (2004), Clark and Watling (2005), Tervonen and Lahdelma (2005), Özdemir et al. (2006), Mateos et al. (2006) and Sohn (2007).

The inexistence texts between economic performance, airport infrastructure, Monte Carlo simulation and multiple regression are the stimulus for this text. Having discussed several applications, it is important to show the simplest model that deal with Monte Carlo Simulation and to use the RiskSim system. Equation 1 shows the arithmetic variables, to create correlations between data usage.

$$Var(\overline{X}) = \frac{Var(X_1) + Var(X_2) + 2Cov(X_1, X_2)}{4} = \frac{Var(X)}{2}(1+\rho) \quad (1)$$

Equation 2 shows the control variables; evaluate the correlations in the analyses.

$$Var(X - kY) = Var(x) + k^2 Var(Y) - 2Cov(X, Y) \quad (2)$$

Equation 3 consists in the probability distribution with the date usage, according to the random analyses.

$$xh_i = F^{-1}\left(\frac{1 - Rand_i}{n}\right) \quad (3)$$

Finally, Equation 4, show the description values, focus on the scenario creation.

$$xd_i = F^{-1}\left(\frac{i - 0{,}5}{n}\right) \quad (4)$$

All of these equations are usage with RiskSim system, available in RiskSim

RiskSim

The analysis for the Monte Carlo simulation should be generated by the RiskSim (available in a version for download in the site www.palidase.com), according to Figure 1, being a system that is easy to use and with the usage of Microsoft Excel, after its installation.

Figure 2, explains the entrance procedures of the RiskSim's data, with mathematical computational parameters shown in Table 1, by statistic calculus of the data that is being analyzed, including minimum, medium and maximum values, standard deviation and weights that were given by the decision maker, as a measure of central tendency.

According to the Table 1, equation (1) is introduced on the cell B4, equation (2) on the cell B5 and equations (03) and (04) on the cell B6. After these steps it is important to use de RiskSim system to simulate the series in analyses All the components of this RiskSim are presented and discussed in mathematical modeling

Multiple regressions

To complete a Monte Carlo Simulation, it is important to

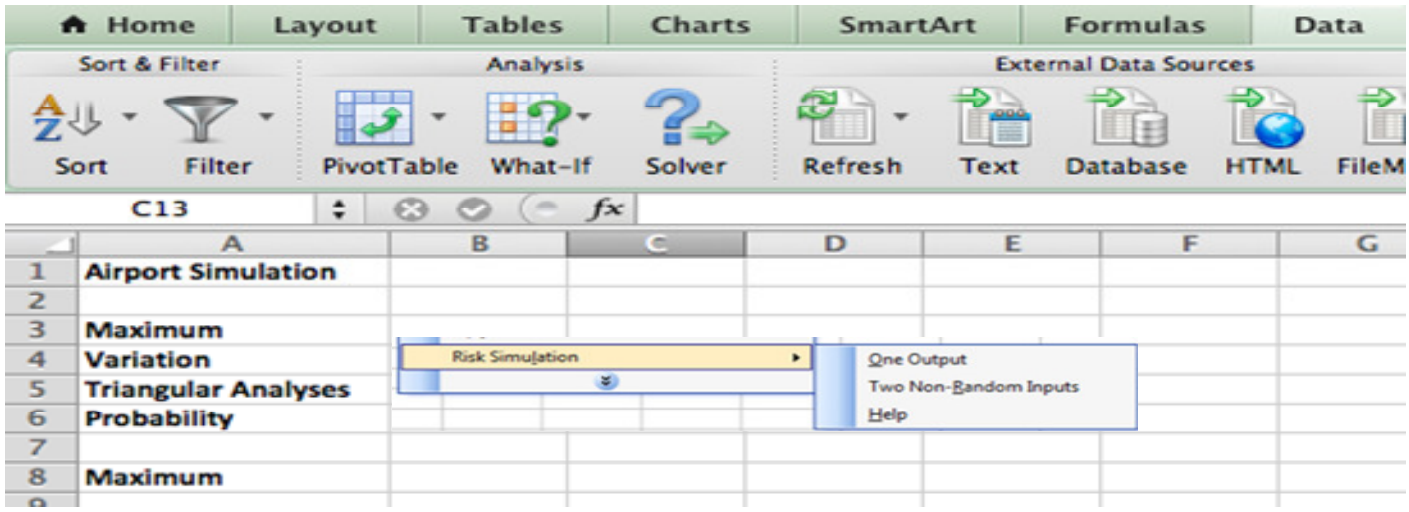


Figure 1. RiskSim example working window.

