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A DEA MODEL FOR MEASURING EFFICIENCY ADAPTED TO THE HOTEL SECTOR

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ABSTRACT

The aim of this paper is propose an improved model based on the technique of Data Envelopment Analysis (DEA) to measure hotel efficiency. For that purpose, an extensive literature review has been carried out, focused mainly on empirical research. As a result, the proposed model incorporates some new operational variables widely accepted within the sector, like the REVPAR indicator, and allows to adapt the efficiency analysis to the current economic conditions and industry circumstances.

KEYWORDS

Hotels, Efficiency, Data Envelopment Analysis, Management Accounting.

ECONLIT KEYS

L830; M190; M410.

1. INTRODUCTION

The current financial crisis is doing more evident the need of a more efficient management at any economic sector in order to the business organization survival (Arnold, 2009).

Efficiency as a concept is closely related to the economy of resources and has been traditionally defined as the ratio of results (outputs) and resources used (inputs). Also, the efficient allocation of resources is one of the traditional objectives of the Economy which includes human behaviour as a relationship between ends and scarce means with alternative uses (Robbins, 1932).

Research on the measurement of efficiency is a classical area in Economics and one of the areas of economic analysis that has undergone further development in recent times due to the increasing competitiveness in all economic sectors, along with progress globalization, has created an economic environment where survival becomes increasingly difficult (Álvarez, 2001; Salazar, 2005).

The measurement of efficiency in the hotel industry is even more important because it is an economic sector whose businesses have a low degree of differentiation. It means that the competition is conducted based on a historically very limited number of factors that have traditionally reduced the price of the services offered or the quality of facilities, in addition to the intrinsic location (Campa, 2004).

Moreover, the factors that have usually been related to the efficiency in the hotel sector are no longer determinant due to the financial crisis the classical factors over which it has traditionally pursued efficiency in the hotel sector have been devalued in recent times due to the outbreak of the crisis that took place in 2007 and the consequent difficulty of access to economic and financial resources. This fact is affecting to all sectors of the global economy (Turespaña, 2009).

Specifically, this crisis has caused in the hotel sector a real price war. It has led the continuing decline in the rate of hotel prices in Spain since November 2008, representing two years of consecutive declines, reaching a sectorial deflation levels of about 8% during the first quarter of 2009 (INE, 2009). These facts have made worse the difficult situation facing by this sector.

Against this situation, there is a need to improve the efficiency hotel as the only way to address the current situation of falling output in the sector, so as to optimize the costs to try to balance the operating results so that you can achieve business

survival in the medium and long term. To measure and evaluate this efficiency have been developed many models for the hotel sector (Anderson *et al.*, 2000), which should be uniform so that they can carry out relevant comparisons in an objective and eventually help to identify which key factors could help to achieve such efficiency.

In this research we focus on the study of different efficiency factors (information systems, revenue management, the method used for wholesale pricing, customer profitability analysis, breakeven analysis, etc.) that are linked to information management, as they are the most important in the hotel sector in the current situation of economic crisis (WTO, 2009). Once justified the importance of improving efficiency in the hotel sector, seeks to put forth an original model that allows measurement of the efficiency in a sample of establishments to reveal later what are the aspects to be improved to increase this efficiency.

To do that, we chose the Data Envelopment Analysis (DEA) by adopting the model of Charnes *et al.* (1981) which satisfies the properties of constant returns to scale, free disposal of inputs and outputs in the strict sense and convexity. Thus, part of the production possibilities set all observed production processes, all arising from rescaling the above and all those who use more inputs with the same output, or obtain less output with the same inputs that the latter, or both at once.

The units of analysis in the DEA are called decision making units (DMU onwards) and our work, each hotel of analyzing its input and outputs represents a single DMU.

Taking into account all the above mentioned, the aim of this paper is to propose an improved model for measuring the efficiency at the hotel industry, this could reveal what factors are those that can open the road for hotel business in the current crisis context, and it uses the DEA as a proven technique that provides better results in the multivariate analysis (Charnes *et al.*, 1978).

An extensive literature review has been carried out to analyze those previous works related to business efficiency, with special attention and detail in those that focused on the hotel industry. Within these we have focused our analysis on those models used to measure the efficiency and more specifically the DEA.

