Sultan Qaboos University
Journal of Arts & Social Sciences

جامعة السلطان قابوس
مجلة الآداب والعلوم الاجتماعية

# Benchmarking the hotel industry in Oman through a three-stage DEA-based procedure

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Date received: 02/07/2016
Date of acceptance: 03/11/2016

# Benchmarking the hotel industry in Oman through a three-stage DEA-based procedure

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Abstract:
This study is concerned with benchmarking the hotel industry in the Sultanate of Oman besides identifying the environmental factors that influence the operational efficiency of hotels. The benchmarking analysis is carried out through data envelopment analysis (DEA), used essentially to evaluate the efficiency ratios of a selected sample of 58 hotels. Although less than 23% of the hotels are found efficient, the average efficiency score of 83% indicates a reasonable efficiency in resource management for most of the hotels. Regarding the contextual effects, hotel Size, Star rating and cultural attractions are found to have the most significant effect on hotel efficiency in Oman. The positive effect of cultural attractions can inform policy makers on the necessity to preserve and promote cultural heritage as an important key factor of attraction.

Keywords: Hospitality management, Performance, Data Envelopment Analysis (DEA), Integrated stochastic model; Oman.

# تحديد المرجعية لقطاع الفندقة في سلطنة عمان من خلال تقنية من ثلاث مراحل قائمة على تحليل مغلف البيانات

عمَار أوكيل وأسماء الزَيدي

الملخص:
الهدف من هذه الدراسة هو تقييم قطاع الفنادق في سلطنة عمان و تحديد العوامل البيئية التي تؤثر على الكفاءة التشغيلية لهذه الفنادق. تمّ قياس الكفاءة على عينة من ٥٨ فندق باستعمال تقنية تحليل مغلف البيانات (Data Envelopment Analysis). أظهرت النتاج أن نسبة الفنادق التي تتمتع بالكفاءة التامة أقل من ٢٣٪ . وجدنا كذلك أن معدل الكفاءة النسبية ٨٣٪، و هذا مؤشر كاف على أن مستوى كفاءة القطاع الفندقي مقبول نسبيا من حيث إدارة الموارد. من جانب آخر، بينت الدراسة أن حجم الفندق (عدد الغرف)، عدد النجوم و كذا المرافق الثقافية المحيطة بالفندق تمثل أهم العوامل البيئية المؤثرة على الكفاءة الفندقية في سلطنة عمان. التأثير الإيجابي للمرافق الثقافية يمكن أن يعزز القرارات المؤسساتية المتعلقة بمضاعفة الجهود لصيانة التراث الثقافي وتعزيز مرافقه.

الكلمات المفتاحية: إدارة الضيافة، الكفاءة، تحليل مغلف البيانات، نموذج عشوائي متكامل، عمان.

## Introduction:

Nowadays, tourism has become a key source for foreign incomes, driving the whole industry into fierce worldwide competition, especially the lodging sector (Chin *et al*., 2013). Hotels must compete globally to attract customers whilst obligated to achieve high profits (Tarim *et al*., 2000), because a hotel that is less efficient than its competitors can barely survive on the market (Barros *et al*., 2011). Achieving efficiency requires the identification of resources that can be cut while keeping returns unchanged. As a result, hotel rooms can be sold at lower prices, enhancing "price" as a key competitive priority. Viewed from this perspective, efficiency analysis becomes essential to developing a meaningful set of benchmarks that dictate best practices and form a successful hotel business model (Min *et al*., 2009a).

The measurement of efficiency in the hotel industry was a focus of attention of several studies up to late 1990s, but it has gained renewed attention over the last decade, due probably to the development of new empirical techniques (Barros, 2005a). Early studies on hotel's efficiency employed performance indicators, such as yield management (Donaghy *et al*., 1995; Kimes 1989), aggregate indices (Wassenaar and Stafford, 1991) and breakeven analysis (Wijeysinghe, 1993). Yet, these approaches remain partial indicators, often inadequate for an accurate analysis of potential efficiency gains (Anderson *et al*., 2000; Barros *et al*., 2009). The main downsides of such analyses dwells in their inability to adequately estimate overall performance measures, identify benchmarking policies, and analyze the effects of economies of scale (Wu *et al*., 2007). To remedy these deficiencies, frontier efficiency methods are introduced, namely, the stochastic frontier (Greene, 2008) and data envelopment analysis (Cooper *et al*., 2002). The stochastic frontier analysis (SFA) requires the output of the decision making units (DMUs) to be expressed through an explicit functional form in terms of a set of inputs, an inefficiency factor, and a random error with a distribution assumed a priori (Coelli *et al*., 2005). In the hotel industry, some leading studies that use SFA include Anderson *et al*. (1999), Barros (2004), Barros (2006), Chen (2007), and Hu *et al*. (2010). Unlike the SFA, data envelopment analysis (DEA) is a non-parametric approach that does not impose functional forms on the data, nor does it need to use probability distributions (Barros *et al*., 2011). Furthermore, DEA has the potentials to evaluate the efficiency of DMUs that employ multiple inputs (resources) to produce multiple outputs (products and/or services).

