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EVALUATION OF LODGING ESTABLISHMENTS IN CAMPOS USING DEA WITH WEBSITE DATA

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Abstract

In this work, Data Envelopment Analysis (DEA) technique has been applied to evaluate the efficiency of lodging establishments, in the municipality of Campos dos Goytacazes (Campos in short), RJ, Brazil, from the perspective of the customers, with the intent to support decision making by managers of family-business establishments. Due to the city economic importance, for the evaluation, besides the lodging establishments already installed in Campos, other chain hotels with the potential to be inaugurated in Campos in the very near future are also considered in the analysis. The input and output data for DEA models were collected from the lodging establishment websites. With the efficiency score results obtained with the oriented-output CCR and BCC models, we further indicate the service items that should be improved by the establishments that are considered inefficient.

Keywords: lodging establishments, Data Envelopment Analysis, efficiency.

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1. Introduction

Taking up space in the relevant national and global economy, the tourism sector has shown strong-growth trend lately. According to the Brazilian Ministry of Tourism (2011a, 2011b), in 2010, the domestic tourism earned $5,900 billion dollars in foreign exchange, registering a record of the historic series that started in 1947. In Figure 1, the evolution of arrival tourists in Brazil from 1970 to 2010 is showed.

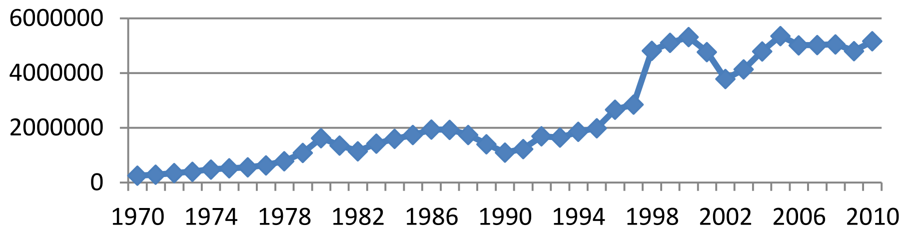

Figure 1: Number of arrival tourists in Brazil from 1970 to 2010

The fact that Brazil will host two major sporting events in the near future promises to boost tourism in the country in large numbers. Table 1 presents the goals to be possibly achieved in terms of the number of arrival tourists and the amount of foreign exchange from 2013 up to 2020, according to the Brazilian Ministry of Tourism (2009).

To accommodate the arrival tourists, the Brazilian hotel industry is composed by independent lodging establishments and national and international hotel-chain establishments. The former represents approximately 92% of the establishments in the country, whereas the hotel chains account for the remainder.

Table 1: Tourism goals to be achieved from 2013 up to 2020

Year	2013	2014	2015	2016	2017	2018	2019	2020
Tourists (in millions)	7,1	8,1	7,8	8,9	8,6	9,3	10,2	11,1
Currency (in millions)	7,907	9,093	10,457	12,026	13,229	14,552	16,007	17,607

In addition, the Brazilian hospitality industry has been characterized as one of the best segments of capital investment in recent times (Mafaldo, 2005). According to the Cadastur System Database (a database system of individuals and legal entities operating in the hospitality industry in Brazil), in January 2011, the domestic hotel industry had approximately 5,925 lodging facilities legally registered in the country, accounting for 275,682 housing units and 662,368 beds (ABIH, 2012).

In view of the Brazilian optimistic economic scenario, Mafaldo (2005) states that major international hotel chains have been investing in medium-sized hotels, coach and business categories in recent years. These hotels offer a good level of service at affordable prices, ideal for business customers.

The expansion of business hotels has already reached other Brazilian cities, besides the state capitals, especially the municipalities of Macaé, Cabo Frio and Campos dos Goytacazes (Campos in short), influenced by the thriving oil industry of the State of Rio de Janeiro. For example, until 2011, Campos had a market composed solely of hosting inns, hotels and flats; nowadays, a hotel-chain establishment is already installed and the inauguration of new national and international chain hotels is expected in the very near future.

Regarding Campos, in the period from 2005 to 2009, the municipality took fourth place in the country's industrial ranking in relation to the gross added value, according to IBGE (2011). Moreover, Campos has the third largest GDP in Brazil and the third largest oil reserves in the world, equivalent to Saudi Arabia (CIDAC, 2011).

Due to the great potential for growth in the hotel industry, the entry of large hotel chains in Campos has established a new level of competitiveness, forcing the lodging establishments already in place to take a new attitude, in order to maintain their market shares in this competitive environment.

Given the above considerations, this work aims to:

- determine, through the application of Data Envelopment Analysis (DEA), the lodging establishments that are efficient and inefficient from the perspective of customers, among the ones already in Campos and the hotel-chains with the potential to be installed in Campos in the very near future,
- provide information to aid decision making of small lodging establishments in Campos to improve the quality of service in order to maintain their competitiveness.

Evaluating hotel services is not novelty in the scientific literature. For example, Mola and Jusoh (2011) evaluated the hotel services in Penang, Malaysia, using the SERVQUAL technique, whereas Dominici and Guzzo (2010) evaluated the services satisfaction of a hotel in Sicily by using the Critical Incident Approach. On the other hand, DEA has become a powerful technique to evaluate efficiency of any industrial/service process/facility. Just to mention a few, the works of López et al. (2011) that evaluated state and private Mexican universities, Alexander et al. (2007) that analysed high schools in New Zealand, Hag et al. (2010) that analysed the efficiency of microfinance institutions of Africa, Asia and Latin America, and Kanesiro (2008) that studied lodging facilities in Brazil from the perspective of economic and financial indices are referred, for example.