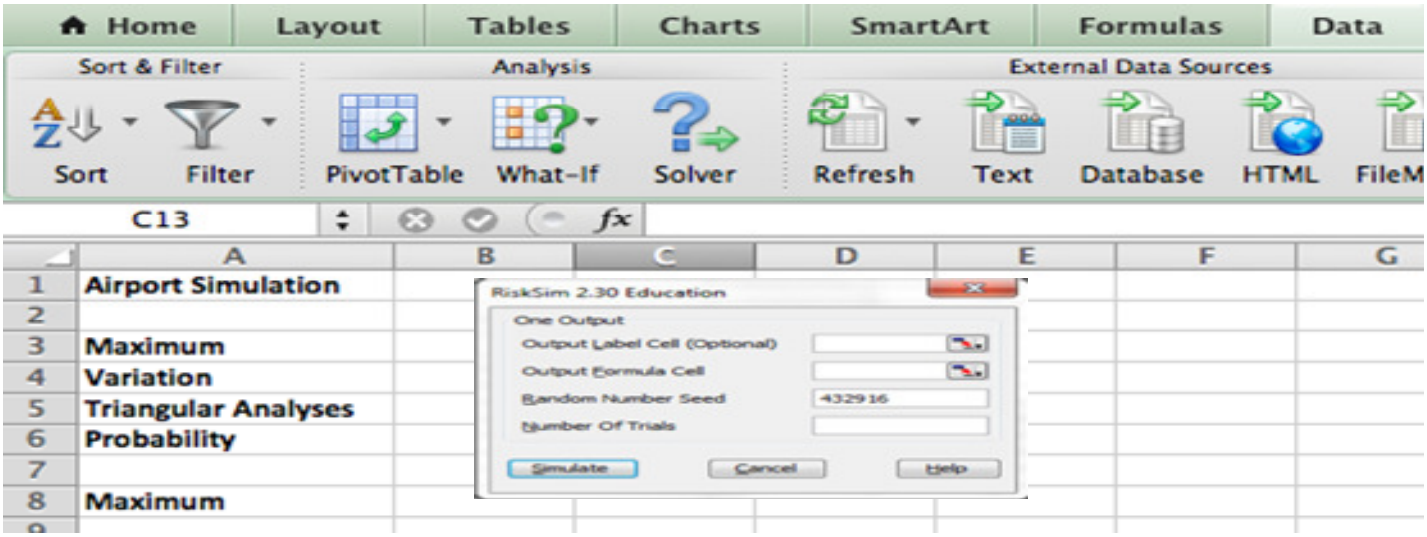


Figure 2. RiskSim example data entrance.

Table 1. RiskSim's computational parameters.

Equation	Computational parameter
01	=Randnormal(MaxMin;Standdesv)
02	=Randtriangular(Min;Medium;Max)
03 and 04	=Randdiscret(Min;Medium;Max) and Weights

create correlations between the usage data. So, the proposal of this topic is to show the multiple regressions, as a simple model. Equation (5) shows the description of this model.

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \varepsilon_i \quad (5)$$

Assumes:

Y_i is the problem answer;
X_{i1} and X_{i2} are the studies variable;
β_0, β_1, β_2 are the problem constants;
ε_i is the estimated error.

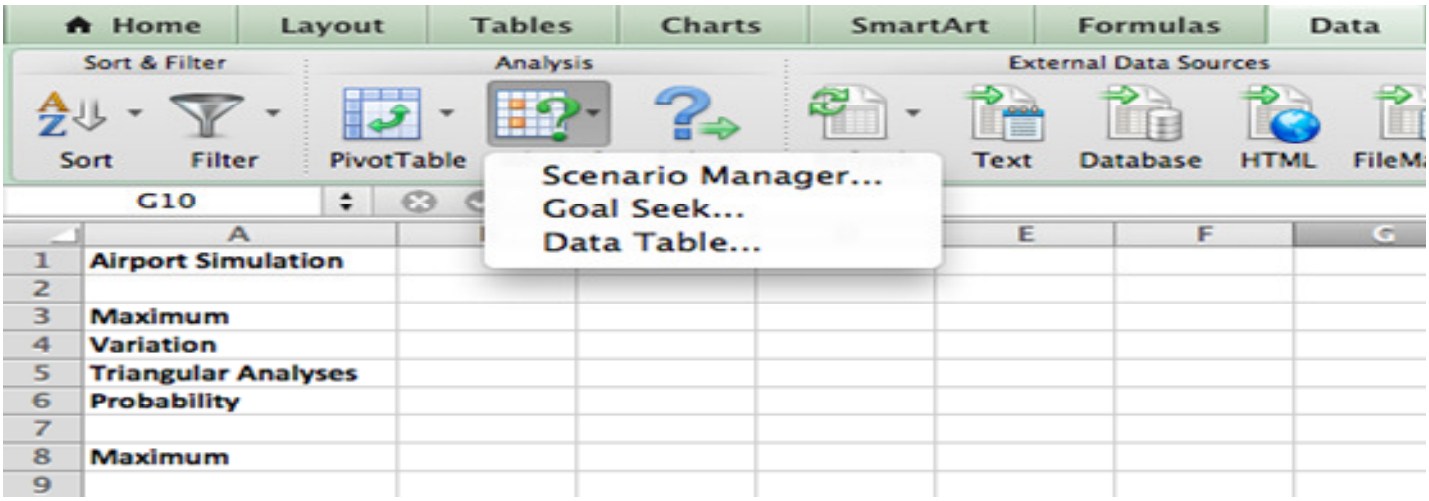


Figure 3. Excel example multiple regressions.

To create the multiple regressions it is possible to use Excel Software, Hillier and Lieberman (1995), to a better decision making process (Figure 3).