According to Wöber (2007), efficient frontier methods have been widely used in the past, but *"it has been just recently that tourism researchers have discovered DEA for examining efficiency in their industry"*. Indeed, banking, healthcare, agriculture, transportation, and education are the most popular application areas of DEA. Liu *et al.* (2013) point out that these areas make up 41% of all DEA application papers while the share of tourism is estimated to only 1.34%. Wöber (2002) confirms that Hruschka (1986) and Banker and Morey (1986a) were the first to apply DEA to hospitality industry, more specifically, to restaurants. Later, Bell and Morey (1994, 1995) used DEA to determine the best practices in corporate travel agencies.

The application of DEA to the hotel industry is pioneered by Morey and Dittman (1995). Over 63% of the publications we surveyed cover destinations in the Asian Pacific region (Keh *et al*., 2006; Assaf, 2012). Around 50% of the papers deal only with cases in Taiwan (e.g., Huang *et al*., 2014; Assaf *et al*., 2010; Chen, 2009, 2011; Chin *et al*., 2013; Chiu and Huang, 2011; Hsieh *et al*., 2010; Lin *et al*., 2012; Shang *et al*., 2008; Shyu and Hung, 2012; and Wang *et al*., 2006). China follows with the work of Zhou *et al*. (2008), Tsai (2009), Zhang and Ma (2011), and Huang *et al*. (2012). Cases in South-Korea are discussed by Hokey *et al*. (2008), Min *et al*. (2009a, 2009b). There is only one case addressed in other countries, like Australia (Avkiran, 2002), India (Sanjeev, 2007), Japan (Honma and Hu, 2012), Singapore (Ashrafi *et al*., 2013), and Malaysia (Rahmati & Jalil, 2014). Studies related to the industry in the United States include Morey and Dittman (1995, 2003), Anderson *et al.* (2000), Brown and Ragsdale (2002), and Hu and Cai (2004). In Europe, Portugal has the highest share (e.g., Barros and Alves, 2004; Barros, 2005a, 2005b; Barros and Mascarenhas, 2005; Barros and Santos, 2006; Barros *et al.*, 2009, 2011; Oliveira *et al*., 2013), preceding the United Kingdom (e.g., Johns *et al*., 1997; Sigala, 2004; Sigala *et al*., 2004; Sigala *et al*., 2005), France (e.g., Botti *et al*., 2009; Perrigot *et al*., 2009), Italy (e.g., Pulina *et al*., 2010; Tundis *et al*., 2012), Greece (Manasakis *et al*., 2013), Spain (Fernández and Becerra, 2013), and Slovenia (Assaf and Cvelbar, 2010). In Africa, performance analyses employing DEA are found for Angola (Barros and Dieke, 2008), Tanzania (Sharma and Sneed, 2008) and Tunisia (Hathroubi *et al*., 2014).

DEA-based research on the hotel industry's performance in the Middle East is very scarce. The few existing publications that have been surveyed consider cases in Turkey (e.g., Tarim *et al*., 2000; Önüt and Soner, 2006; Tumer, 2010), Iran (Shirouyehzad *et al*., 2012) and Israël (Hadad *et al*., 2005). Apart from the study of Assaf and Barros (2011) which involves Saudi Arabia (KSA), the United Arab Emirates (UAE) and Oman as a block, there is no known research dedicated to a specific country of the Gulf region. Therefore, conducting such a study in Oman stems primarily from a gap that needs to be filled in the literature alongside the importance of Oman as a major touristic and economic destination in the Gulf region, as well as an excellent location for investments (Assaf and Barros, 2011).

With these objectives in mind, the present study aims to provide efficiency measures and identify potential sources of inefficiency through a two-stage approach (Barros *et al*., 2011; Shang *et al*., 2010). The approach starts with a DEA evaluation of each hotel's technical efficiency using endogenous variables, i.e. variables that are under the control of decision makers over the time period of consideration. In the second stage, these efficiency scores are regressed over a set of exogenous factors that are neither inputs nor outputs, but can still influence the operating process (Jeong *et al*., 2010). The objective of the second stage is to detect, among these factors, those that contribute most significantly to the efficiency of the hotels.