This work has a new proposal when consider applying DEA technique to evaluate lodging facilities in Brazil, particularly in Campos, from the perspective of the costumers. For the first trial with DEA, the classic CCR and BCC mathematical models are considered. Other existing academic works evaluated lodging facilities, also from the perspective of the costumers, but with a different technique, such as Freitas and Morais (2009), and Mola and Jusoh (2011), whereas Kanesiro (2008) shows an application of DEA to evaluate lodging facilities in Brazil with a different perspective, not considering particularly the lodging facilities located in Campos.

In general terms, this paper is structured as follows: Section 2 presents an overview of the research methodology and the material used in this study. Section 3 briefly describes the DEA technique. The application of DEA to evaluate the efficiency of the lodging establishments in Campos is presented in Section 4, where the procedure to collect the relevant data, the computational results and the analysis of the results are also presented. Section 5 presents the final comments.

2. Methodologies

In order to achieve the above mentioned objectives, an exploratory research was conducted to directly address the economic importance of Campos to the hotel industry, which motivates hotel chains to install facilities there. This involves mostly literature review and search on the internet, interviews with people who have had practical experience with the subject of study and analysis of examples in order to encourage understanding. In most cases, it takes the form of literature review or case study (Selltiz et al., 1967 cited in Gil, 2002).

According to Miguel (2007), a case study is an empirical study, in which a certain phenomenon is analyzed in a real context, in order to stimulate the understanding, to suggest hypotheses and to develop theories.

To further investigate the quality of services being provided by lodging establishments in Campos, a case study of quantitative nature was conducted, using the DEA technique. As an evolved tool of Operational Research, DEA is used in several areas, with the purpose of prioritizing the technical efficiencies of production units and assisting the process of managing them (Ramos, 2007).

For Bertrand and Fransoo (2002), the quantitative research seeks to solve real life problems with the aid of scientific development. In this type of research, models of causal relationships between control variables and performance are developed, analyzed and tested.

According to these authors, the quantitative research considers that it is possible to construct models aiming to support managers of operational processes in decision making and explaining the behaviour of these processes in everyday life.

For the performance evaluation of the service being provided, besides the lodging establishments already installed in Campos, other chain hotels with the potential to be inaugurated in Campos in the very near future were also considered in the analysis, due to the economic importance of Campos. The input and output data required for DEA technique were collected from websites of the lodging establishments in Campos and from the selected hotel-chain establishments. As this study is strongly based on information available at the websites of the hotels to be evaluated, we have assumed that the information contained in the sites corresponds to the reality of these hotels.

The CCR and the BCC basic models with output orientation were chosen to evaluate the performances. The constructed mathematical models relating to DEA were solved by CPLEX solver 12.3, which applied the dual simplex algorithm (the default approach) to find optimal solutions.

3. Data Envelopment Analysis

In this section, the DEA technique is briefly presented. The focus is to show the linear programming models that will be used to evaluate the service performance of the lodging facilities in Campos.

Developed by Charnes et al. (1978), the Data Envelopment Analysis (DEA) is a non-parametric technique firstly used to measure the technical efficiency of organizations based on mathematical programming. Precisely, this technique is used to analyze or compare homogeneous Decision Making Units (DMUs) that perform similar tasks, but differ only in the quantities of inputs (resources) and outputs (products/services) during the production process. DEA aims to classify the performance of DMUs as efficient or inefficient through the solution of optimization problems formulated as linear or non linear programming models.

As explained by Charnes et al. (1978), while the parametric method obtains a plan of simple regression, DEA obtains an efficient frontier, through the optimization of inputs used or outputs produced by each individual DMU, one over the other. In relation to the orientation, that is, the form of projection of inefficient plans onto the efficient frontier (or envelopment surface), the linear programming models can be oriented to inputs, to outputs or driven without guidance. The efficient units are on the efficient frontier, while the inefficient ones do not lie on the frontier (Cooper et al, 2006).

The CCR and BCC are the linear programming models commonly addressed by the users of DEA. Developed by Charnes et al. (1978), the CCR model measures full efficiency given constant returns to scale, that is, any variation in the inputs generates a proportional variation in the outputs. It is also known as the Constant Returns-to-Scale (CRS) model.

Unlikely the CCR model, the BCC model developed by Banker et al. (1984) identifies technical and scale inefficiency, besides pure technical efficiency, considering variable returns to scale, that is, any variation in the inputs generates a non proportional variation in the outputs (Cooper et al., 2006). It is also known as Variable Returns-to-Scale (VRS) model.

In this work, the dual form of CCR and BCC oriented-output (or just CCR-O and BCC-O) models are considered. In Table 2, the corresponding dual problems of the CCR-O and BCC-O models are presented. Let N be the total of DMUs to be evaluated, with m inputs (resources) and s outputs (services/products). The index $i,\ i = 1, \dots, m$, represents an input, the index $r,\ r = 1, \dots, s$, represents an output, whereas the index $j,\ j = 1, \dots, N$ represents a DMU. The DMU that is being evaluated with respect to the others has index $j = 0$. The CCR-O and BCC-O models parameters are x_{ij}, which represents the input i corresponding to DMU

j; y_{rj} represents the output *r* corresponding to DMU *j*; and x_{i0} and y_{r0} represent respectively the input *i* and output *r* corresponding to the DMU being evaluated.

