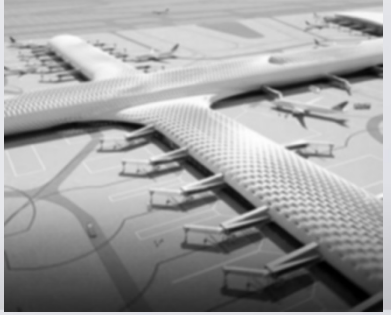
AIRDEV

Airport Development



Performance of the Portuguese Airports

Jorge Silva

Airdev National Meeting
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INSTITUTO SUPERIOR TÉCNICO

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Airport Development

Performance of the Portuguese Airports

Introduction

The air transportation provides to its users a fast net of transports at a global scale that is used annually by about 2.2 thousand million of passengers.

Goods carried by this mode of transport represent 35% of the international trade.

About 40% of the international tourists travel using air mode.

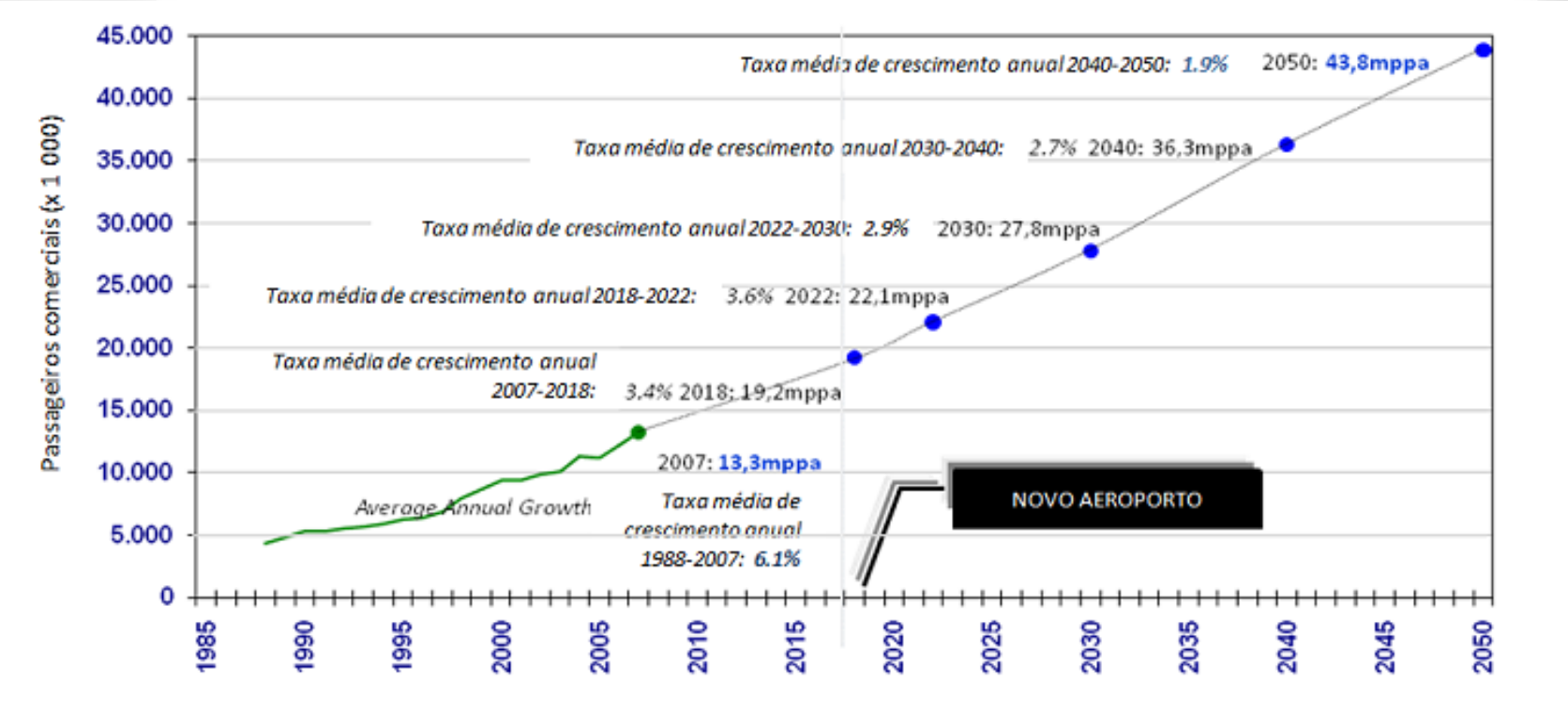
About 2,000 air companies in the world operate a fleet with about 23,000 aircraft connecting about 3,750 airports through a net of routes of some millions of miles managed for about 160 providers of air services.

Performance of the Portuguese Airports

Introduction

Forecast of the evolution of the air transportation of passengers at a world-wide level, for the period between 2008 and 2027 (ICAO, 2008).