To carry out this literature review of the papers published to date were used to query the database (SCOPUS, Google Scholar, others University of Seville on-line databases), which were gradually introduced different searches to limit our field of work publications directly related to the object of study, beginning with "efficiency"

combined with "hotels" (provided in both Spanish and English) and limiting the search to the last 17 years. Also filters were used to detect all papers found, which had used DEA as a technique for modeling measurement.

Once detected and analyzed all published papers as the criteria for our investigation proceed to the next phase consisting in setting out an improved model for measuring efficiency based on DEA, which is required to use a series of tools that allow us know their profitability (performance) compared to the rest of the industry and thus allow for comparisons based on benchmarking as a technique for studying and improving quality, seeking the best practice benchmark for the sector.

Consequently, the paper is structured as follows: Firstly, we analyzed the historical evolution of the hotel sector in Spain. Then in the third section we set out the basic approach to the efficiency and the DEA. In the fourth section are summarized the results of previous studies that posed models of efficiency for the hotel sector. In the fifth section outlines the proposed model and, finally, we present the concluding remarks and references.

2. THE HOTEL SECTOR IN SPAIN

From a macroeconomic perspective, the efficiency in the Spanish hotel sector is a key issue giving its importance in the economy. In fact, since the sixties, tourism has been established in Spain as a one of the major means of prosperity generation and one of the key industries, especially, considering factors such as the ability to generate employment, the resulting auxiliary industry, the alternative is for declining sectors such as agriculture and low environmental impact (in most cases) compared with other sectors. All this contributes to the consideration of strategic industry for tourism within the national economy (Campa, 2004; Cayon, 2007; Turespaña, 2009).

The tourism industry in Spain has been evolving and adapting to the rapid changes that have occurred in recent decades, particularly in relation to the following factors (Biosca, 2001): demographic and social primarily those related to changes in the composition of households (single-parent families with multi-income, geographic dispersion of its members,...), with changes in customs and practices (reduced holiday periods, healthy living and sport, new religions, approach to the oriental culture, etc.) and emergence of new technologies, mostly related to communication such as mobile phones and the Internet.

These changes have resulted in many cases the emergence of new business alternatives, which have been observed related to the revolution experienced in the systems of on-line or hotel establishments specializing in new forms of tourism such as rural or adventure tourism, or in other cases simply the adaptation of existing and new alternatives such as the spas with medical tourism.

However, it is quite ironic that this revolution in the structure and business innovation (Freeman, 2009), has not been matched also with substantial changes in management. Thus, we have seen in some hotels that offer wireless Internet service in rooms, but at the reception, however, have to use pen and paper to calculate a currency exchange. In the same vein, Nightdress (1996) and showed a high level of utilization of information technology (hereafter IT) in the front office applications, but weak in managing resources and costs. It also highlights that companies consider IT as a burden rather than as an asset that can gain competitive advantage. A similar conclusion was reached by Buhalis and Main (1998) in Wales, France and Greece hotels, finding that the managers of the hotels trying to introduce IT to facilitate the operational or strategic, but their lack of these tools often leads them to select, install and operate systems that generally do not react to their needs.

The Spanish hotel industry is a clear example of this phenomenon within the tourism sector. One of the main reasons could be that the majority of them have a family ownership structure as well as the small average size of establishments in Spain (Campa, 2004; Giráldez *et al.*, 2004) is common to find establishments will continue to manage the traditional way, ignoring the opportunities for improvement that would result in an increase of efficiency. This approach of maintaining traditional techniques in the management of hotel business has been maintained over time probably because they have been getting good financial results, although perhaps more usually caused by exogenous reasons for the appropriateness of the techniques used (Bayón *et al.*, 1999).