The decision variables of both models are u_r and v_i, which represent the weights of inputs and outputs, respectively. In relation to the CCR-O model, the BCC-O model additionally introduces the decision variable v_0, which represents the variable return to scale, assuming that the maximal productivity varies according to the production process.

With respect to the constraints of the models, the first set of constraints (1) of the CCR-O model represents the results for the performance evaluation of DMU j. For an efficient DMU j the constraint is active. Particularly, in the BCC-O model, the summations differ in the amount of at least v_0 for each DMU in (1). The constraint (2) in both models indicates that the convex linear combination of the outputs of the DMU being evaluated should be equal to one, since their weights are not negative by (3).

Table 2: The dual oriented-output CCR and BCC models

Dual CCR-O model	Dual BCC-O model
Minimize $h_0 = \sum_{i=1}^{m} v_i x_{i0}$ Subject to $\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0 \quad \forall j = 1, \dots, N$ (1) $\sum_{r=1}^{s} u_r y_{r0} = 1$ (2) $u_r, v_i \geq 0 \quad \forall r, \forall i$ (3)	Minimize $h_0 = \sum_{i=1}^{m} v_i x_{i0} - v_0$ Subject to $\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} + v_0 \leq 0 \quad \forall j = 1, \dots, N$ (1) $\sum_{r=1}^{s} u_r y_{r0} = 1$ (2) $u_r, v_i \geq 0 \quad \forall r, \forall i$ (3) $v_0 \in R$ (4)

Source: Adapted from Banker, Charnes and Cooper (1984)

For both CCR-O and BCC-O models, the conceptual objective is to maximize output production while not exceeding the given resource levels. But in the context of dual space, the interpretation is geometric, referring to the minimization of the vertical distance from the supporting hyperplane (that lies on some DMUs or is above all DMUs) to the DMU being evaluated. A DMU is characterized efficient if the optimal objective function value is one.

Comparing the CCR-O and BCC-O models, the difference between them is given by the scale efficiency v_0 (algebraic explanation) or is given by the shape of the envelopment surface (geometric explanation). When the resulting efficiency values for both models are equal to one, then the DMU being evaluated has fully productive efficiency, that is, it is totally efficient in processing resources into products. However, when one gets for the CCR model the efficiency result less than one and to the BCC model efficiency result equal to one, then it means that the DMU presents technical efficiency. Also, when the results of both models do not achieve maximal efficiency, that is, both efficiency values are less than one, this means that the DMU presents productive inefficiency due to a technical origin (Cooper et al., 2006).

4. Data, results and discussions

Below, the selection of the lodging establishments, the data handling as well as the application of the DEA technique are detailed to evaluate the lodging establishments in Campos. Also, the numerical efficient results are presented and discussed.

a) Selection of lodging establishments

First, 10 establishments in Campos with active websites on the Internet were selected. They are denoted by $h_1, h_2, h_3, \dots, h_{10}$. Also, 11 establishments belonging to economic trademarks of larger hotel chains operating in Brazil with potential to be in Campos in the very near future were additionally selected. They are denoted by $e_1, e_2, e_3, \dots, e_{11}$. For the selection of the hotel chains, mostly those already operating in the Brazilian cities with population equal to or greater than 463,545 inhabitants (the current population of Campos) and with similar economical importance were considered. To protect their brand, the order of the notation does not match the order of the selected hotels presented in Table 3.

Table 3: Selected lodging establishments

Selected Hotels	
In Campos	**From hotel chains**
Pousada Cravo & Canela Hotel	Ibis (Accor)
Canaan Hotel	Formule 1 (Accor)
Fazenda Pedra Lisa Hotel	Go Inn (Atlantica Hotels)
Pousada das Garças	Othon Travel (Othon)
Pousada dos Chalés	Holiday Inn Express (InterContinental Hotels)
Via Park Flat Service	Bristol Hotels e Resorts Padrão Flexy (Bristol Hotéis & Resorts)
Terrazo Tourist Hotel	Blue Tree São José dos Campos (Blue Tree Hotels)
Palace Hotel	Blue Tree Towers Joinville (Blue Tree Hotels)
Jardim de Allah Flat Service	Transamerica Flat The First (Transamerica Flats)
Comfort Hotel (Atlantica Hotels)	Transamerica Flat Parságada (Transamerica Flats)
	Tryp Hotels (Sol Meliá Hotels & Resorts)

b) Definition of input and output data

The more information on the website, the better is the evaluation of the service from the perspective of the customers. As the evaluation of the lodging establishments is conducted from the customers' perspective, a suitable set of data from the establishment websites were collected as output data. To fill the input data intrinsic items of those websites were collected.

Table 4: Input and output data items

Data	Items
accommodation (*O1*)	TV (1.1); telephone (1.2); Internet connection (1.3); mini bar (1.4); air conditioner (1.5); nice room (1.6); nice bathroom (1.7); comfortable bed (1.8).
facilities (*O2*)	nice exterior facade (2.1); nice interior facade (2.2); stairs (2.3); sauna (2.4); fitness room (2.5); nice restaurant (2.6); adaptation for disabled people (2.7).
services (*O3*)	laundry service (3.1); room service (housekeeping) (3.2); breakfast (diverse options) (3.3); lunch/dinner (3.4).
website (*I1*)	hotel photos (4.1); website layout (4.2); available data (4.3); on-line attendance (4.4).