Performance of the Portuguese Airports



Evolution of the air transportation in Portugal, verified (green line) and foreseen (cinereous line), between 1985 and 2050 (NAER, 2010).

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Performance of the Portuguese Airports

Introduction

The airport sector has in the Benchmarking a tool for analysis not only of the performance and efficiency of each airport but also for the definition of objectives on the basis of the performance and efficiency of its pairs.

There are some works concerning benchmarking of airports each one using different indicators of performance; some use simple indicators as, for example, the number of slots, while others consider productivity indicators as, for example, the number of passengers for the area of passengers terminal.

The use of simple indicators in the process of benchmarking produces rankings of performance, in turn the use of productivity indicators produces rankings of efficiency.

Performance of the Portuguese Airports

Performance Indicators

The simple indicators can be divided in two groups:

Inputs: Runways, Slots, Area of the Passengers Terminal, Area of the Cargo Terminal;
Outputs: Aircraft Movements, Passengers, Cargo.

The productivity indicators are based on both input and output simple indicators:

Passengers / Area of the Passengers Terminal;
Cargo / Area of the Cargo Terminal;
Aircraft Movements / Slots;
Aircraft Movements / Runways.

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Performance of the Portuguese Airports

MCDA and MacBeth

The methodologies in use to evaluate the performance of airports are divided in two groups: single-dimensional and multi-dimensional.

Among single-dimensional ones the prominence goes for the Method of the Partial Measure.

The multi-dimensional ones are divided in 3 sub-groups:

those of Average Approach (Total Factor Productivity - TFP, and Ordinary Least Square - OLS);

those of Frontier Approach (Stochastic Frontier Analysis - SFA, and Data Envelopment Analysis - DEA);

Multi Criteria Decision Analysis (MCDA).

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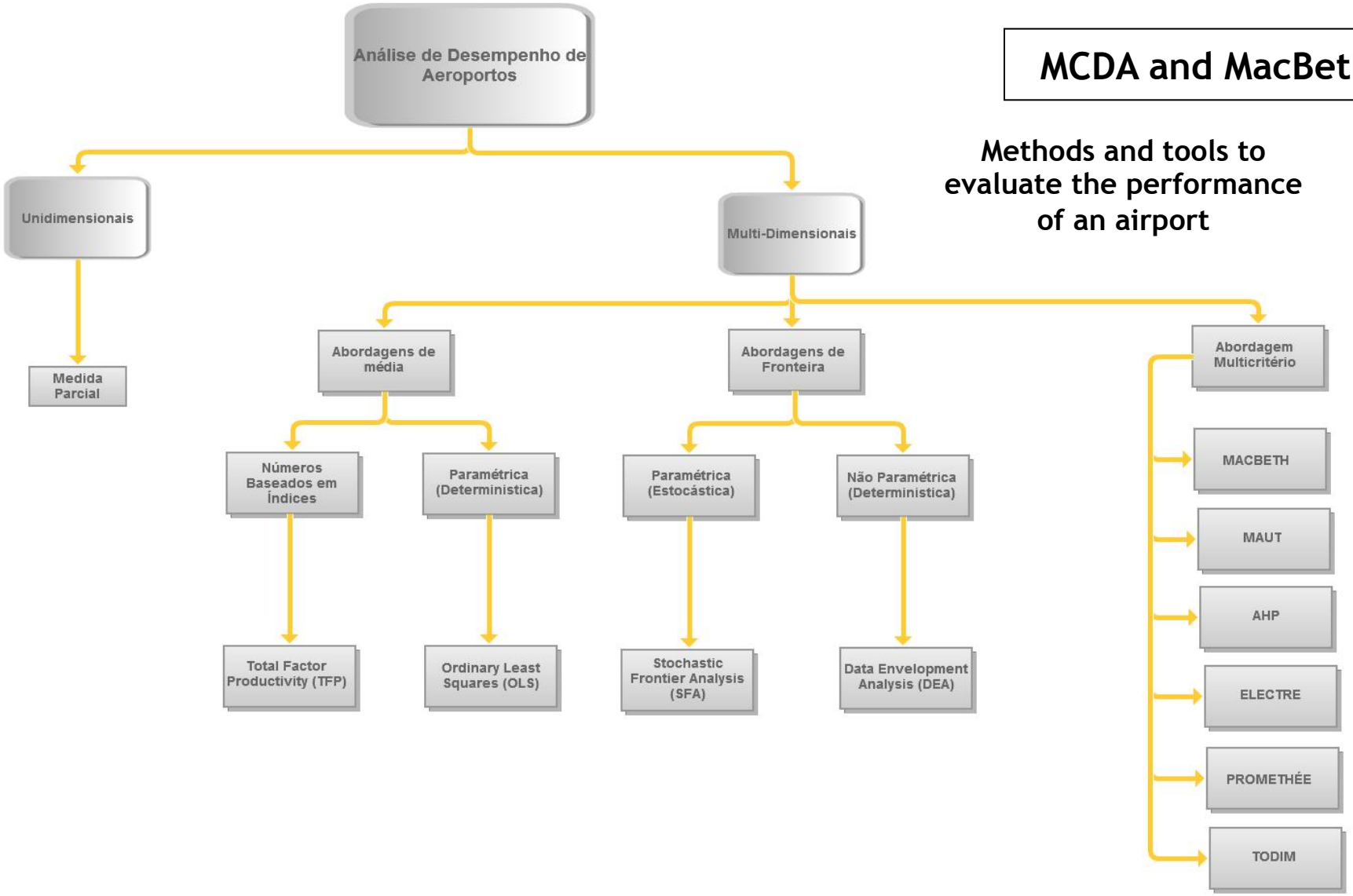
Performance of the Portuguese Airports