METHODOLOGY

The research method adopted is bibliographic in nature, using quantitative tools to analyze the using data. To begin with databases were use to retrieve articles on the "Brazilian airport infrastructure", "Monte Carlo Simulation" and "Multiple Regressions". Search results showed different papers and applications. So it was necessary to expand the research to retrieve more papers discussing the concepts of the proposal paper. The strategy each included theses sources was:

i. Fundação Dom Cabral digital library resources;
ii. Centro Universitário UNA digital library resources;
iii. Universidade Fumec digital library resources;
iv. Universidade de Caxias do Sul digital library resources;
v. e-journals containing " airport infrastructure", "Brazilian airport infrastructure", " Monte Carlo Simulation" and "Multiple Regressions" in their titles;
vi. Google Academic – searching for material not previously published in the form of journal papers.

This expanded search strategy resulted in a corpus of papers, dissertations and books that constituted the study`s database. The time-span covers papers published from 1989 to 2010 and the authors were academics and practitioners from many different countries in the world.

Patton (2002) suggested that quantitative data analyses should occur in three activities: data search, data analyses and conclusion. All the data analyses were created using RiskSim, a software to construct and analyses complex problems.

RESULTS

Mathematical modeling

The applied simulation in the airport infrastructure is related to the nature of the data that were used, leading to a modeling process, with the necessity of expressed preferences in the distribution of the RiskSim probabilities (Adler and Golany, 2001).

The entrance data are presented by an independent sequence, with the execution of approximations and possible estimations, in this case, represented by the economical behavior and by the series that are related to the airport transport (Nelson and Yamnitky, 1997).

As basic components to implement the Monte Carlo simulation, according to the Analysis to the economic performance, analyses of the national and international demand analysis of the airport infrastructure and multiple regressions, the most important are:

Analysis to the economic performance

The National GDP's behavior is a basic variable to project scenarios for the airport infrastructure, having a relevant impact in the sector's characteristics, which involve the aspects that are related to supply and demand.

Table 2 elucidates the result that was generated by the entrance data's modeling, presented initially in Graph 1, considering the maximum, minimum and measured risk values.

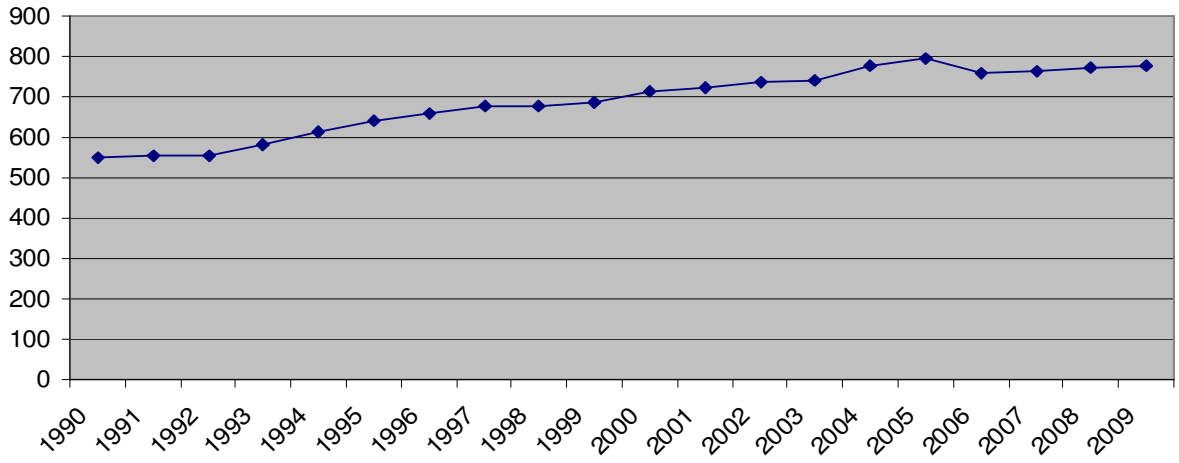
All the graphs generated (Graphs 1 to 10) are the result for the long term simulation, considering the period of 2010 – 2017, the same as the strategic Brazilian government plan to the airport sector (ANAC, 2010).

Analyses of the national and international demand

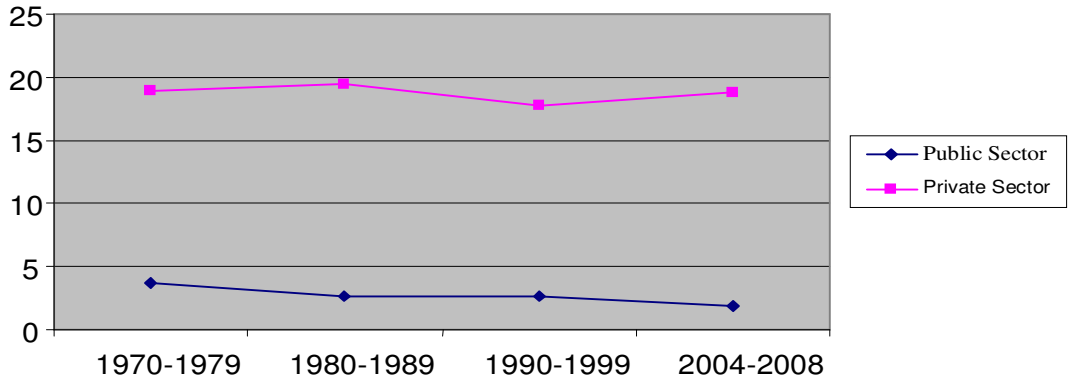
The National and International Demand show the volume of passengers in Brazil and the aspects of supply and demand.