In this way, the Spanish hotels were profitable during the tourist boom of the 60's by a supply shortage and the difference in the price level of our country with respect to the sending countries, mainly European such as France, Britain and Germany. Later, during the 70's and 80's hotel business continued to be benefiting from this circumstance commented on the difference in the level of prices, which joined the impact of monetary policies that devalued the Spanish currency (peseta) by the effect on the perception of lower prices from abroad were multiplying. In the 90's and

thanks to the political and social instability that was experienced in most host countries competing in our environment (mainly the Balkan War in the Adriatic and the Gulf War in Arab countries), again hotel industry benefited from external circumstances that gave rise to a higher occupancy rates and profitability. Finally, institutional support to the sector for the renovation of the hotel facilities attached to the housing boom made the hotel investments they had high rates of return for the beginning of the century and until the start of the crisis in 2007 (Campos, 2008) that disappears when any external competitive advantage that differentiates to hotels Spanish of their environment, therefore face the challenge of survival.

As a result the only way of obtaining return on investment is the operating hotel business hotel itself, although the latter is also much more difficult today because the crisis has also caused a sharp drop in demand for hotel beds (INE, 2009) which, in turn, has led to a much greater competition level among hotels.

Given this increased competition, most establishments have opted to reduce their prices (hotel Situation Report, 2009) to attract customers and keep sales figures, to produce even a general deflationary since November 2008 that still exists on today and that was in the second half of 2009 was repeated falls observe the annual rate of hotel price index close to 7% (INE, 2009).

When prices have fallen, one could sense the danger that the profits decrease significantly, unless there is a cost rationalization so as to get that they adapt to the decreasing rate of income or what the same, thanks to increased efficiency can be maintained rates of return. Thus, the efficiency goes to a close in hotel management as their principal means of subsistence in the medium and long term due to its vulnerability (Turespaña, 2008).

Consequently, the evaluation of the efficiency that has always been of great importance in business, going to acquire even a more relevant significance today due to lack of resources caused by the current crisis that initially had a financial situation, but has subsequently resulted in an economic crisis and drastic consequences whose effects are still getting noticed in our day, particularly in the hospitality industry, and is also one of the sectors hardest hit by the recent crisis (WTO, 2008).

3. DEA AND EFFICIENCY

The efficient allocation of resources is one of the traditional objectives of economics that considers human behavior as the relationship between ends and scarce means with alternative uses (Robbins, 1932).

As companies often produce multiple outputs from multiple inputs, the efficiency will be in any case a multidimensional scale. Thus, the question is how to measure efficiency. This is done through the comparison of these companies based on their performance in relation to level of outputs achieved in terms of volume of inputs used, so that classifications can be established according to the values obtained from this comparison.

The efficiency, therefore, is a relative concept, as arises from comparing similar companies according to their behavior. Thus, a producer is technically inefficient if it uses more factors than the other to produce the same product or using the same resources it obtains a lower production. Thus, the measure of efficiency is based on the distance of individual decision units analyzed for frontier function and it is estimated from the best practices in all the units tested (Rubio, 2007).

The different types of efficiency were defined by Farrell (1957) who pointed out in his seminal work its importance in the study of business management and how using multiple outputs / inputs could reach a "satisfactory measure of productive efficiency" which would take into account all the inputs (resources used), also showing as it could be calculated.

Farrell contribution has been widely studied from the work of business efficiency, although in the case of the hotel sector have noted that there are many works in this regard. Therefore we intend to introduce a measure in economic terms what is known of performance (Rubio, 2007) for hotel companies to determine to what extent is carried out a proper distribution of the means employed in relation to the results, which is especially relevant today to the general lack of resources that reaches even to the consideration of environmental aspects in the calculation of business costs (Casanueva *et al.*, 2000).

The importance of management in the hotel business success is evident in several works, among which that of Mattimoe (2000) which states that the basic factors are distributed on different groups, among which individual factors of each hotel, either functional (organizational structure and management, to the extent that

facilitates or not the flow of information) or financial (cost structure, business diversification, financial leverage, operational flexibility ...) or factors related to information management (information systems, revenue management, the method used for pricing, selling, customer profitability analysis, breakeven analysis, etc.).

We should employ a method to measure efficiency once defined it and the factors that give rise. To choose this method among the various possibilities, it should meet the following classification of existing approaches regarding assessment systems efficiency through various indicators and models (Cayón, 2007):

- Indicators of economic performance. Profitability ratios and contribution margin are used mainly.

- Indicators of average cost. The average cost is, in principle, the most logical indicator to assess the competitiveness of an enterprise, while is a good indicator of production efficiency with which a particular company operates, especially if the average cost is calculated at constant prices, i.e. taking into account the effect of inflation so that the values obtained are not distorted.