MCDA and MacBeth

Methods and tools to evaluate the performance of an airport

Performance of the Portuguese Airports

MCDA and MacBeth

MCDA is one of the most used methodologies; others, purely mathematical, as the SFA and the DEA, have more complex formulations.

Advantages of the MCDA:

It constructs a base for the dialogue between analysts and deciders that makes use of wide range and common points of view;

It facilitates the incorporation of uncertainties on the data in each point of view;

(…)

Performance of the Portuguese Airports

MCDA and MacBeth

Advantages of the MCDA:

It interprets each alternative as a commitment among the objectives in conflict; that is, it prevents any situation where may exist a superior alternative to the remaining ones on all the points of view;

It produces a good ordinance of the alternatives, essential when it is intended to construct rankings.

Disadvantages of the MCDA:

In the choice of the performance indicators, but mainly in the attribution of the respective relative weights, which of course involve some degree of subjectivity.

Performance of the Portuguese Airports

MCDA and MacBeth

Tools associated with the MCDA:

MAUT (Theory of the *Multivariable* Utility);

AHP (Analytic Hierarchy Process*);*

MACBETH (Measuring Attractiveness by a Categorical Based Evaluation Technique);

ELECTRE (Elimination and Choice Expressing Reality);

TODIM (Taking Of Interactive Decision Multi Criteria);

PROMETHÉE (Ranking Organization Method for Enrichment of Evaluations).

Performance of the Portuguese Airports

MCDA and MacBeth

MacBeth allows to evaluate options having in account multiple criteria.

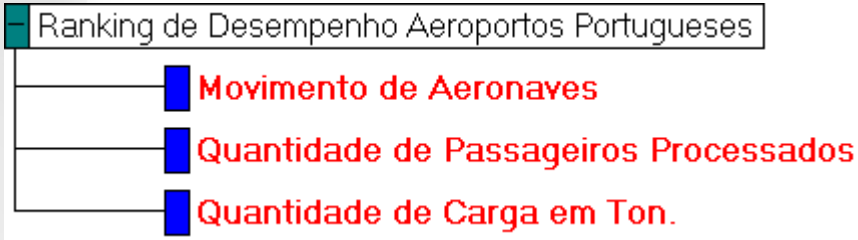
The basic distinction between MacBeth and other methods of Multi Criteria Decision Analysis is that this requires only qualitative judgments on the differences of attractiveness between elements to generate punctuations for the options in each criterion and to ponder the criteria.

MacBeth compares the alternatives among themselves but also with references, that can be better or worse than the alternatives, being therefore an ideal tool to produce rankings.

The main disadvantage is the subjectivity that can be induced in the determination of the weights of the criteria, but… can be mitigated.

Performance of the Portuguese Airports

1) Ranking of performance of the portuguese airports



Decision Tree

Tabela de performances

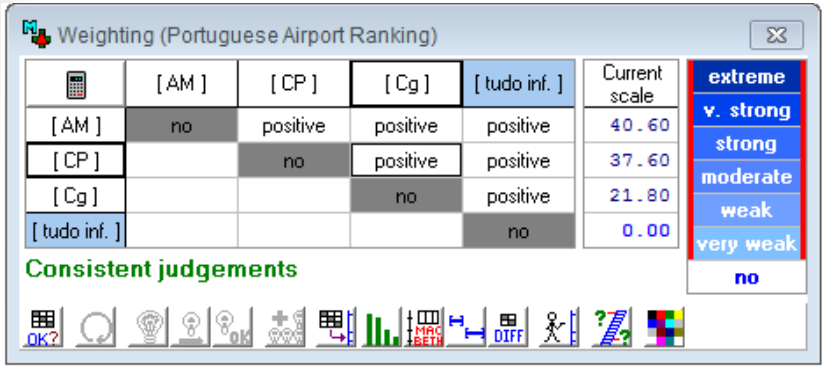
Opções	AM	CP	Cg
FAO	42494	5089672	953
FLW	1558	37820	310
FNC	25828	2360857	9200
HOR	4809	196939	1233
LIS	137109	12314314	99483
OPO	49215	3402816	34444
PDL	12165	909609	8593
PXO	6300	153052	343
SMA	3439	96831	360