Table 2. Maximum and minimum for the national GDP (US$).

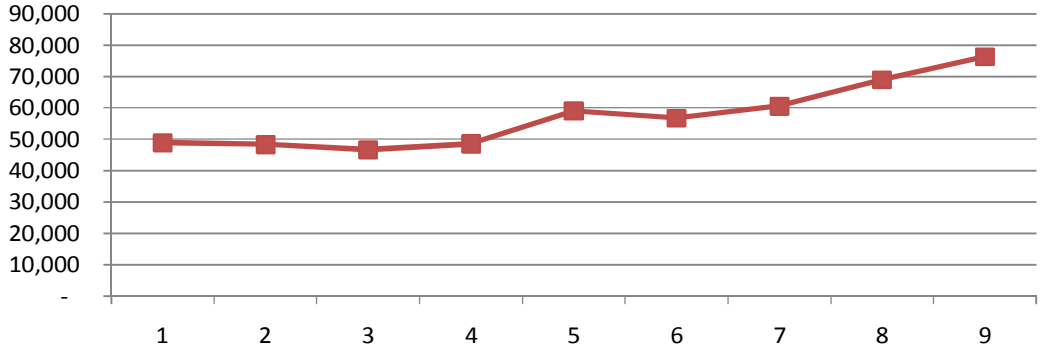
Criteria	GDP Max	GDP Min
National GDP	1.489.3	1.314.2
Risk	95.09	85.54



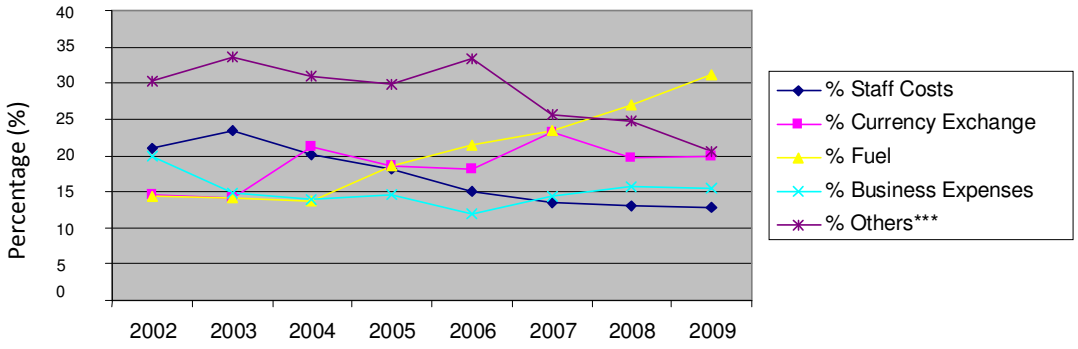
Graph 1. Variation of the Gross Domestic Product (US$). Source: IPEA (2010).



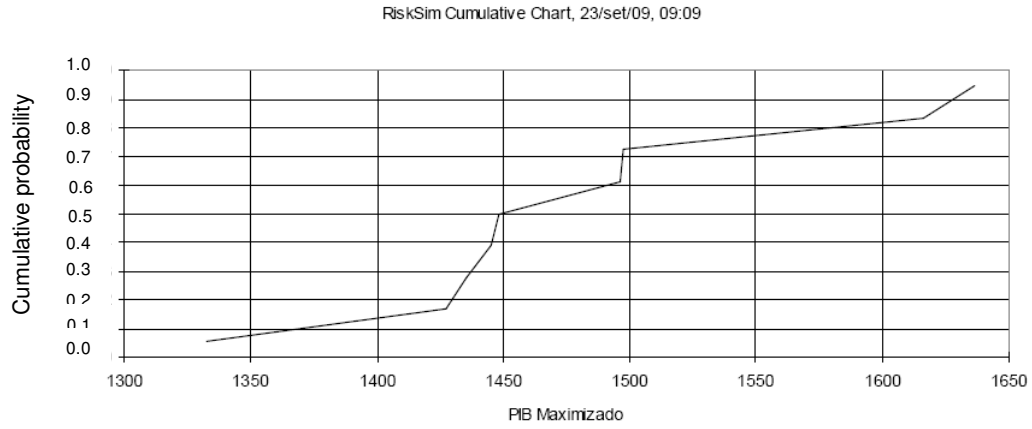
Graph 2. Investment in Infrastructure (% GDP). Source: BNDES (2010).