Based on Freitas et al. (2009) and Cruz (2010), for each hotel website the output data refers to: (1) accommodation, which gathers the items of the housing units, (2) facilities, which gather the indoor and outdoor items of the lodging establishment, (3) services, which gather the extra-service items offered by the hotels. The input data refers to the items of website of each hotel: photos, layout, available data, and on-line attendance. Table 4 shows the input and output data with their corresponding items considered in the assessment.

c) Definition of the score scale for input and output data items

To evaluate the lodging establishments based on the input and output data items described in Table 4, a score scale of five marks is used, ranging from ‘Very Good’ to ‘Very Bad’, including the mark ‘Not Available’, as in Freitas et al. (2009). The marks were converted into scores, so that marks equally distant correspond to scores equally distant.

Thus, an input or an output item of a hotel is set to zero if it is not available for the customer or it is not informed on the website, the score 0.2 is set to the item that results in ''Very Bad’, 0.4 is set to the item classified as ‘Bad’, and so on. Table 5 presents the score scale used here.

Table 5: Score scale for input and output data item

Very good	Good	Regular	Bad	Very bad	Not available
1.0	0.8	0.6	0.4	0.2	0

d) Scoring the input and output data item

In order to employ the DEA technique, the hotel websites were accessed and the scores of the input and output items were annotated according to the score scale showed in Table 5. Table 6 summarizes the mean values obtained for the output data (accommodation, facilities and services) and for the input data (website) of the lodging establishments here evaluated, which will be used as data in the DEA models. The score result for each input and output item of each establishment is listed in the Appendix.

Table 6: The mean score values for input and output items of each hotel

hotels	acommodation *O1*	facilities *O2*	services *O3*	website *I1*
e_1	0.50	0.97	0.30	0.95
e_2	0.58	0.46	0.70	0.75
e_3	0.65	0.51	0.55	0.65
e_4	0.83	1.00	0.70	0.95
e_5	0.73	0.69	0.60	0.75
e_6	0.65	0.60	0.40	1.00
e_7	0.78	0.57	0.70	1.00
e_8	0.60	0.29	0.60	0.70
e_9	0.63	0.94	0.45	0.85
e_{10}	0.63	0.69	0.95	0.75
e_{11}	0.33	0.37	0.70	0.95
h_1	0.40	0.06	0.35	0.75
h_2	0.45	0.34	0.35	0.75
h_3	0.78	0.77	0.65	1.00
h_4	0.80	0.54	0.65	0.95
h_5	0.58	0.17	0.55	0.85
h_6	0.60	0.09	0.65	0.85
h_7	0.75	0.14	0.50	0.85
h_8	0.73	0.29	0.35	0.85
h_9	0.40	0.14	0.35	1.00
h_{10}	0.88	0.83	1.00	0.95

e) Solving DEA mathematical models

In this study, the dual form of the CCR-O and BCC-O models were considered in order to assess the quality of products/services (accommodations, facilities and services) as perceived by the costumers (information available on the website) of the selected lodging establishments.

First, the CCR-O dual model was solved for each lodging establishment with the corresponding input and output data; a total of 21 resolutions. The weights (variables) are determined for each establishment, obtaining the maximal efficiency possible in relation to the others. For example, if for an analysed establishment the model result gives 80% efficiency (i.e., the optimal objective function value is 0.8), then its efficiency will be less than or equal to this percentage value in the performance analyses of all the remaining establishments. As the total number of data values is 4 (3 mean values of output and 1 mean value of input) for each lodging establishment, the number of variables in each model instance is 4.

Through the CPLEX 12.3 solver installed in the package AIMMS, the linear programming problems related to the CCR-O dual models were solved by the implemented dual simplex algorithm, which is the default choice of the solver. The computational results show that the establishments e_3, e_4, e_5, e_9, e_{10} and h_{10} obtained maximal efficiency (optimal objective function value equals to one), while the establishment h_9 was categorized as the most inefficient followed by h_1 and e_{11}. The computational results referring to the CCR-O dual model for 21 lodging establishments, here evaluated, are presented in Figure 2.

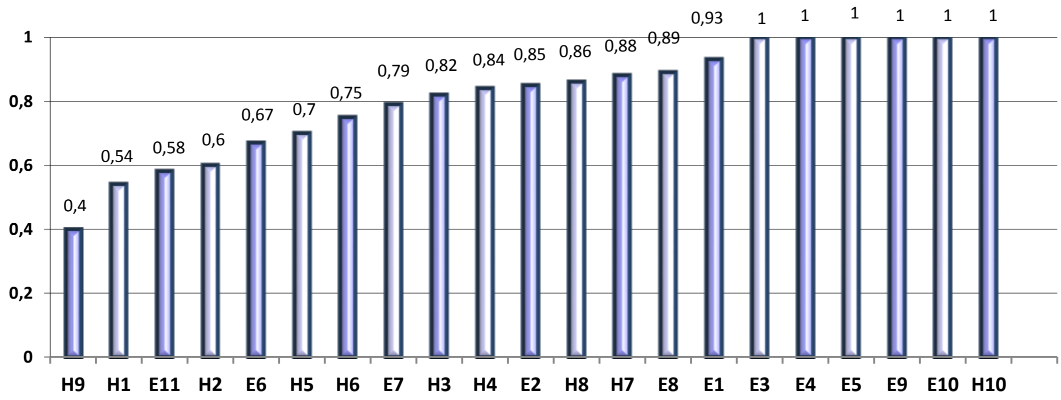

Figure 2: Efficiency performance for the lodging establishments using CCR-O dual model