Airport data

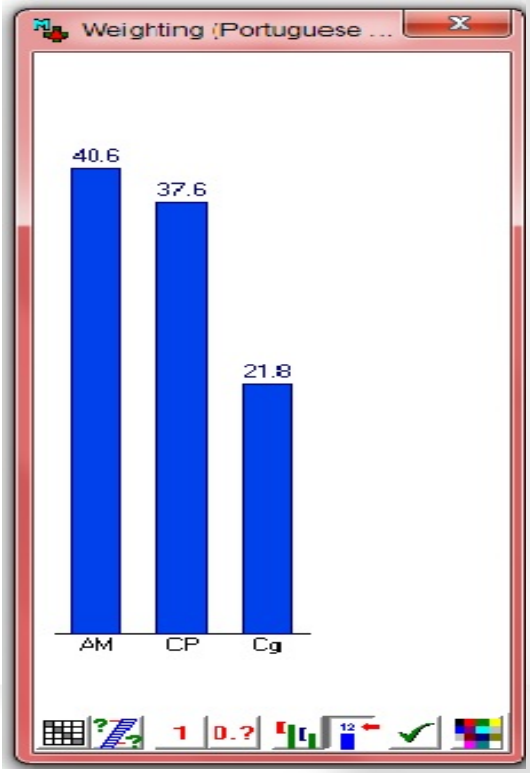
Performance of the Portuguese Airports

1) Ranking of performance of the portuguese airports

An inquiry was launched to 30 aeronautical specialists for the determination of the weights of each criterion.



Attractiveness of the criteria based on the opinion of the specialists



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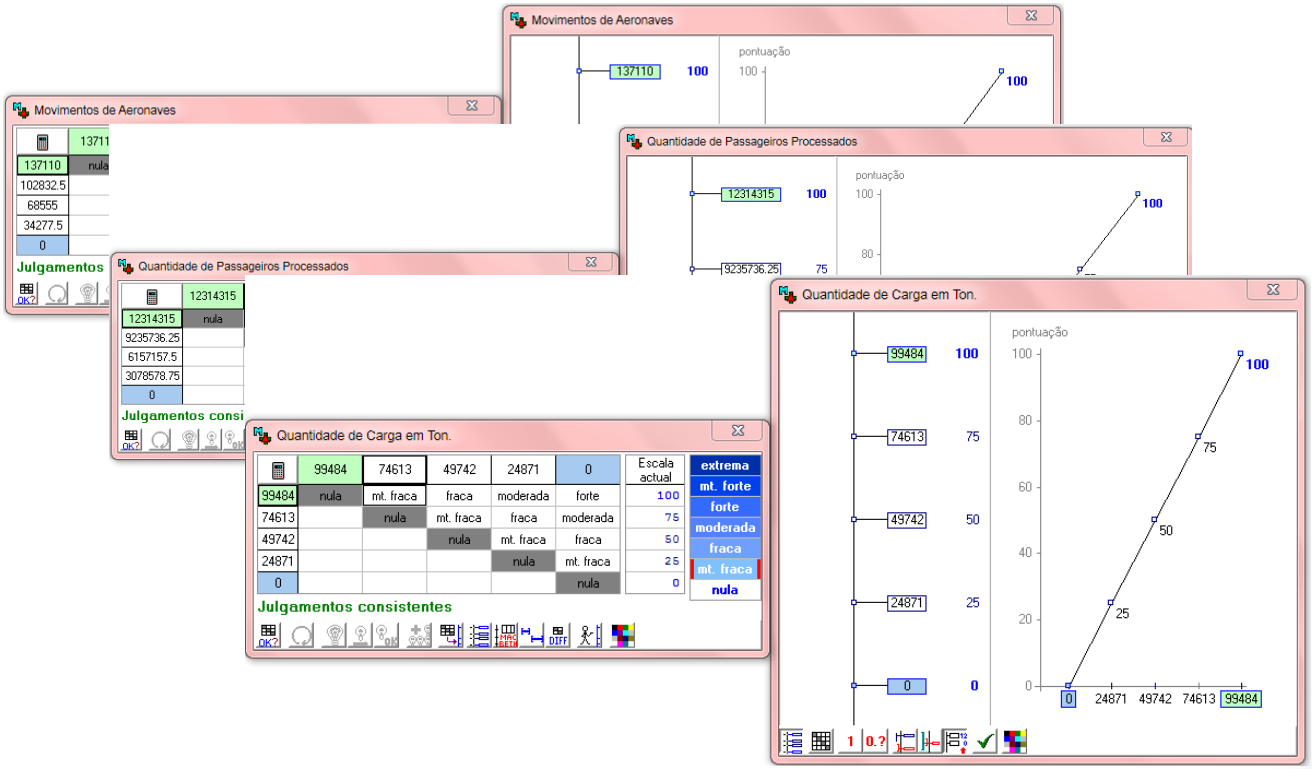
Performance of the Portuguese Airports