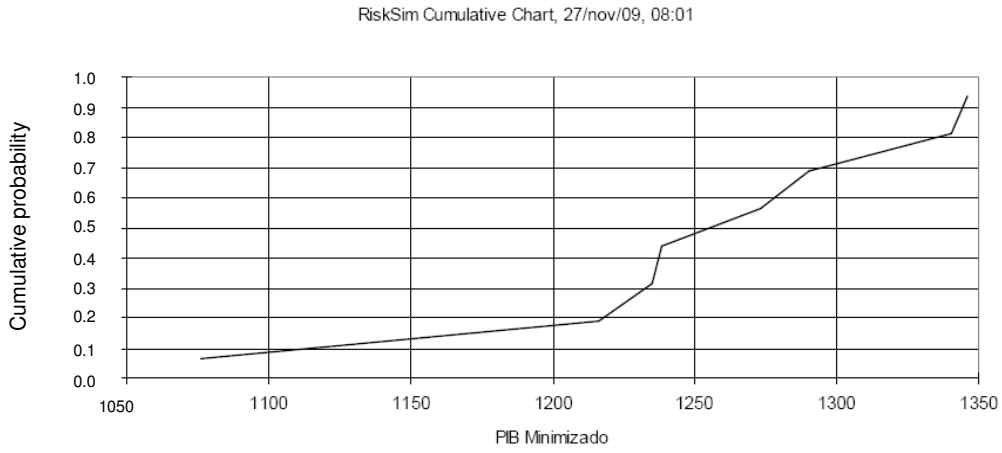
Graph 3. National and International Demand. Source: ANAC (2010).



Graph 4. Costs of the Airport Companies. *** Refers to Payment of Installments, Tax Expenses, and Public Services. Source: Coppead (2010).



Graph 5. Maximum national GDP (US$).

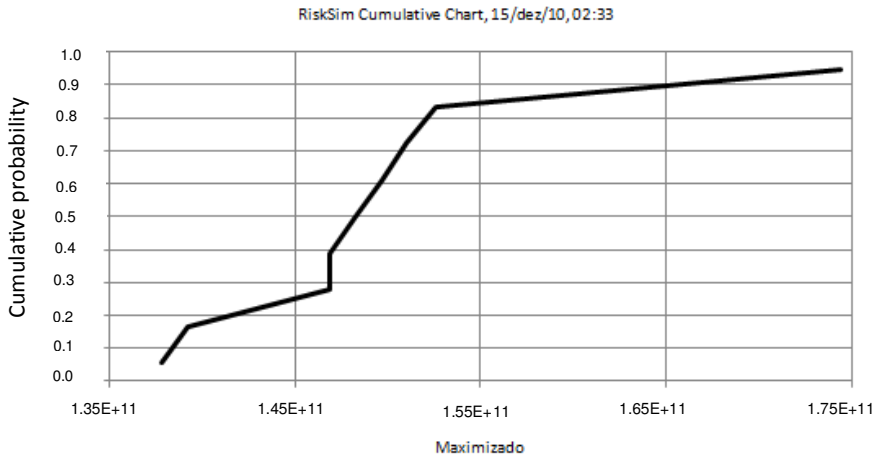


Graph 6. Minimum National GDP (US$).

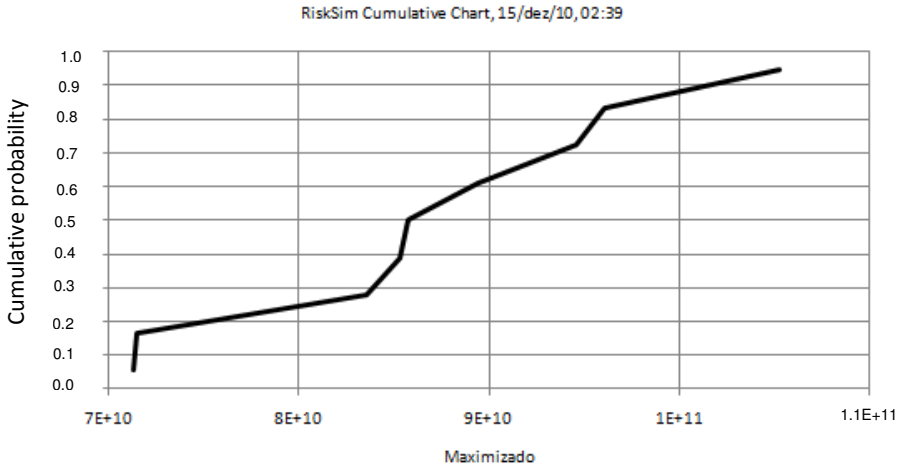
Table 3 elucidates the result that was generated by the entrance data's modeling, presented initially in Graph 3, considering the maximum, minimum and measured risk values.

Analysis of the airport infrastructure

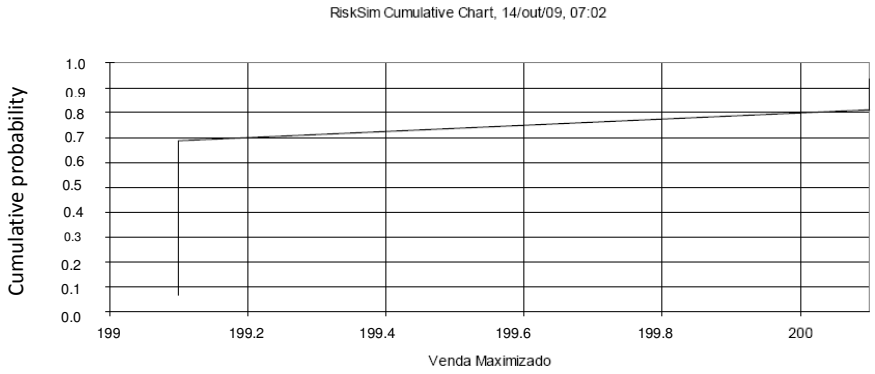
The analysis of the airport infrastructure includes the following data (Table 4):



Graph 7. Maximum national and international demand.