- Indicators of productivity. Technically, they are closest to the economic concept of efficiency. Different options can be distinguished (Prior *et al.*, 1993):

A) Basic options:

- The rate of total factor productivity or overall rate of productivity.
- The partial productivity indices, primarily of labor.
- Econometric approaches that use a production function or cost-benefit, and also allow to measure the efficiency decomposed or explain efficiency differences depending on some factors.

B) Options using a stochastic production frontier:

- Parametric models. Consider the boundary as a parametric function of inputs and start from a particular form of function (Cobb-Douglas, CES, SFA, etc.).
- Non-parametric models. Not impose any pre-defined way to the function. Like, for example, DEA.

Among all this models and indicators highlighted the DEA presents several advantages that have become, in a relatively short time, a widely used technique. Charnes *et al.* (1994) highlighted important features of the DEA as the following three:

1. To characterize each of the units through a single efficiency score.
2. By projecting each inefficient unit efficient bound on highlighting areas of improvement for each of the units.
3. The DEA does not need an alternative and indirect approach and specify statistical models and make inferences based on the analysis of residues and coefficients of parameters.

Besides the three characteristics listed above, Charnes *et al.* (1994) provide other peculiarities of the DEA as, for example, the ability to adjust to exogenous variables and incorporate categorical variables.

Another aspect to take into account the DEA is its ability to support multiple inputs and outputs (Restzlaff-Roberts and Morey, 1993) expressed in different units of measurement (Charnes *et al.*, 1994). Likewise, the DEA is a nonparametric technique and therefore does not assume any functional form of the relationship between inputs and outputs, nor does distribution of inefficiency (Banker *et al.*, 1993).

Frontier efficiency techniques, therefore, seen as the most commonly used to measure performance on a comparable, since they have the advantage of concentrating this performance into a single composite measure obviate the differences between different companies thanks to a series of complex multidimensional tools that has its roots in economic theory (Rubio, 2007).

Therefore, DEA is precisely the most commonly chosen method for measuring the efficiency of hotel management (Rubio and Roman, 2007; Morey and Dittman, 1995; Johns *et al.*, 1997; Avkir, 1999; Hwang and Chang, 2003) because it possibilities the definition of a model that is able to provide a range of production frontiers posed normal efficiency levels and will serve to classify a number of companies choosing a sample based on the score achieved respect to the said border.

4. DEA LITERATURE REVIEW FOR THE HOTEL SECTOR

Before defining output-input variables used in the model that we propose, we have analyzed those used by the authors in the literature review. In this selection we have identified the author, the year of publication, place and input-output variables considered by them, summarizing all this information in Table 1. Analysis of the information contained in the table can draw the following conclusions:

Table 1: Literature review of the most frequent inputs and outputs variables

AUTHOR	UNITS	INPUTS	OUTPUTS
George Assaf (2012) (In press)	192 hotels in 12 Asia Pacific countries (2007-2009)	<ul style="list-style-type: none"> · Revenues · Number of FTE · Number of rooms · Other operational costs 	<ul style="list-style-type: none"> · Average daily room · Food and beverage revenue · Other revenue
Wu <i>et al.</i> (2011)	23 four and five-plum international tourist hotels (ITHs) in Taipei (2006)	<ul style="list-style-type: none"> · Total number of employees · Total number of guest rooms · Total area of F&B · Total operating cost 	<ul style="list-style-type: none"> · Room revenue · Food and beverage revenue · Other revenue
Shuai <i>et al.</i> (2011)	48 international tourist hotels (ITHs) in Taiwan (2006 y 2007)	<ul style="list-style-type: none"> · Total number of guest rooms · Number of full-time employees · Operating expenses 	<ul style="list-style-type: none"> · Room revenue · Food and beverage revenue
Cheng <i>et al.</i> (2010)	in Taiwan (1997-2006)	<ul style="list-style-type: none"> · Total number of guest rooms · Number of employees · Total area of catering department · Total operating expenses · Catering expenses 	<ul style="list-style-type: none"> · Total operating revenues · Average occupancy rate · Average room rate · Average production value per employee
Hsieh <i>et al.</i> (2010)	57 international tourist class hotels Taiwan (2006)	<ul style="list-style-type: none"> · Accommodations costs · Employees of the accommodations department · Catering costs · Employees of the catering department 	<ul style="list-style-type: none"> · Rooms · Catering floors
Pulina <i>et al.</i> (2010)	150 hotels in Sardinia Island (2002-2005)	<ul style="list-style-type: none"> · Labour cost 	<ul style="list-style-type: none"> · Sales revenue · Value added
Yu <i>et al.</i> (2009)	in Taiwan (2004)	<ul style="list-style-type: none"> · Room Labor · Food and Beverage Labor · Rooms · Food and Beverage area · Expense 	<ul style="list-style-type: none"> · Room revenues · Food and beverage revenue · Other revenue