A large number of topical papers, including Hoff (2007), McDonald (2009), and Ramalho *et al*. (2010), argue that the second stage should use either log-linear or Tobit models. Using empirical results, these models might fail to discriminate the most influential contextual factors. Building on related theory, we develop a methodology to circumvent such a hindrance.

The contribution of the present study to the hospitality and tourism literature is four-fold. First, the study researches efficiency measures of the Omani hotel industry, a topic that has not been addressed yet, in spite of its pertinence to such a growing industry. Second, the study examines the contextual factors that impact the hotel industry in Oman as well as in other tourism destinations with similar characteristics. A new methodology is developed not only to identify these factors, but also to assess the consistency of DEA decisions. Last, an empirical approach is introduced to quantify the attractiveness of touristic destinations.

The remainder of the paper unfolds as follows. In the next section, we present a brief review of the literature pertaining to the two-stage approach in the hotel industry. In Section 3, we describe the application context and stress the importance of the current study. In Section 4, we explain our methodology and define related efficiency measures, including aggregate, technical and scale efficiencies. Section 5 discusses the conceptual model as well as the choice of input and output variables. Section 6 is dedicated to the application of DEA models and discussion of the findings. In the next section, we conduct an econometric analysis to establish potential correlation between the hotel contextual factors and efficiency levels. We conclude with recommendations and possible venues for future research.

## The two-stage approach in the hotel industry: A review:

In the literature of performance analysis, several studies have provided updated reviews of the application of data envelopment analysis (DEA) in the hospitality industry (see, e.g., Manasakis *et al*., 2013, Shyu & Hung, 2012). The application of the two-stage approach in the hotel industry is quite recent. In Hu *et al*. (2009), DEA is adopted to evaluate the operational performance of international tourist hotels (ITHs) in Taiwan during 1997–2006, prior to a regression of the efficiency ratios on a set of environmental variables using Tobit model. Within the same context, Chen *et al*. (2010) estimate the cost efficiency scores of the ITHs before applying the Tobit approach. The latter approach is also adopted in Honma and Hu (2012), where DEA and SFA are first used to assess performance of 15 Japan's major hotel companies.

Barros *et al*. (2011) use CCR (Charnes, Cooper, and Rhodes, 1978) model to estimate technical efficiency of 21 Portuguese hotels, and a truncated regression analysis (Simar and Wilson, 2007) is carried out to determine the drivers of efficiency. Tundis *et al.* (2012) employ a similar approach to gauge the explanatory power of a large set of management and entrepreneurial variables. Meanwhile, CCR model is used jointly with the approach of Sampaio de Souza and Stosic (2005) to screen outliers out of the initial dataset before calculating the final efficiency. The truncated regression model is also used to investigate the effect of regional environmental quality (Chen *et al*., 2014) or traffic convenience and medical services (Hu *et al*., 2014) on the cost efficiency of hotels in Taiwan. Hathroubi *et al.* (2014) adopt similar approach to analyze the influence of environmental attributes on hotels' technical efficiency in Tunisia.

Huang *et al*. (2012) use data envelopment window analysis through years 2001-2006 to identify general trends of efficiency and individual patterns of relative efficiency variation of 31 regional hotel sectors in China. The impact of macro contextual variables on technical efficiency over the time horizon is investigated via a dynamic Tobit model that incorporates the historical average technical efficiency score as an explicative variable. Oliveira *et al.* (2013) apply a two-stage approach to investigate the influence of star ratings, golf courses and location on the efficiency of a sample of 84 hotels in Portugal. First, CCR and BCC (Banker, Charnes, and Cooper, 1984) models are used to evaluate the efficiency of each hotel. In the second stage, a statistical test (Carvalho and Marques, 2011) is applied to conclude that hotels without golf courses are more efficient than their counterparts.

In line with previous research, we adopt Tobit and log-linear models for the second-stage, and we show that these models, although widely applied in the literature, may statistically fail to support any plausible decision. As an alternative, we develop a stochastic model that gauges potential influence of environmental factors on efficiency evaluation and appraises the consistency of the DEA decisions.