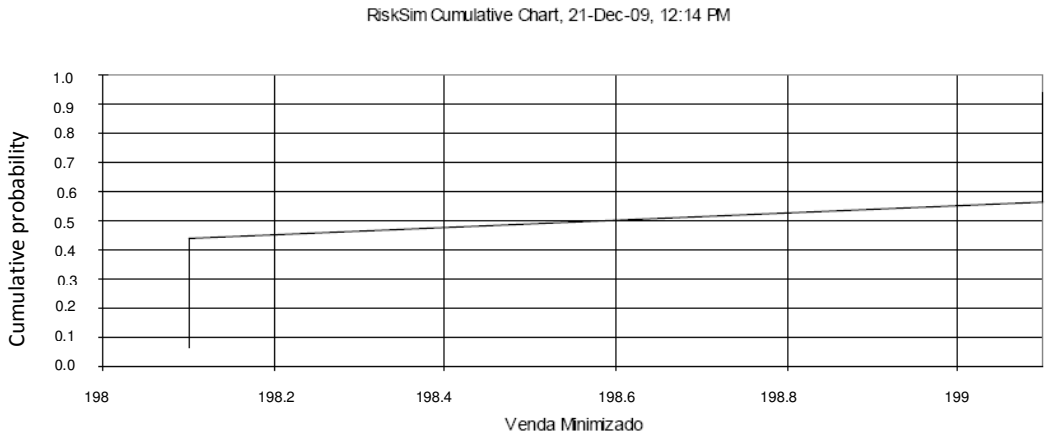
Graph 8. Minimum national and international demand.



Graph 9. Maximum Costs for National Traffic (US$).

i. Considering the costs with personnel, exchange rates, fuel, business and others.
ii. The fuel's cost represents, in average, 32% of the total costs.

According to the generated graphs it is possible to conclude that GPD, demand and costs will have the



Graph 10. Minimum Costs for National Traffic (US$).

Table 3. Maximum and minimum for the national and international demand.

Criteria	Demand max	Demand min
Demand	174,364,289,777	71,293,403,103
Risk	10,533,158,852	11,064,233,340

Table 4. Maximum and minimum results for the cost of national traffic (US$).

Data	Max Costs	Min Costs
Costs	200.1	198.1
Risk	0.46	0.18

Table 5. Multiple regressions with maximum values aggregate.

Year	Demand	GDP	Cost
2010	135,000,000,000	1,300	199
2011	140,000,000,000	1,350	199.2
2012	145,000,000,000	1,400	199.4
2013	150,000,000,000	1,450	199.6
2014	155,000,000,000	1,500	199.8
2015	160,000,000,000	1,550	199.8
2016	165,000,000,000	1,600	199.8
2017	170,000,000,000	1,650	200
Maximum	170,000,000,000	1,650	200

highest possibility with a considerable impact at the Brazilian airport infrastructure. The next step consists in the Multiple Regressions with all the results of Monte Carlo Simulation and to understand probabilities to the sector.

Multiple regressions

The first steps consist of the aggregation data that are represented in the Table 5. After this procedure the Excel software was used to solve the problem, considering the demand as the variable Y. The GDP and Cost as the variable X, in respect to the Equation (5).

Figure 4 consists in the Multiple Regression Results after the Excel programming.

Figure 6 consists in the Multiple Regression Results after the Excel programming.

In Figures 5 and 6 it is possible to determine an absolutely dependence to the airport infrastructure with

Results Summary

Regression Statistics	
Multiple R	1
R-squared	1
R-adjusted squared	0.8333
Standard error	2586824.164
Observations	8

ANOVA

	gl	SQ	MQ	F	Significative F
Regression	2	1.87E+26	9.36E+22	13980090198	4.28E-25
Residual	6	4.02E+13	6.69E+12		
Total	8	1.87E+26			

	Coeficients	Std error	Stat t	P-value	95% inferior	95% superior
Intercept	0	N/D	N/D	N/D	N/D	N/D
DGDP	99930721.41	8146.41	12266.84	1.98	99910787	99950654
Cost	25565250.76	60388.97	423.343	1.17	25417484	25713017.26

Figure 4. Multiple regressions with maximum values results.

Residuals Results

Observations	Demand Forecast	Residuals	Standard residuals
1	1.35E+11	2577269	1.15
2	1.40E+11	928148	0.41
3	1.45E+11	-720971	-0.32
4	1.50E+11	-2370092	-1.05
5	1.55E+11	-4019212	-1.79
6	1.60E+11	-555283	-0.24
7	1.64E+11	2908646	1.29
8	1.70E+11	1259525	0.56

Probability results

Percentil	Demand
6.25	1.35E+11
18.75	1.40E+11
31.25	1.45E+11
43.75	1.50E+11
56.25	1.55E+11
68.75	1.60E+11
81.25	1.65E+11
93.75	1.70E+11

Figure 5. Probability results.