Source: Own elaboration.

- Most of the works have been carried out before the outbreak of the global crisis of 2007.
- There are very few published papers on Spanish hotels (Rubio and Roman, 2007, Riera *et al.*, 2007), which also relate to previous data to the global crisis of 2007.
- Most of them consider variables related to the staffing inputs that are difficult to obtain reliable data bases, having to resort to rely on the fact that the DMU provide, with the risk with respect to accuracy of the information. Thus, the work of Barros and

Alves (2004), Wang *et al.* (2006), Avkir (2002), Anderson *et al.* (2000), Shang *et al.* (2008), Chiang *et al.* (2004) and Barros (2005), using data on number of employees.

Table 1: Literature review of the most frequent inputs and outputs variables (Cont.)

AUTHOR	UNITS	INPUTS	OUTPUTS
Perrigot <i>et al.</i> (2008)	24 international tourist class hotels in Taipei (2005)	<ul style="list-style-type: none"> · Age of the hotel chain in years · Number of rooms in the chain · Number of hotel openings during the year · Royalties in percentage · Quality: chain ranking 	<ul style="list-style-type: none"> · Room revenues: Occupancy rate in percentage · Other revenues: Total sales in millions of euros
Shang <i>et al.</i> (2008)	in Taiwan (2005)	<ul style="list-style-type: none"> · Number of full-time employees · Number of guest rooms in a hotel · Operating expenses · Food and beverage (F&B) capacity (total floor area utilized by all such outlets in a hotel) 	<ul style="list-style-type: none"> · Room revenue · Food and beverage revenue · Miscellaneous revenue
Riera <i>et al.</i> (2007)	50 three and four stars hotels in Balearic Islands (2004)	<ul style="list-style-type: none"> · Labor Expenses · Operating expenses diferent to labor · Number of beds · Number of operating months 	<ul style="list-style-type: none"> · Total operating revenue per room of the establishment compared to total operating revenue per room on the industry ratio · Number of room sold · Operating non-room revenue
Rubio & Román (2007)	385 hotels in Andalusia (2002-2004) 2609 hotels in Spain	<ul style="list-style-type: none"> · Cost of Good Sold · Labor Expenses · Depretiation · Otros gastos 	<ul style="list-style-type: none"> · Total income
Wang <i>et al.</i> (2006)	49 international hotels Taiwan (2001)	<ul style="list-style-type: none"> · Number of full-time employees in room departments · Number of rooms · Total floor area of food and beverage departments · Number of full-time employees in food and beverage departments 	<ul style="list-style-type: none"> · Revenue from food & beverage departments · Revenue from room departments · Other revenue
Barros (2005)	42 state-owned hotels Portugal (1999-2001)	<ul style="list-style-type: none"> · Number of full-time employees · Cost of labor · Number of rooms · Area (square metres) · Book value of property · Operating Costs · External expenses 	<ul style="list-style-type: none"> · Sales · Number of guest rooms · Nights spend in the hotel
Sigala <i>et al.</i> (2005)	93 three stars hotels United Kingdom	<ul style="list-style-type: none"> · Rooms · Front office payroll · Administration material and other expenses · Other rooms' division payroll · Other rooms' division material and other expenses · Total demand variability 	<ul style="list-style-type: none"> · Average Room Rate (ARR) · Number of room nights sold · Non room nights revenue
Chiang <i>et al.</i> (2004)	25 four and five stars hotels Taiwan (2000)	<ul style="list-style-type: none"> · Food and beverage (F&B) capacity · Hotel rooms · Total cost of the hotel · Number of employees 	<ul style="list-style-type: none"> · RevPar individual hotel / Market RevPar · Food and beverage revenues · Miscellaneous revenues

Source: Own elaboration.