## Contextual setting:

The sultanate of Oman is located on the southern tip of the Arabian Peninsula with, on its borders, the UAE, KSA and Yemen. Oman covers an area of 309,500 km², with rugged mountains and rocky deep-water fjords to the north, the mountains and green hills of the Dhofar region to the south, and the Wahiba Sands in the center (Choufany and Younes, 2005). Lying on the Tropic of Cancer, Oman is one of the world's hot, arid regions though part of the south of the country has a tropical climate (Figure 1).

insertOman's economy is oil based, with an oil activity accounting for 35% of Gross Domestic Product (GDP) (ithraa, 2016). Oman has been successful at turning its oil wealth into broad-based economic growth, stirred by the government's strategy of diversifying the economy and reducing dependence on petroleum resources. Although the latest among the Gulf countries to join the tourism "race", Oman is emerging as one of the most attractive tourism destinations on the Arabian Peninsula with the number of tourists increasing every year (Winckler, 2007). As such, tourism industry is perceived among the key alternatives to petroleum based economy (Subramoniam *et al*., 2010) and set as one of the top targets of the long-term socio-economic plan, namely, "Oman 2020" (Winckler, 2007). According to data from the World Travel & Tourism Council (WTTC), the industry's total contribution to GDP nears 5.7% in 2015 with 111,500 jobs, equivalent to 5.7% of total employment (WTTC, 2016). The same source predicts a figure of 7.7% contribution to GDP by 2026 with 164,000 jobs representing 7.9% of total employment.

The statistics of the Ministry of Tourism reveal that there are 315 hotels in Oman, accounting for 16,691 rooms, with 128 hotels in the capital Muscat alone. The ministry also expects 10,000 additional hotel rooms, including those from luxury resorts to budget hotels, by 2018. Much of this additional capacity consists of resort-style complexes outside the capital, both on the Arabian Sea and Gulf of Oman coasts. With a sector expanding so rapidly, policy makers as well as private investors need tools that would grip as intimately as possible the dynamics of the hospitality market to support their decisions. Here, performance analysis of the hotel industry becomes an imperative.

## Methodological framework:

Our methodological approach deploys over two-stages. The first stage uses DEA to estimate the hotels' efficiency scores. In the second stage, an econometric analysis is conducted to discern possible correlation between technical efficiency and the contextual factors. The latter factors, also known as environmental, exogenous, or non-discretionary variables (Fried *et al*., 2002), are not easy to control, though potentially influencing the efficiency (Shang *et al*., 2010).

Data envelopment analysis (DEA) is a non-parametric approach that employs linear programming (LP) to construct a production technology frontier out of the fully efficient DMUs, and relative efficiencies of all DMUs are evaluated in relation to the estimated frontier.

The DEA models that are most frequently applied in the hotel industry are CCR (Charnes *et al.*, 1978), which assumes constant returns to scale (CRS), and BCC (Banker *et al.*, 1984), which allows variable returns to scale (VRS). VRS implies disproportionate variation in outputs when inputs are increased. Under either CRS or VRS assumption, the managerial purposes of efficiency analysis, in a competitive context, are the measurement of relative efficiency ratios as an essential step to setting industry's benchmarks, besides the estimation of allowable reductions of the inputs consumed by inefficient DMUs. Resource reduction enables hotels to achieve cost savings which, in turn, provide flexibility to lower room prices and be more competitive on the market. Therefore, the input-oriented versions of CCR and BCC models are more suitable to pinpoint resources that can be reduced without altering the outputs (Oliveira *et al.*, 2013). Other models are used in the literature, depending on the contexts and managerial objectives. Recent reviews and references can be found in Manasakis *et al*. (2013) and Shyu and Hung (2012).

## CCR and BCC input-oriented models:

Assume a set of $K$ hotels, each hotel $k$ defined with $N$ inputs $x$ and $M$ outputs $y$. With reference to the underlying production technology, hotel ($x_k$, $y_k$) is fully defined with the observed values $x_{ik}$ and $y_{jk}$ , with $i$=1,.., $N$ and $j$=1,.., $M$. To estimate the efficiency score $\theta$ of hotel ($x_0$, $y_0$) and set production targets for inefficient hotels, the input-oriented formulation of CCR model can be represented as follows.

(CCR)

$$\min \theta \qquad (1)$$

Subjectto :

$$\sum_{k=1}^{K} \lambda_k x_{ik} \le \theta x_{i0} \qquad i = 1,...,N \qquad (2)$$

$$\sum_{k=1}^{K} \lambda_k y_{jk} \ge y_{j0} \qquad j = 1,...,M \qquad (3)$$

$$\lambda_k \ge 0 \qquad k = 1,...,K \qquad (4)$$

The efficiency $\theta$ of hotel ($x_0$, $y_0$) represents the minimal radial reduction of inputs that is required to reach the efficiency frontier for a specified level of outputs. The vector λ measures the weights of peers in producing the projection of hotel ($x_0$, $y_0$) on the efficiency frontier. Constraints (2) and (3) state that reference points are linear combinations of the input and output values of efficient peers for hotel ($x_0$, $y_0$). (CCR) represents an LP model with $N+M$ constraints (not counting the non-negativity constraints) and must be solved $K$ times, once for each hotel.