1) Ranking of performance of the portuguese airports

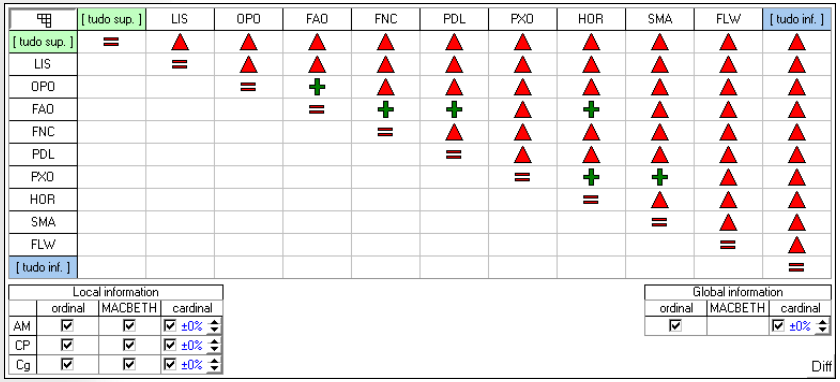


Coefficients of balance for the performance indicators

Airport Development

Performance of the Portuguese Airports

1) Ranking of performance of the portuguese airports



Analysis of robustness

Table of scores

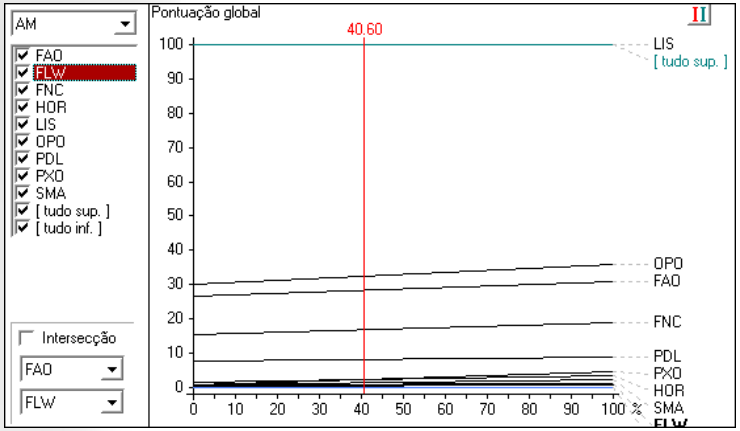
Options	Overall	AM	CP	Cg
[tudo sup.]	100.00	100.00	100.00	100.00
LIS	100.00	100.00	100.00	100.00
OPO	32.51	35.89	27.63	34.62
FAO	28.33	30.99	41.33	0.96
FNC	16.87	18.84	19.17	9.25
PDL	8.26	8.87	7.39	8.64
PXO	2.41	4.59	1.24	0.34
HOR	2.30	3.51	1.60	1.24
SMA	1.39	2.51	0.79	0.36
FLW	0.64	1.14	0.31	0.31
[tudo inf.]	0.00	0.00	0.00	0.00
Weights :		0.4060	0.3760	0.2180