• In most of these papers the output variables used as production data and statistical indicators are difficult to obtain hotel and no possibility of contrast such as the level of service (Morey and Dittman 1995, Brown and Ragsdale 2002) or service revenues (Johns *et al.*, 1997, Hwang and Chang, 2003, Chiang *et al.*, 2004, Sigala *et al.*, 2005, Wang *et al.*, 2006, Riera *et al.*, 2007 and Shang *et al.*, 2008).

- Further works are however limited to considering only financial variables, without taking into account properly the nature of hotels, as with those of Rubio and Roman (2007).

Table 1: Literature review of the most frequent inputs and outputs variables (Cont.)

AUTHOR	UNITS	INPUTS	OUTPUTS
Barros & Alves (2004)	42 state-owned hotels Portugal (1999-2001)	<ul style="list-style-type: none"> · Number of full-time employees · Cost of labor · Number of rooms · Area (square metres) · Book value of property · Operating Costs · External expenses 	<ul style="list-style-type: none"> · Sales · Number of guest rooms · Nights spend in the hotel
Hwang & Chang (2003)	45 four and five stars hotels in Taiwan (1994-1998)	<ul style="list-style-type: none"> · Food and beverage (F&B) capacity (total floor area utilized by all such outlets in a hotel) · Number of guest rooms in a hotel · Operating expenses · Number of full-time employees 	<ul style="list-style-type: none"> · Room revenue · Food and beverage revenue · Miscellaneous revenue
Brown & Ragsdale (2002)	46 hotels from Consumer Reports. U.S.A. (1999-2000)	<ul style="list-style-type: none"> · Typical price · Problems (extent to which respondents repoted having complaints during their visits) · Service (hotel clerks' efficiency at checkin and checkout) · Upkeep (condition and cleanliness of room, grounds and public spaces) · Number of hotels properties in the U.S.A. · Number of guest rooms in the U.S.A. 	<ul style="list-style-type: none"> · Guest satisfaction on a 100-point scale · Chain's overall value on a 5-point scale
Avkiran (2002)	23 hotels Queensland (Australia) (1997)	<ul style="list-style-type: none"> · Full-time staff · Part-time staff · Bed capacity 	<ul style="list-style-type: none"> · Revenue · Room rate
Anderson <i>et al.</i> (2000)	48 hotels U.S.A. (1994)	<ul style="list-style-type: none"> · Full-time equivalent employees · Number of rooms · Total gaming related expenses · total food and beverage expenses · Other expenses 	<ul style="list-style-type: none"> · Total revenue
Johns <i>et al.</i> (1997)	15 hotels over a 12-month period United Kingdom (1992)	<ul style="list-style-type: none"> · number of room nights available · total labour hours · total food and beverage costs · total utilities cost 	<ul style="list-style-type: none"> · number of room nights sold · total covers served · total beverage revenue
Morey & Dittman (1995)	54 hotels	<ul style="list-style-type: none"> · Room-division expenditures · Energy cost · P.O.& M.-division expenses · Advertising and promotion-division expenses · Administration and general-division expenses · Gastos no salariales por propaganda · Gastos fijos de mercado 	<ul style="list-style-type: none"> · Total room revenue · Average level of guest satisfaction

Source: Own elaboration.

- No one of them is considered as an indicator variable output on the liquidity situation of the business case instead of a strategic variable in our day. We consider this last point as a constraint in an ongoing study of efficiency.

Taking into account all the above mentioned questions, we propose a number of variables to avoid as far as possible what we understand can mean either not testable results or not considered significant factors for the hotel business at the present time.

5. IMPROVED DEA MODEL ADAPTED TO TE HOTEL SECTOR

As a result of all the above mentioned, the proposed DEA model is completely determined. Thus, in Figure 1 below shows the functional diagram of the model with the variables discussed.