BCC model can be obtained from (CCR) by adding the convexity constraint that guarantees that only weighted averages of efficient hotels enter the reference set, i.e. $\sum_{k=1}^{K} \lambda_k = 1.$ CCR and BCC models are both formulated with the implicit assumption that the assessed hotels operate within homogeneous environments, which presupposes that only variables representing proper inputs are integral part of the production technology.

## Scale efficiency:

Let $\theta^*_{CCR}$ and $\theta^*_{BCC}$ denote the efficiency scores of hotel ($x_0$, $y_0$) calculated using CCR and BCC models, respectively. $\theta^*_{CCR}$ refers to the aggregate efficiency which entails two ratios: the pure technical efficiency, $\theta^*_{BCC}$, and the scale efficiency, $SE$. The score $\theta^*_{BCC}$ measures the managerial performance of the hotel to organize the inputs in the service process and, as a result, it identifies inefficiencies due to managerial underperformance (Manasakis *et al*., 2013).

The scale efficiency $SE$ assesses the managerial ability to set the optimal resource size, that is, the best production scale needed to achieve the output levels. A hotel is scale efficient when its scale efficiency is equal to one, suggesting that the hotel is operating at the most productive scale size, and any alteration of its size will lead to inefficiency. Scale inefficiency occurs for values of $SE$ less than one, due to either increasing or decreasing returns to scale. Following Banker *et al.* (2004), if $\lambda^*$ is an optimal solution of CCR model and $\sum_{k=1}^{K} \lambda^*_k > 1$, we can say that the hotel exhibits decreasing returns to scale (DRS), implying that it is operating at a scale greater than the most productive scale size of the inputs. Conversely, $\sum_{k=1}^{K} \lambda^*_k < 1$ suggests that the hotel is operating in the increasing returns to scale (IRS) region, at a scale smaller than the most productive scale. The productivity of such hotels can be increased by transferring resources from hotels operating at DRS to those operating at IRS (Boussofiane *et al*., 1992).

## Conceptual model:

The adequate choice of *inputs* and *outputs* for a DEA based benchmarking problem lies often on the dicta *"less is better"* and *"more is better"*, respectively (Cook *et al.*, 2014). Thus, with respect to the specific context of our study, we identified 4 outputs and 4 inputs, as shown in Figure 2.

The output variables are *Annual revenue* (Chiang *et al*., 2004; Barros and Mascarenhas, 2005; Neves and Lourenco, 2009; Pulina *et al*., 2010), *Number of guests* (Barros, 2005b), *Number of nights* (Barros, 2005b; Barros and Mascarenhas, 2005; Sigala *et al*., 2005) and *Occupancy rate* (Chiu *et al*., 2012; Ting and Huang, 2012; Yang and Lu, 2006). *Annual revenue* includes incomes from the rental of the hotel rooms, food and beverages served to customers, phone call bills, as well as laundry services. *Number of guests* counts hotel's guests, no matters the duration of their stay. *Number of nights* provides a cumulative value of full nights spent in the hotel. *Occupancy rate* refers to the proportion of hotel capacity effectively used over a specific time period (e.g. one year), i.e. number of rooms rented out over the total of rooms available. Occupancy rate has been used freshly and it is managerially useful (Perrigot *et al*., 2009). The input variables are Number of beds (Manasakis *et al.*, 2013), Number of rooms (Anderson *et al*., 2000; Assaf *et al*., 2010; Barros, 2005b; Chen *et al*., 2010), Number of employees (Chiang *et al*., 2004; Barros and Mascarenhas, 2005; Hwang and Chang, 2003; Sun and Lu, 2005; Chiang, 2006; Yang and Lu, 2006; Yu and Lee, 2009), and Salary of employees (Assaf and Agbola, 2011; Morey and Dittman, 1995; Reynolds, 2003).

In order to achieve clear efficiency discrimination, Cooper *et al*. (2002) suggest that the minimum number $\Psi$ of DMUs must satisfy $\Psi \geq \max[MN,\ 3(M+N)]$. As regards our study, $N$=4 and $M$=4, implying that we need a sample of at least $\Psi$=24 hotels.