For each instance of the CCR-O dual model, the value of the shadow price of each constraint, in the set (1) of Table 2, was observed in order to identify the establishment with maximal efficiency (i.e., the establishment associated to the constraint with null slack) and the establishment whose performance could be improved (i.e., the establishment with positive slack). Then, for the inefficient lodging establishments in Campos, the efforts needed by each output to reach the efficient frontier are computed based on the linear combination of the input and output data of the efficient establishments. In Table 7, the targets relative to the inefficient lodging establishments are presented, with the ranking positions going from 9 (most inefficient) to 1 (least inefficient).

Table 7: CCR-O output targets for the inefficient lodging establishments in Campos

		h_1	h_2	h_3	h_4	h_5	h_6	h_7	h_8	h_9	h_{10}
O1	target	0.34	0.30	0.18	0.15	0.25	0.20	0.10	0.12	0.59	-
	(%)	46.24	40.00	18.33	15.79	29.87	24.81	11.77	14.12	59.68	-
O2	target	0.54	0.25	0.17	0.21	0.52	0.64	0.53	0.38	0.65	-
	(%)	89.93	42.28	18.26	27.52	75.50	87.67	79.01	56.52	82.37	-
O3	target	0.30	0.29	0.15	0.15	0.23	0.22	0.22	0.37	0.59	-
	(%)	46.24	44.88	18.34	19.15	29.85	24.86	30.59	51.32	59.68	-
total		1.18	0.83	0.49	0.51	1.01	1.05	0.85	0.87	1.76	-
(total %)		59.32	42.24	18.31	20.37	43.60	44.00	37.84	38.73	66.46	-
ranking		8	5	1	2	6	7	3	4	9	-

From Table 7, we verify that h_9 needs to make the maximal effort (66.46%) in its production/service processes to become efficient, whereas h_3 needs to make the minimal effort (18.31%). Taking h_9 as example, to reach 100% efficiency h_9 must pursue the targets proposed by the CCR-O dual model in order to increase performance of its outputs, which are: (1) in respect to accommodation, its total score should go from 0.4 to 0.992, resulting in a possible gain of 59.68%; (2) in respect to facilities, its total score should go from 0.14 to 0.79, with a possible gain of 82.37%; and (3) in respect to services, its total score should go from 0.35 to 0.87, with a possible gain of 59.68%. Also, it can be observed that the establishments in Campos that have the largest deviations from efficiency are: h_9, h_1 and h_6, while h_{10} has been evaluated as efficient. One can see that greater improvement is required to be made in the facility items by the majority of the inefficient establishments.

Similar to CCR-O dual model, the BCC-O dual model was then solved for each lodging establishment with the corresponding input and output data, summing 21 model resolutions, using CPLEX 12.3 solver installed in package AIMMS, as well.

The computational results for the BCC-O dual model instances show that the lodging establishments e_3, e_4, e_5, e_9, e_{10} and h_{10} are the ones with highest efficiency, while the establishment e_{11} is the most inefficient, which is followed by h_9 and e_6. Figure 3 presents the computational results referring to the BCC-O dual model for the 21 evaluated lodging establishments. As expected from Cooper et al. (2006), the CCR-O dual model obtained efficiency scores equal to or higher than the ones obtained by the BCC-O dual model.

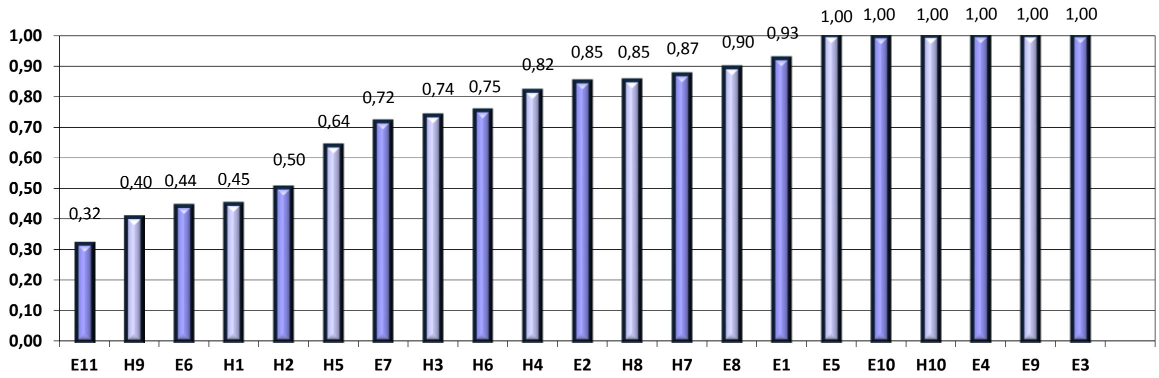

Figure 3: Efficiency performance for the lodging establishments using BCC-O dual model

Using analogous computational procedure as for the CCR-O dual model, Table 8 shows the adjustment needed to improve the output scores by the establishments in Campos that were indicated by the BCC-O dual model as inefficient ones.