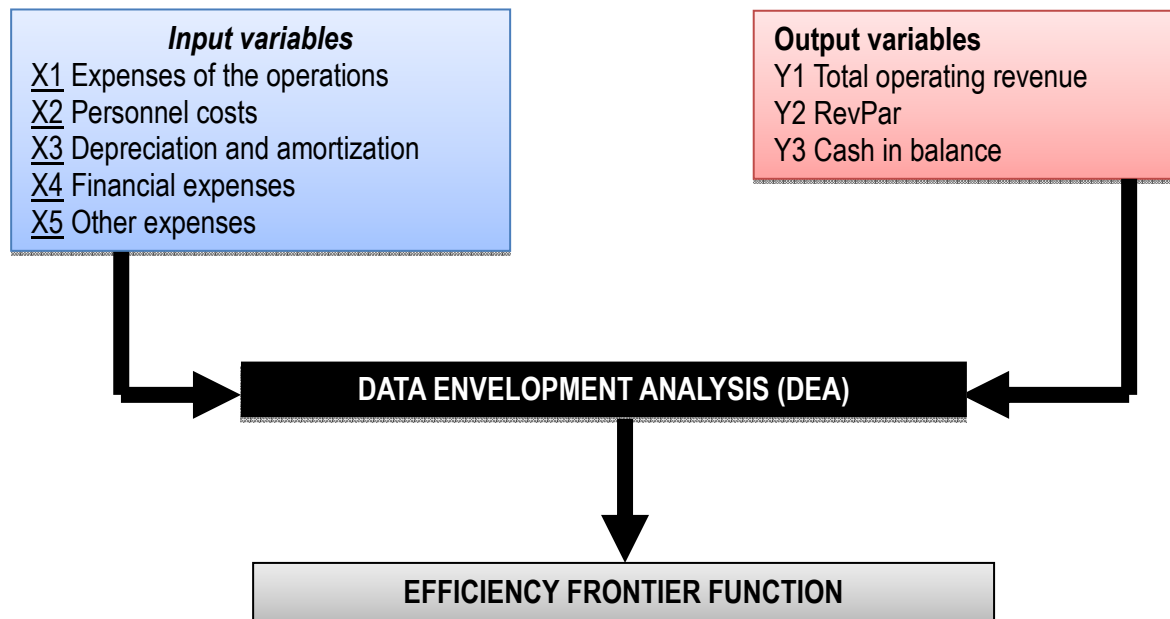


Figure 1: Outline of the proposed model.

Source: Own elaboration.

The selection of the most representative variables of the production process developed by the DMU -hotels- could be done by estimating the efficient production frontier using data for a representative sample of establishments whose size depends on the total size of the population sampled, and the number of input and output variables to consider.

However, we must emphasize that the selection of variables takes a leading role in the development of research and constitutes, given the deterministic and non-parametric DEA, a fundamental decision that greatly affects the results derived from the model, is not possible to statistically validate the robustness of these (Pedrajana and Salinas, 2004).

In this sense, we begin by defining the way we use the DEA technique to get it and then continue by defining the variables used in the proposed model, justifying the use of each.

As can be seen in the table shown in Table 1 to the measurement of inputs, it is customary to consider data on the productive capacity of the facilities, such as the number of rooms, number of employees or the area under to restore (Wang *et al.*, 2006; Shang *et al.*, 2008, Chiang *et al.*, 2004). This option is recommended, since the objective is to estimate the productive efficiency of firms and this is a fundamentally technical question. However, in many cases to obtain data on the production capacity is not simple, since they are not data to be published individually, but only aggregates. This difficulty in obtaining the information is common to most cases of application of DEA and particularly in the hospitality industry (Sigala *et al.*, 2005). However, this fact should not be an excuse to stop using this variable, but quite the opposite, so you have to find those variables that are related to the productive capacity that are readily available and having the lowest degree of subjectivity possible, supplementing them with financial variables that are contained in the Annual Statements, whose objectivity is beyond doubt to be easily testable.