Results Summary

Regression Statistics	
Multiple R	0.9998
R-squared	0.9996
R-adjusted squared	0.832
Standard error	1906505517
Observations	8

ANOVA

	Gl	SQ	MQ	F	Significative F
Regression	2	6.23E+22	3.11E+22	8567.02164	1.45E-09
Residual	6	2.18E+19	3.63E+19		
Total	6	6.23E+22			

	Coeficients	Std error	Stst t	P-value	95% inferior	95% superior
Intercept	0	N/D	N/D	N/D	N/D	N/D
GDP	115229899	6955570	16.5665	3.084	98210229	132249567
Cost	-263051797	42628720	-6.17076	0.0008	-367360517	-158743076

Figure 6. Multiple regressions with minimum values results.

Table 6. Multiple regressions with minimum values aggregate.

Year	Demand	GDP	Cost
2010	70,000,000,000	1050	198
2011	75,000,000,000	1100	198
2012	80,000,000,000	1150	198.2
2013	85,000,000,000	1200	198.4
2014	90,000,000,000	1250	198.6
2015	95,000,000,000	1300	198.8
2016	100,000,000,000	1300	199
2017	105,000,000,000	1350	199

GDP behavior. A high possibility to the demand growth exists in correlation with economic raise and airport costs. Table 7 shows the final results, after all the simulations.

CONCLUSIONS AND RECOMMENDATION

The objective of this study is to present an integrated quantitative modeling for the airport infrastructure, in function of the available GDP, demands growth and costs historical series, searching for knowledge and to identify critical processes. After a literature review a new methodology is proposed with Monte Carlo simulation and multiple regressions focus on quantitative analyses.

According to the generated graphs, it is possible to conclude that GPD, demand and costs will have the highest possibility with a considerable impact at the Brazilian airport infrastructure. The Multiple Regressions identify an absolutely dependence to the airport infrastructure with GDP behavior. Exists a high possibility to the demand growth in correlation with economic raise and airport costs.

The recommendation is that new studies about airport infrastructure should be correlated with mathematical models and new data, in order to have more estimations and for an optimum strategic direction in the sector, considering the private participation.

Residuals Results

Observation	Demand Forecast	Residuals	Standard residuals
1	68907137600	1092862400	0.6619
2	74668632526	331367474	0.2006
3	80377517092	-377517091	-0.2286
4	86086401658	-1086401658	-0.6579
5	91795286224	-1795286224	-1.0873
6	97504170790	-2504170790	-1.5166
7	974551560430	2548439570	1.5434
8	1.03213E+11	1786944644	1.0822

Probability results

Percentil	Demand
6.25	1.35E+11
18.75	1.40E+11
31.25	1.45E+11
43.75	1.50E+11
56.25	1.55E+11
68.75	1.60E+11
81.25	1.65E+11
93.75	1.70E+11

Figure 7. Probability results.

Table 7. Final results.

Analyses	Maximum	Minimum
Demand	165,000,000,000	105,000,000,000
GDP	Rise	Rise
Costs	Rise	Rise

REFERENCES

Adler N, Golany B (2001). Evaluation of Deregulated Airline Networks Using Data Envelopment Analyses Combined with Principal Component Analyses. Eur. J. Oper. Res., 132 (2): 18-31.

Barat J (2007). Transportation and Logistics in the Process of Globalization: Opportunities for Brazil. Editora Unesp.

Barraquand J, Martineau D (2005). Numerical Valuation of High Dimensional Multivariate American Securities. J. Financ. Quant. Anal., 27(4): 781-800.

Boda D, Busath D, Henderson D, Sokołowski S (2000). Monte Carlo Simulations of the Mechanism for Channel Selectivity: The Competition between Volume Exclusion and Charge Neutrality. J. Chem. Phys., 3(1): 3-15.

Broadie M, Glassermang P, Jain A (2007). Enhanced Monte Carlo Estimates for American Option Prices. J. Derivat., 32(2): 88-111.

Button K (2003). The Potencial of Meta-Analysis and Value Tranfers as Part of Airport of Airport Environmental Appraisal. J. Air Transp. Manage., 9(3): 167-176.

Castillo-Ramírez A (2000). An Application of Natural Resource Evaluation Using a Simulation-Dynamic Programming Approach. J. Comput. Finan., 5(1): 97-112.

Chakarvartula S, Haque I, Fadel G (2003). A modified Monte-Carlo simulation approach to heavy vehicle design for good dynamic performance in multiple scenarios. Int. J. Heavy Veh. Syst., 2(2): 107-156.

Charnes A, Cooper WW, Rhoedes E (2007). Measuring the Efficiency of Decision Making Units. Eur. J. Oper. Res., 132 (2): 429-444.

Chwif L (2006). Modelagem e Simulação de Eventos Discretos. São Paulo: Bochura.

Clark S, Watling D (2005). Applications of sensitivity analysis for probit stochastic network equilibrium. Eur. J. Oper. Res., 131(2): 32-45.