Table 8: BCC-O output targets for the lodging establishments in Campos

		h_1	h_2	h_3	h_4	h_5	h_6	h_7	h_8	h_9	h_{10}
O1	target	0.33	0.28	0.11	0.08	0.23	0.20	0.06	0.08	0.53	-
	(%)	45.13	38.36	12.75	9.09	27.95	24.81	6.83	9.32	56.80	-
O2	target	0.60	0.35	0.11	0.29	0.59	0.64	0.62	0.47	0.73	-
	(%)	90.94	50.73	12.70	34.94	77.63	87.64	81.58	61.84	83.96	-
O3	target	0.29	0.25	0.32	0.35	0.25	0.21	0.30	0.45	0.65	-
	(%)	45.14	41.67	33.06	35.00	31.25	24.77	37.50	56.25	65.00	-
total		1.22	0.88	0.55	0.72	1.07	1.05	0.96	1.00	1.91	-
(total %)		60.01	43.56	19.91	26.57	45.03	43.93	41.23	42.07	68.20	-
Ranking		8	5	1	2	7	6	3	4	9	-

From Table 8, it can be observed that h_9 is the lodging establishment in Campos with lowest efficiency, as it needs a total effort of 68.20%. So, in order to reach 100% efficiency, h_9 must pursue the targets to increase the performance of their outputs, which are: (1) for accommodation, the total scores should go from 0.4 to 0.93 with a possible gain of 56.80%; (2) for facilities, the total scores should go from 0.14 to 0.87 with a possible gain of 82.96%, and (3) for services, the total scores should go from 0.35 to 1 with a possible gain of 65%. On the opposite, h_3 is the least inefficient lodging establishment in Campos, since it needs to make a total improvement of 18.31% to become efficient.

From now on, CCR-O and BCC-O dual models are compared based on the computational results for shadow price of each lodging establishment. Table 9 shows, in the first and second columns, the hotels that were considered as benchmark in the evaluation and the overall ranking positions of inefficiency, going from 15 (most inefficient) to 1 (least inefficient), considering that a hotel with better ranking position needs less improvement to reach the efficient frontier, that is, to get 100% efficiency. In addition, Table 9 shows, in the third column, the productive efficiency category of each evaluated hotel: productive inefficiency (PI) or productive efficiency (PE).

Table 9: Efficiency ranking for the evaluated hotels

Hotel	CCR-O Ranking	BCC-O Ranking	Productive efficiency	Hotel	CCR-O Ranking	BCC-O Ranking	Productive efficiency
e_1	3	4	PI	h_1	14	14	PI
e_2	2	1	PI	h_2	10	10	PI
e_3	benchmark		PE	h_3	1	2	PI
e_4	benchmark		PE	h_4	4	6	PI
e_5	benchmark		PE	h_5	11	12	PI
e_6	8	7	PI	h_6	12	11	PI
e_7	6	5	PI	h_7	7	8	PI
e_8	5	3	PI	h_8	9	9	PI
e_9	benchmark		PE	h_9	15	15	PI
e_{10}	benchmark		PE	h_{10}	benchmark		PE
e_{11}	13	13	PI				

As it can be seen from Table 9, for both models, the benchmark lodging establishments e_3, e_4, e_5, e_9, e_{10} and h_{10} are the ones considered totally productive efficient (PE), whereas e_1, e_2, e_6, e_7, e_8, e_{11}, h_1, h_2, h_3, h_4, h_5, h_6, h_7, h_8 and h_9 are considered totally productive inefficient hotels due to a technical origin (PI). According to the computational results of both models, there is no scale inefficiency for the collected data range. The inefficiency of the hotels is related to technical origins, and all efficient hotels present totally productive efficiency.

According to the results showed in Table 9, the hotels located closer to the efficient frontier are e_1, e_2 and h_3. In the opposite, the hotels e_{11}, h_1 and h_9 have the longest distances from the efficient frontier and, therefore, are less efficient than the others. It is worth mentioning that the hotels e_3 and h_{10} are more often defined in the analysis of shadow prices as benchmark hotels.

Finally, it is noted that the lodging establishment h_{10} belongs to a hotel chain. From the perspective of the costumers, its higher efficiency score shows that this hotel offers better quality services when compared to the family business hotels in Campos, being a good example to be followed. Furthermore, despite the fact that e_{11} is a hotel-chain establishment, its lower efficiency score indicates that it cannot be considered as a role model to be followed by any independent hotel in Campos.

5. Conclusions

In this work, a study was conducted with the aim of supporting decision making by managers of smaller establishments in the city of Campos, RJ, pointing out the necessary improvements to be made in their service processes in order to stay competitive on the market. In fact, this study evaluated the efficiency of lodging establishments from the viewpoint of the customers. To this end, the DEA technique was employed with input and output data taken from the websites of lodging establishments in Campos and of those hotel chains with potential to be in Campos in the very near future, due to the vertiginous economic growth of the city.

For the first trial with DEA, the CCR and the BCC models with output orientation were chosen to evaluate the service performances. For each hotel in Campos, the efforts to reach efficiency in terms of accommodation, facilities and services were indicated to help the manager's decision in improving their overall services, or at least to improve the most critical output that is the facility items.

The assessment results confirm that the hotel chains have, in general, a higher efficiency performance than the independent hotels. In particular, in Campos, the sole existing hotel chain has the maximal efficiency, and so it can be considered as role model by the other local hotels. Therefore, the managers of the independent and family business hotels already in Campos should focus their efforts on improving accommodation, facilities and services, in order to remain competitive in the market.