## Data collection:

To collect relevant data for our study, questionnaires were distributed to all the hotels that are registered with the Ministry of Tourism in 2009. Of 107 hotels, 60 have responded and two have been discarded for missing information. The 58 hotels are spread over the seven regions of Oman (Muscat, Dhofar, Al-Buraymi, A'Dakhiliyah, A'Sharqiyah, Al-Batinah, and Musandam). Hence, we consider $K$=58 hotels, a number that is comfortably larger than $\Psi$=24. A statistical summary of the corresponding inputs and outputs is given in Table 1.

## Evaluating efficiency :

To solve both CCR and BCC models for each hotel, we use IBM-ILOG CPLEX version 12.4. We compute the optimal efficiency scores $\theta$* for each hotel, besides the corresponding optimal solutions $\lambda$* and the slack values (Table 2).

Out of 58 hotels, 13 are technically efficient under CRS and more than double (27 hotels) under VRS. At an individual stakeholder's level, the aggregate efficiency measure $\theta^*_{CCR}$ suggests that the hotel has the flexibility to reduce specific inputs by 100(1-$\theta^*_{CCR}$)% and still produce the same level of outputs. On average, the input reduction nears 30% for an average aggregate efficiency of 70%. Furthermore, the average technical efficiency is 0.83, implying that the majority of hotels are efficient in managing their resources.

Over the seven regions involved in the study, almost all the efficient hotels are located in Muscat. Such a high concentration is primarily justified, knowing that Muscat is the capital and hosts most of the country's touristic sites, besides more than half the number of hotels.

## Identifying performance drivers:

Commonly, the efficiency evaluation is carried out with endogenous inputs without considering contextual factors. In the hotel industry, hotel size (Assaf *et al*., 2010), location (Barros, 2005a; Bernini and Guizzardi, 2010; Tundis *et al*., 2012), and type of ownership (Barros, 2004; Barros and Dieke, 2008; Yu and Lee, 2009) are the most popular factors which are found to be strong determinants of hotel efficiency in many case studies (Assaf *et al*., 2010). Other variables could also be pertinent, like star rating (Assaf and Cvelbar, 2010), used essentially to reflect quality of service, even though it is far from being a wholly satisfactory proxy for such an operational factor (Oliveira *et al.*, 2013).

Variables selection:

Based on previous studies, we consider four contextual variables: Type of ownership, Hotel size, Star rating and Attractions. The variable *Attractions* is introduced to investigate the influence of hotel's location on its efficiency. Bernini abd Guizzardi (2010) suggest that location is positively correlated with technical efficiency, especially for sun and beach destinations, as well as cities with renowned cultural importance. Thus, resources that may contribute to the attractiveness of a hotel's location need to be conserved (Gomezelj and Mihalič, 2008). The latter being nominal, it cannot be used in a regression model without a prior quantification. For that reason, the number of attractions is used as a quantitative substitute.

Based on the classification of the Ministry of tourism, there are three categories of attractions: *Nature*, *Culture*, and *Activities.* The items that fall under each category are as follows:

-Nature: Reserves, valleys, strait of Hormuz, mountains, caves, deserts, beaches, islands, water springs, lagoons, rocks park, canyon, Muscat geo-site.

-Culture: Aflaj system, traditional villages, souqs, world heritage, museums, forts, castles, archeological and religious sites, crafts, frankincense, cities.

-Activities: Scuba diving, boating, climbing, Via Ferrata, trekking, camping, caving, golf, kite-surfing, kite-boarding, shopping, watching (whales, birds, turtles, dolphins), racing (camels, horses), off-road, Muscat geo-heritage.

In order to gauge the individual effect of each category and draw more focused decisions, we consider them as separate variables.

Accordingly, the variable location is represented with three variables, whose values are calculated as follows. First, we identify all potential attraction sites and activities related to each destination. Next, we cluster these items based on the above classification scheme. Finally, we count the number of items for each category. Each number translates the weight of each location with respect to each attraction category. The values obtained are presented in Table 3.

For instance, the value of variable *Nature* is 16 for Muscat, that is, there are potentially 16 touristic sites in Muscat corresponding to, at least, one of the items listed under category *Nature*. Similar reasoning applies to the other variables. Muscat is, apparently, the most attractive with respect to cultural sites, while Dhofar is leading with its natural sites. The majority of regions offer some sort of activities, except Al-Batinah.