Ranking of performance

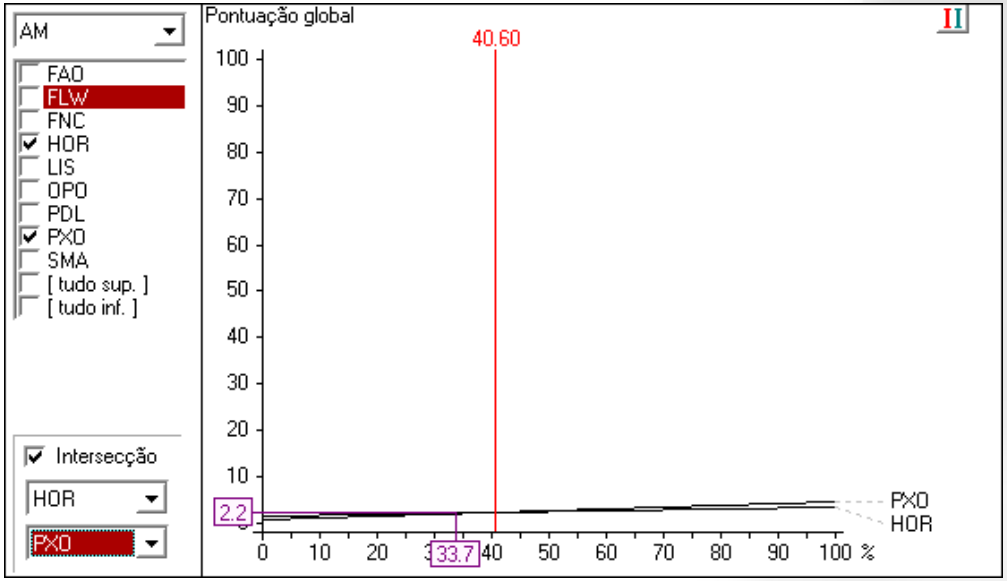
Airport Development

Performance of the Portuguese Airports

1) Ranking of performance of the portuguese airports



Analysis of sensitivity of the weight of criterion AM



Analysis of sensitivity of the weight of criterion AM for the airports of Horta and Porto Santo

Airport Development

Performance of the Portuguese Airports

2) Ranking of performance of some world-wide airports with the CP => Lisbon (LIS)

País	Aeroporto	Código	AM	CP	Cg (ton)
Estados Unido da América	Portland	PDX	260.510	14.043.489	
Coreia do Sul	Seoul	GMP	104.214	13.766.523	
Arábia Saudita	Jeddah	JED	101.845	13.357.093	
Espanha	Malaga	AGP	127.769	13.056.155	
Rússia	Moscow	SVO	155.660	12.764.263	
Portugal	Lisboa	LIS	137.109	12.314.314	
Finlândia	Helsinki	HEL	65.072	12.142.873	
Coreia do Sul	Jeju	CJU	78.611	12.109.837	
Alemanha	Hamburg	HAM	37.619	11.954.560	
Alemanha	Berlin	TXL	20.384	11.812.625	
Colombia	Bogota	BOG	216.592	11.770.339	

Airport data

Table of scores

Options	Overall	AM	CP	Cg
[tudo sup.]	100.00	100.00	100.00	100.00
PDX	88.70	100.00	100.00	48.15
BOG	87.07	83.14	83.81	100.00
SVO	62.93	59.75	90.89	20.64
GMP	61.18	40.00	98.03	37.06
JED	58.96	39.09	95.11	33.61
LIS	58.02	52.63	87.69	16.88
AGP	55.11	49.05	92.97	1.13
CJU	54.24	30.18	86.23	43.90
HEL	47.64	24.98	86.47	22.88
HAM	39.26	14.44	85.13	6.38
TXL	35.56	7.82	84.11	3.46
[tudo inf.]	0.00	0.00	0.00	0.00
Weights :		0.4060	0.3760	0.2180

Ranking of performance

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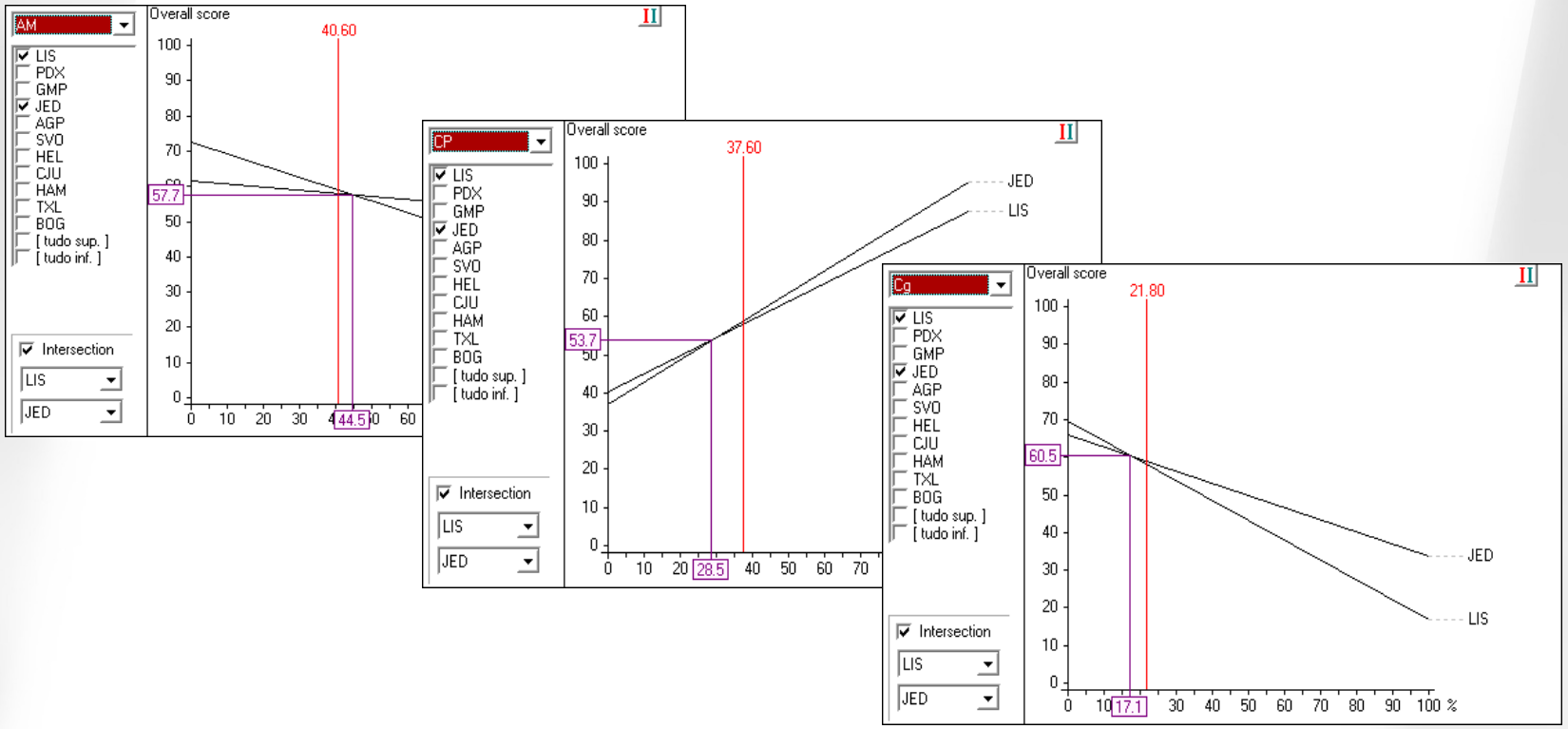
Performance of the Portuguese Airports