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References

ABIH (2012). Brazilian Association of Hotels. In Hospitality Industry. In Portuguese. Available at: http://www.abih.com.br. Last access in 27/12/2012.

Alexander, WRJ, Haug, AA, Jaforullah, M (2007). A two-stage double-bootstrap data envelopment analysis of efficiency differences of New Zealand secondary schools. Journal of Productivity Analysis, 34, 99-110.

Banker, RD, Charnes, A, Cooper, W (1984). Some models for estimating technical scale inefficiencies in data envelopment analysis. Management Science, 30(9), 1078-1092.

Bertrand, JWM, Fransoo, JC (2002). Modeling and Simulation: Operations Management Research Methodology using Quantitative Modeling. International Journal of Operations and Production Management, 22(2), 241-264.

Brazilian Ministry of Tourism (2009). In Aquarela Plan 2020. In Portuguese. Available at: http://www.turismo.gov.br/export/sites/default/turismo/o_ministerio/publicacoes/downloads_publicacoes/Plano_Aquarela_2020.pdf. Last access in 25/04/2013.

Brazilian Ministry of Tourism (2011a). In Record Revenue for Tourism. In Portuguese. Available at: http://www.dadosefatos.turismo.gov.br/dadosefatos/geral_interna/noticias/detalhe/

20110126_1.html. Last access in 25/04/2013.

Brazilian Ministry of Tourism (2011b). In Statistical Yearbook of Tourism 2011, Vol. 38, Base Year 2010. In Portuguese. Available at: http://www.dadosefatos.turismo.gov.br/export/sites/default/dadosefatos/anuario/downloads_anuario/Anuxrio_Estatxstico_2011_-_Ano_base_2010_-_24-05-2011.pdf. Last access in 20/02/2012.

Charnes, A, Cooper, WW, Rhodes, E (1978). Measuring Efficiency of Decision Making Units. European Journal of Operational Research, 2(6), 429-444.

CIDAC (2011). Center for Information and Data Campos. In Campos: R$ 40,5 million of royalties. In Portuguese. Available at:

http://www.cidac.campos.rj.gov.br/index.php?option=com_content&view=article&id=240:campos-r-405-milhoes-dos-royalties&catid=45:noticia&Itemid=62. Last access in 23/03/2012.

Cooper, WW, Seiford, LM, Tone, K (2006). Introduction to Data Envelopment Analysis and its uses with DEA-Solver software and references, Springer.

Cruz, NACC (2010). Evaluation and classification of lodging facilities: lodging establishments belonging to independent hotels and hotel chains [Graduation Monograph of the Production Engineering Course], Center of Science and Technology of the Universidade Estadual do Norte Fluminense Darcy Ribeiro- UENF. In Portuguese.

Dominici, G, Guzzo, R (2010). Customer Satisfaction in the Hotel Industry: A Case Study from Sicily. International Journal of Marketing Studies, 2(2), 3-12.

Freitas, ALP, Morais, ASC (2009). Assessing lodging establishments via the internet. Banas Qualidade Revista. In Portuguese. Available at: http://www.banasqualidade.com.br/2012/portal/conteudo.asp?codigo=12447&secao=Revista. Last access in 12/2/2012.

Gil, AC (2002). Como Elaborar Projetos de Pesquisa. 4ª Ed., Editora Atlas. In Portuguese.

Hag, M, Skully, M, Pathan, S (2010). Efficiency of Microfinance Institutions: A Data Envelopment Analysis. Asia-Pacific Financial Markets, 17, 63–97.

IBGE (2011). Brazilian Institute of Geography and Statistics. In Coordination of Services and Trade, 2011. In Portuguese. Available at: http://www.ibge.gov.br/home/presidencia/noticias/imprensa/ppts/0000000766540212201254192852 8009.pdf. Last access in 28/03/2012.

Kanesiro, JC (2008). Economic and Financial Performance and Data Envelopment Analysis (DEA): A Study in Lodging Facilities in Brazil. Master in Tourism and Hospitality. Center for Higher Education II. Universidade Vale do Itajaí (Univali). In Portuguese.

López, JA, Quijano, GA, Bernal, JM, López, JM, Gómez, JC (2011). Development of Model for Data Envelopment Analysis with nonparametric Integer Programming for the Analysis of Efficiency and Productivity of Universities Mexican State versus Private. In International Conference on Sociality and Economics Development. IPEDR Vol.10 IACSIT Press, Singapore.

Mafaldo, MN (2005). Administration and Hospitality Management. Institute of Social Sciences Applied in Tourism Course, Feevale. In Portuguese. Available at: https://sites.google.com/site/hotelariabrasil/home3. Last acess in 28/03/2012.

Miguel, PAC (2007). Case Study in Production Engineering: Structuring and Recommendations for driving. Revista Produção, 17 (1), 216-229. In Portuguese.

Mola, F, Jusoh, J (2011). Service Quality in Penang Hotels: A Gap Score Analysis. World Applied Sciences Journal (Special Issue of Tourism & Hospitality), 12, 19-24.

Paschoalino, FF et al. (2012). Análise da Eficiência de Subestações – uma aplicação de DEA em uma empresa do setor de energia da região metropolitana do Estado do Rio de Janeiro, PODES Pesquisa Operacional para o Desenvolvimento, 4(1), 1-12. In Portuguese.