Regarding the other contextual variables, *Type of ownership* is a dichotomous variable taking a value 1 if the hotel is part of a chain of hotels, a value 0 otherwise. For *hotel size*, we use values 0, 1 or 2 depending on whether the hotel is *small*, *medium* or *large*, respectively, that is, the number of rooms is less than 100, between 100 and 300, or more than 300. *Star rating* refers to the number of stars assigned to a hotel for the previous year's exercise, a number varying between 1 and 5. Ray and Phillips (2005) and Assaf and Agbola (2011) suggest that the number of stars and efficiency are positively correlated, that is, the more stars, the better the performance.

More than 67% of hotels are independent from a chain, with a close proportion of small size hotels. Such figures reflect the fact that the lodging industry in Oman is still a growing sector. The same can be read from the star ratings, with 15 hotels registered as one star and 8 only as five star hotels. The summary statistics for the contextual variables are given in Table 4.

In order to assess the cross-sectional association of these factors with the DEA efficiency scores, the second stage analysis (Fried *et al*., 2002) is conducted through a Tobit analysis. To enable an analysis under the operating scale of the hotels, we use the pure technical efficiency $\theta^*_{BCC}$ instead of $\theta^*_{CCR}$.

## Tobit regression analysis:

Given that technical efficiency scores $\theta = \theta^*_{BCC}$ take continuous values in the interval [0, 1], Tobit regression model (Tobin, 1958) is primarily more suitable than Ordinary Least Square (OLS), the latter's estimators being biased downward for this data configuration (see, e.g., Greene, 1997).

Let $z_1$, $z_2$, $z_3$, $z_4$, $z_5$, and $z_6$ denote the contextual variables *type of ownership*, *hotel size*, *star rating*, *nature*, *culture*, and *activities*, respectively. Using the classification of Amemiya (1985), type I Tobit model (Tobin, 1958) is defined as follows:

$$\theta^L_k = \beta_0 + \sum_{p=1}^{6} \beta_p z_{kp} + \varepsilon_k \qquad k = 1,\dots, K \tag{5}$$

$$\theta_k = \begin{cases} \theta^L_k & \text{if } \theta^L_k < 1 \\ 1 & \text{if } \theta^L_k = 1 \end{cases}$$

where $\theta$ is the dependent variable, observed for values less than 1 and censored for values of 1. $\theta^L$ is the latent dependent variable; $\beta$ is the vector of the model's coefficients; and $\varepsilon$ is the error term. The values of the $\varepsilon_k$'s are assumed independent and normally distributed; i.e., $\varepsilon_k \sim N(0,\sigma)$. Each estimated coefficient $\hat{\beta}_p$ is interpreted as the marginal effect of a change in $z_p$ on the latent variable $\theta^L$. We used R software for statistical analysis to estimate the parameters of model (5). The regression results are displayed in Table 5.

The squared correlation between the predicted and observed values of $\theta^*_{BCC}$ is $R^2 = 0.03186$, indicating that predicted values share only 3.18% of their variance with $\theta^*_{BCC}$. Hence, there is globally no significant relationship between the hotel efficiency and the selected set of contextual variables. Moreover, all the *p*-values being above 10%, failure to achieve statistical significance is by far the dominant result for every one of the contextual variables.

Theoretically, the failure of Tobit model to provide valid inference can be imputed to the fact that conventional inference methods use DEA estimates of efficiency, which are correlated by construction, instead of true efficiency (Simar & Wilson, 2011). However, the intuitive explanation for such a failure is the "*double role*" played by some output variables, specifically *Number of guests*, *Number of nights* and *Occupancy rate*. In spite of being perceived as outputs with respect to the dictum *"more is better"* of a DEA based benchmarking problem (Cook *et al*., 2014), these variables can also be treated as exogenous variables in a production system whose objective is maximizing profit. Effectively, the output *Annual revenue* itself depends on these variables, and such a property alone can affect some results if handled outside the DEA framework. To assess this hypothesis, we developed a production model integrating all variables within a unified framework that (1) preserves the role of the latter output variables in generating the efficiency estimates and enhances their contribution as potential exogenous variables, (2) circumvents the autocorrelation of DEA efficiency estimates, and (3) allows for the results of the DEA stage to be further assessed..

## Integrated stochastic model

Banker & Natarajan (2008) remark that "*we cannot theoretically justify the use of a Tobit regression in the second stage in terms of an underlying data-generating process*". As an alternative, the authors propose a statistical model in which the second-stage regression equation is log-linear and writes the efficiency score $\theta$ in terms of the contextual variables *z* as:

$$\ln\theta = \beta_0 - \sum_{p=1}^{6}\beta_p z_p + \omega \tag{6}$$

where $\beta_p, p = 1,\ldots,6$ are the model's parameters, and $\omega$ is the error term which follows a two-sided distribution. Assuming normality, $\omega \sim N(0,\sigma^2_\omega)$.