Given the above, we define five input variables:

- Expenses of the operations, to capture the effect of resource input consumables, as in the case of raw materials in the restoration of the hotel area (X1).
- Personnel costs to reflect the effect of labor. Therefore, it will include all concepts, for example, wages and salaries, Social Security contributions by the company, compensation and other social costs (X2).
- Depreciation and amortization in order to capture the effect of physical capital factor, through the depreciation of property, plant for its use, the simple passage of time or obsolescence (X3).
- Financial expenses, in order to capture the effect of foreign capital through the cost of it caused by the interest earned on funds invested outside (x4).
- Other expenses, to capture the effect of other factors of production such as energy supplies, professional services, insurance, taxes, etc. (X5).

To carry out the selection of input variables we considered the quality of data to achieve as a fundamental criterion. Therefore, all the variables mentioned their common feature the ease of obtaining them through databases of financial statements in the market, as is the case SABI (Iberian Annual Statement Analysis Database) used also in such works as those of Rubio and Roman (2007). Thus, using this information there is no doubt about their reliability because they come from the accounting records issued and deposited in relevant public records, for

companies to examine. It could therefore be said that the selected input variables are similar to those used in previous works like Rubio and Roman (2007), with the novelty of the introduction of a pioneer of the corresponding financial costs, with the intention of obtain an estimate of the efficiency of external financial resources, something we consider very important, especially at the present time, due to lack of financial resources caused by the crisis.

Regarding to the outputs variables during the analysis of the work detailed in the Table 1, we have observed that in most cases, is considered as output of hotel revenue generated from, basically, overnight stays and food and beverage services provided (Anderson *et al.*, 2000). Therefore, we consider the total operating revenue of the hotel business as the first variable output.

Moreover, we consider necessary to balance the amount of income so that we can take into account the effect of prices and employment. To this end, the best index commonly used in the sector is known as REVPAR (Revenue per available room) calculated by dividing the total income earned by the number of hotel rooms available during the opening period. In this way, come together in a single variable the effect of employment and average selling prices. Of all the studies analyzed, only Chiang *et al.* (2004) considered this factor, but did not use concrete in their absolute values, but compared to the industry average. In this case, the ease of access to specific data will not be as high as the REVPAR not usually issued by the hotels. However, their components, i.e., the magnitudes through calculated, yes they are available, as well as in the case of income, accessing databases, as well as the number of available rooms, accessing the public records of the Tourism Administration, so we consider it feasible to use.

Finally, consider a variable that serves to measure the liquidity situation of the establishment because as mentioned above, at present the capacity to generate financial resources has become a matter of first order because the international financial crisis we are facing has caused has been greatly restricted access to this type of resource. To access this third variable, consult the SABI database for each facility and take balances for balance sheet items most liquid asset, so we must consider the amounts set out in Chapters III, IV and VI that under "Investments in Group companies and associated short term", "short-term financial investments" and "Cash and cash equivalents, respectively, all items with a high degree of liquidity.

6. CONCLUSIONS

In this paper we have proposed an improved DEA model in order to measure the efficiency in the hotel sector. That could allow us to easily carry out a comparison analysis of the efficiency factors involved in the hotels management.

It should be noted that the proposed model, unlike previous models in which the DEA technique was applied to the hotel sector, has included specifically the financial component, because of the importance that has taken the issue of financing for the hotels following the international financial crisis that began in mid 2007 and that is affecting all economic sectors, especially, the hotel sector.

Furthermore, also due to the lack of research works in this area in Spain, this may constitute a contribution that will enrich the knowledge on efficiency in general terms for the hotel sector.

Logically, the proposed model is based just the on the literature review but we will test the model in a small sample of hotels that will grow in light of the results being obtained in a short future research.

In this sense, our aim was to find some applicable evidence in order to improve our knowledge on hotel efficiency measurement and provide some applicable results.

We also wanted to combine this model with other techniques to achieve progress in certain areas of interest, such as temporal analysis through Malmquist indexes that allow us to obtain a long-term perspective compare different hotels in the sample.

Finally, the comparisons will be carried out by geographical area, type of establishments, size and / or any other factor that achieves or not at optimal levels of efficiency.

As a final remark, we believe that it would be valuable to conduct further research studies focusing on the specific input and output variables taking into account in the model, in order to improve our understanding of the subject. For that purpose, we consider that case study could be an appropriate method given the multidisciplinary character of the various topics of study, the advantages resulting from its holistic character, and the techniques required to obtain evidence.

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