Ramos, REB (2007). Michael J. Farrell and the Measurement of Technical Efficiency. In Annals of XXVII ENEGEP, Foz do Iguaçu, PR, Brazil. In Portuguse.

Available at:http://www.abepro.org.br/biblioteca/ENEGEP2007_TR630471_0508.pdf

Appendix

Tables A1 and A2 show the score of each input and output item of the hotels considered in the efficiency analysis.

Table A1: Score of input and output items of the hotel-chain establishments

Items	e_1	e_2	e_3	e_4	e_5	e_6	e_7	e_8	e_9	e_{10}	e_{11}
1.1	1	1	0.6	0.6	0.4	0.6	0.6	0.6	0.6	1	0.8
1.2	0	0.4	0	1	1	1	1	0	1	1	0
1.3	1	0.6	0	0	0.8	0.8	0.2	1	0.4	0.4	0.8
1.4	0	0	1	1	1	0	1	1	0	0	0
1.5	0	1	1	1	1	0.8	1	1	1	1	1
1.6	1	0.8	0.8	1	0.8	1	0.8	0.6	1	0.8	0
1.7	0	0	1	1	0	0	0.8	0	0	0	0
1.8	1	0.8	0.8	1	0.8	1	0.8	0.6	1	0.8	0
***O1* mean**	0.50	0.58	0.65	0.83	0.73	0.65	0.78	0.60	0.63	0.63	0.33
2.1	1	1	1	1	1	1	0.8	0	1	1	1
2.2	1	1	0.8	1	0.8	1	1	0	1	1	0
2.3	1	1	1	1	1	1	1	1	1	1	0
2.4	0.8	0	0.6	1	1	0.6	0.6	1	0.8	0	0
2.5	1	0	0.2	1	1	0.6	0.6	0	0.8	0	0.6
2.6	1	0	0	1	0	0	0	0	1	1	0
2.7	1	0.2	0	1	0	0	0	0	1	0.8	1
***O2* mean**	0.97	0.46	0.51	1.00	0.69	0.60	0.57	0.29	0.94	0.69	0.37
3.1	0	0	0.8	1	1	1	1	1	0	1	1
3.2	0	1	0	1	0.8	0	1	0.8	1	1	0
3.3	0.4	1	0.6	0	0	0.6	0.8	0	0	1	0.8
3.4	0.8	0.8	0.8	0.8	0.6	0	0	0.6	0.8	0.8	1
***O3* mean**	0.30	0.70	0.55	0.70	0.60	0.40	0.70	0.60	0.45	0.95	0.70
4.1	1	0.4	0.4	1	0.6	1	1	0.4	0.6	0.4	1
4.2	1	0.8	0.8	1	0.6	1	1	0.4	1	0.8	0.8
4.3	1	0.8	0.6	1	0.8	1	1	1	0.8	0.8	1
4.4	0.81	1	0.8	0.8	1	1	1	1	1	1	1
***I1* mean**	0.95	0.75	0.65	0.95	0.75	1.00	1.00	0.70	0.85	0.75	0.95

Table A2: Score of input and output items of lodging establishments in Campos

Items	h_1	h_2	h_3	h_4	h_5	h_6	h_7	h_8	h_9	h_{10}
1.1	0.4	0.6	0.8	0.6	0.6	0.6	0.4	0.6	0.6	1
1.2	0	1	1	0.8	0.8	0	1	1	0	1
1.3	0	0	0.8	0.8	0	0.8	0.8	0.8	0	1
1.4	1	1	1	1	1	1	1	1	0	1
1.5	1	1	1	1	1	1	1	1	1	1
1.6	0.2	0	0.8	0.6	0.6	0.6	0.8	0.6	0.4	1
1.7	0	0	0	1	0	0	0	0	0.6	0
1.8	0.6	0	0.8	0.6	0.6	0.8	1	0.8	0.6	1
***O1* mean**	0.40	0.45	0.78	0.80	0.58	0.60	0.75	0.73	0.40	0.88
2.1	0	0.8	1	0.8	0	0	0	0.8	0.6	1
2.2	0.4	0.6	1	1	0.6	0.6	1	0.6	0.4	0.8
2.3	0	1	1	1	0	0	0	0	0	1
2.4	0	0	1	0	0	0	0	0.6	0	0
2.5	0	0	0.6	0	0	0	0	0	0	1
2.6	0	0	0.8	1	0.6	0	0	0	0	1
2.7	0	0	0	0	0	0	0	0	0	1
***O2* mean**	0.06	0.34	0.77	0.54	0.17	0.09	0.14	0.29	0.14	0.83
3.1	0	0	0	0	0	1	0	0	0	1
3.2	0.4	0	1	0.8	0.8	0.8	1	0.8	0.8	1
3.3	0.4	0.6	0.8	0.8	0.6	0.8	1	0.6	0.6	1
3.4	0.6	0.8	0.8	1	0.8	0	0	0	0	1
***O3* mean**	0.35	0.35	0.65	0.65	0.55	0.65	0.50	0.35	0.35	1.00
4.1	1	0.6	1	0.8	0.6	0.6	1	0.6	1	1
4.2	1	1	1	1	1	1	1	1	1	0.8
4.3	0.4	0.6	1	1	0.8	0.8	0.8	1	1	1
4.4	0.6	0.8	1	1	1	1	0.6	0.8	1	1
***I1* mean**	0.75	0.75	1.00	0.95	0.85	0.85	0.85	0.85	1.00	0.95