2) Ranking of performance of some world-wide airports with the CP => Lisbon (LIS)



Analysis of sensitivity of the weight of criteria AM, CP and Cg for airports LIS and JED

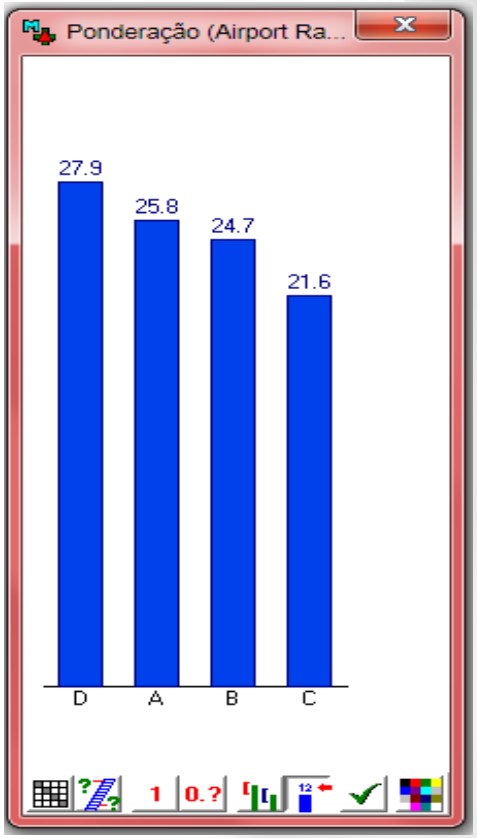
Airport Development

Performance of the Portuguese Airports

3) Self Benchmarking of efficiency of some portuguese airports

- Ranking de Eficiência de Aeroportos
  - Quantidade de Passageiros Processados / Àrea do Terminal de Passageiros
  - Quantidade de Carga em Ton. / Área do Terminal de Carga
  - Número de Operações de Aeronaves / Número de Posições de Parqueamento de Aeronaves
  - Número de Operações de Aeronaves / Número de Pistas

Decision tree



Weight of the productivity criteria

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Performance of the Portuguese Airports

3) Self Benchmarking of efficiency of some portuguese airports

Número de Pistas	2006	2007	2008	2009	2010
Porto (OPO)	1	1	1	1	1
Funchal (FNC)	1	1	1	1	1
Área T. Passageiros (m^2)	2006	2007	2008	2009	2010
Porto (OPO)	69.112	69.112	69.112	69.112	69.112
Funchal (FNC)	44.590	44.590	44.590	44.590	44.590
Área Terminal Carga (m^2)	2006	2007	2008	2009	2010
Porto (OPO)	19.141	19.141	19.141	19.141	19.141
Funchal (FNC)	7.535	7.535	7.535	7.535	7.535
Posições Parq.º Aeronaves	2006	2007	2008	2009	2010
Porto (OPO)	48	48	48	48	48
Funchal (FNC)	17	17	17	17	17
Passageiros Processados	2006	2007	2008	2009	2010
Porto (OPO)	3.402.805	3.986.748	4.534.829	4.508.330	5.279.531
Funchal (FNC)	2360857	2.419.697	2.448.574	2.348.040	2.239.353
Operações de Aeronaves	2006	2007	2008	2009	2010
Porto (OPO)	47.061	50.745	56.095	52.194	55.432
Funchal (FNC)	25.828	25.616	25.961	25.162	25.898
Carga Processada (ton)	2006	2007	2008	2009	2010
Porto (OPO)	34.444	32.585	32.215	27.375	28.782
Funchal (FNC)	9.368	9.012	9.303	8.732	8.654