Consulted Agencia Nacional de Aviação Civil electronic site on the 17th of April of 2010 <www.anac.org.br>
Consulted Boeing's electronic site on the 17th of April of 2010 <www.boeing.com>
Consulted Center for Logistics UFRJ electronic site on the 24th of August of 2010 <www.centrodelogistica.org>
Consulted the Institute of Applied Economic Research electronic site on the 8th of July of 2010 <www.ipeadata.gov.br>
Consulted the International Association of Civil Aviation's electronic site on the 23rd of August of 2010 <www.iata.org>
Consulted the National Bank for Economic Development Social's electronic site on the 9th of August of 2010 <www.bndes.gov.br>
Consulted World Bank's electronic site on the 7th of July of 2010 <www.worldbank.org>
Dempster M, Scott J (2000). Planning Logistics Operations in the Oil Industry. J. Oper. Res. Soc., 25(2): 73-89.
Fichthorn K, Weinberg W (2005). Dynamical Monte Carlo simulations. Eur. J. Oper. Res., 135(3): 42-56.
Figuereido K, Fleury P, Wanke P (2003). Logistics and supply chain management: Planning the flow of products and resources. Sao Paulo: Atlas.
Fu MC, Laprise SP, Madan DB, Su Y, Wu R (2001). Pricing American Options: A Comparison of Monte Carlo Simulation Approaches. J. Comput. Finan., 25(3): 20-38.
Gillen D (2006). Airline Business Models and Networks: Regulation, Competition and Evolution in Aviation Markets. J. Netw. Econ., 5(4).
Gillen D (2009). The Volatility of Airfares in Markets. Transp. Res. E-Log. Transp. Rev., 45(6): 1020-1029.
Haghani A, Chen MC (1998). Optimizing Gate Assignments at Airport Terminals. Transp. Res. Part A: Pol. Pract., 32(6): 437-454.
Hillier FS, Lieberman GJ (1995). Introduction to Operations Research. Nova York: Mc Graw-Hill.
Kleijnen J (2004). An Overview of the Design and Analysis of Simulation Experiments for Sensitivity Analysis. Eur. J. Oper. Res,. 134(2): 62-77.
Lacerda L, Ribeiro A (2003). Ways to Pay for Logistic Service Providers. In: Logistics and supply chain management: planning the flow of products and resources. São Paulo: Atlas.
Liu W (2005). Random Field Finite Elements. Int. J. Numer. Meth. Eng., 21(1): 23-31.
Mankiw N (1999). Introduction to Economics: Principles of Micro and Macroeconomics. Rio de Janeiro. Publisher Campus.
Mateos A, Jiménez A, Ríos-Insua A (2006). Monte Carlo simulation techniques for group decision making with incomplete information. Eur. J. Oper. Res., 136(4): 32-45.
Nelson BI, Yamnitsky M (1997). Input Modeling Tools for Complex Problems. Proceedings of the 1998 Winter Simulation Conference.
Özdemir Z, Yücesan E, Herer E (2006). Multi-location transshipment problem with capacitated transportation. Eur. J. Oper. Res., 136(6): 42-55.
Patton MQ (2002). Qualitative Research and Evaluation Methods. Thousand Oaks, California: Sage Publications.
Peterson SK, Murtha JA, Schneider FF (2007). Risk Analysis and Monte Carlo Simulation Applied to the Generation of Drilling AFE Estimates. Society of Petroleum Engineers.
Profillidis VA (2000). Econometric and Fuzzy Models for the Forecast of Demand in the Airport of Rhodes. J. Air Transp. Manage., 6(2): 95-100.
Saliby E (1989). Rethinking Simulation. São Paulo: Atlas.
Siddiqui M, Al-Yateem K, Al-Thawadi A (2007). A new tool to evaluate the feasibility of petroleum exploration projects using a combination of deterministic and probabilistic methods. SPE Middle East Oil and Gas Show and Conference.
Sohn S, Lim A (2007). The effect of forecasting and information sharing in SCM for multi-generation products. Eur. J. Oper. Res.. 137(2): 32-45.
Sun Z, Axelbaum R, Huertas J (2004). Monte Carlo Simulation of Multicomponent Aerosols Undergoing Simultaneous Coagulation and Condensation. Aer. Sci. Technol., 2(3): 279-302.
Suslick SB, Schiozer DJ (2004). Risk analysis applied to petroleum exploration and production: An overview. J. Petrol. Sci. Eng., 2(12): 113-135.
Tadeu HFB (2009). A Study on the Logistic Model Airport: Model Industry Airport to City Airport. Dom (Fundação Dom Cabral), 1: 64-72.
Tadeu HFB (2010). Cenários de Longo Prazo para o Setor de Transportes e Consumo de Combustíveis. Belo Horizonte, 227f. Doctoral Thesis Presented at Catholic University of Minas Gerais.
Tadeu HFB, Tasso J, Lahdelma R (2010). Logística Aeroportuária. São Paulo. Editora Cengage Learning.
Tervonen T, Lahdelma R (2006). Implementing stochastic multicriteria acceptability analysis. Eur. J. Oper. Res., 136(4): 32-45.
Tsitsiklis JN, Van Roy B (2001). Regression Methods for Pricing Complex American-Style Options. IEEE Trans. Neural Netw., 12(4): 694-703.
Vreeker R, Nijkamp P, Welle C (2002). A Multicriteria Decision Support Methodology for Evaluating Airport Expansion Plans Part D: Transp. Res. Transp. Environ., 7(1): 27-47.
Walls MR (2004). Combining decision analysis and portfolio management to improve project selection in the exploration and production firm. J. Petrol. Sci. Eng., 3(1): 13-25.