Data on the airports of Porto (OPO) and Funchal (FNC), 2006 - 2010

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Performance of the Portuguese Airports

3) Self Benchmarking of efficiency of some portuguese airports

Tabela de performances

Opções	A	B	C	D
OPO2006	49.24	1.8	980.44	47061
OPO2007	57.69	1.7	1057.19	50745
OPO2008	65.62	1.68	1168.65	56095
OPO2009	65.23	1.43	1087.38	52194
OPO2010	76.39	1.5	1154.83	55432

Data on the airport of Porto (OPO), (productivity indicators)

Tabela de performances

Opções	A	B	C	D
FNC2006	52.95	1.24	1519.29	25828
FNC2007	54.27	1.2	1506.82	25616
FNC2008	54.91	1.23	1527.12	25961
FNC2009	52.66	1.26	1480.12	25162
FNC2010	50.22	1.15	1523.41	25898

Data on the airport of Funchal (FNC), (productivity indicators)

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Performance of the Portuguese Airports

3) Self Benchmarking of efficiency of some portuguese airports

Tabela de pontuações

Opções	Global	A	B	C	D
[tudo sup.]	100.00	100.00	100.00	100.00	100.00
FNC2008	99.40	100.00	97.58	100.00	100.00
FNC2006	98.43	96.43	98.39	99.49	99.49
FNC2007	97.85	98.83	95.16	98.67	98.67
FNC2009	97.42	95.90	100.00	96.92	96.92
FNC2010	95.49	91.46	91.13	99.76	99.76
[tudo inf.]	0.00	0.00	0.00	0.00	0.00
Pesos :		0.2580	0.2470	0.2160	0.2790

Ranking of efficiency of the airport of Funchal, (2006-2010)

2008 is the more efficient year of the airport of Funchal, when it reached the best results for the criteria A, C and D.

2010 is the less efficient year, with the lowest results of all the period for the criteria A and B.

Although the efficiency of this airport always presents values above 95.49% between 2006 and 2010, in the really they oscillated from year to year.

Performance of the Portuguese Airports

3) Self Benchmarking of efficiency of some portuguese airports

Tabela de pontuações

Opções	Global	A	B	C	D
[tudo sup.]	100.00	100.00	100.00	100.00	100.00
OPO2010	95.30	100.00	83.33	98.82	98.82
OPO2008	94.72	85.90	93.33	100.00	100.00
OPO2009	87.71	85.39	79.44	93.05	93.05
OPO2007	87.59	75.52	94.44	90.46	90.46
OPO2006	82.86	64.46	100.00	83.90	83.90
[tudo inf.]	0.00	0.00	0.00	0.00	0.00
Pesos :		0.2580	0.2470	0.2160	0.2790

Ranking of efficiency of the airport of Porto, (2006-2010)

For the airport of Porto (OPO) the year of 2010 was the most efficient, for opposition to the year of 2006 that was the less efficient.

In the perspective of each criterion: 2006 presents the best score for B, 2008 for C and D, and 2010 for A.

It is remarkable the increment in the efficiency of this airport between 2006 (82.86%) and 2010 (95.30%), that is, 12.44% during these 5 years.

Performance of the Portuguese Airports

Conclusion

The capacities of the MacBeth were explored through its application to 3 distinct cases of study involving Portuguese airports and others of a world-wide scale.

The results are conditioned for some constraints we assumed since the beginning, and for some limitations inherent to the MCDA methodology and the MacBeth tool.

These are exploratory results… but they are also enough elucidative of the potentialities of these, methodology and tool.

(…)

Performance of the Portuguese Airports

Conclusion

For decision makers the main advantages can be:

to construct rankings of performance and efficiency for a set of airports, allowing to verify the position of the infrastructure in the ranking, and in the comparison with pairs to perceive where it is possible to get increments necessary to modify that position;

to construct rankings of performance and efficiency of the same airport throughout the years, allowing a clear notion of the impact of eventual investments (or the lack of them) in the behavior of the infrastructure.

Performance of the Portuguese Airports

Conclusion

Future research:

to introduce in the model other criteria that translate the impacts of (for example) the ramp accidents or the sudden climatic alterations;

to widen the base of specialists of the aeronautical sector for the constitution of more robust weights for the criteria to be adopted.

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Performance of the Portuguese Airports

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