The application of the proposed approach to our case study gives the results shown in Table 6.

The overall significance level is only 90.998% and the adjusted $R^2$=-7.414%, indicating that the log-linear model fails to show any relationship between the hotel efficiency and the contextual variables.

Let $x_1$, $x_2$, $x_3$ and $x_4$ represent the input variables *Number of beds*, *Number of rooms*, *Number of employees*, and *Salary of employees*, respectively. We also denote by *y*, $x_5$, $x_6$ and $x_7$ the output variables *Annual revenue*, *Number of guests*, *Number of nights* and *Occupancy rate*, respectively. Assuming that the entire industry is described by a Cobb-Douglas production function,

$$y = \delta_0 \prod_{i=1}^{7} x_i^{\delta_i} e^{\gamma} \tag{7}$$

where $\delta$ is the vector of unknown parameters, and $\gamma$ is the stochastic disturbance term (Gujarati, 2003). Under normality assumption, $\gamma \sim N(0,\sigma^2_\gamma)$.

From (6), we can write:

$$\exp(\ln\theta - \beta_0 + \sum_{p=1}^{6}\beta_p z_p - \omega) = 1 \tag{8}$$

Multiplying the left-hand side of (8) by the right-hand side of (7), we have, after manipulation:

$$y/\theta = \delta_0 \exp(-\beta_0)\prod_{i=1}^{7} x_i^{\delta_i} \exp(\sum_{p=1}^{6}\beta_p z_p + \gamma - \omega)$$

Setting $y^* = y/\theta$, $\beta_0^* = \delta_0 \exp(-\beta_0)$ and $\varepsilon^* = \gamma - \omega$, and log-transforming,

$$\ln y^* = \ln\beta_0^* + \sum_{i=1}^{7}\delta_i \ln x_i + \sum_{p=1}^{6}\beta_p z_p + \varepsilon^* \tag{9}$$

Equation (9) represents a production function that incorporates all variables into a linear model, with $\ln x_i$ and $z_p$ as independent variables and $\ln y^*$ as a dependent variable.

With $\varepsilon^* \sim N(0, \sigma_\gamma^2 + \sigma_\omega^2)$, ordinary least square (OLS) can be used to estimate the model's parameters and OLS estimators are equivalent to the maximum likelihood estimators, and therefore are asymptotically efficient in the class of all regular estimators. Meanwhile, note that the variable $z_2$ (hotel size) is dropped from the model since it is, by definition, correlated with the variable $x_2$ (number of rooms). The outputs of the regression analysis are given in Table7.

The p-value of the F-test is nearly zero ($1.43 \times 10^{-23}$). Hence, the multiple regression relationship is significant. The value of the adjusted coefficient of determination reveals that 93.06% of the variability in $\ln y^*$ is explained by $\ln x_i$'s and $z_p$'s, meaning that the estimated multiple regression equation fits the data very well. Furthermore, *RTS*=1.796 indicates that the entire industry displays increasing returns to scale.

With respect to individual significance levels, the results show that variables *Type of ownership*, *Nature* and *Activities* are statistically insignificant, with p-values larger than 10%. In addition, the negative coefficients of variables *Nature* and *Activities* suggest a negative contribution to hotel efficiency. This may also advocate that these factors are not important drivers for choosing a specific hotel location.

*Number of rooms* (viz. *hotel size*), *Star rating* and *Culture* are found to have the most significant effect on efficiency, with all p-values smaller than 5%. This confirms, to some extent, the outcome of the DEA analysis. The positive impact of *Star rating* on efficiency conforms to the findings of Ray and Phillips (2005) as well as Assaf and Agbola (2011).

Variable *Culture* seems affecting efficiency positively, although with a lower intensity $(\hat{\beta}_5 = 0.07194)$. This can inform policy makers on the necessity to preserve and promote cultural heritage as an important key factor of attraction. In an attempt to depict customers' profile, this may also reveal that most of the hotels' guests are educated tourists, looking for knowledge and discovery. In addition, *Star-rating* is found to be an important determinant of efficiency. In practice, this result remains consistent with the natural parity quality-demand.

## Conclusions, implications and future research

As the first analysis of the performance of the hospitality industry in Oman, the present study involved a sample of 58 hotels from different regions of the country. The estimation of technical efficiency revealed an average score of 0.83 under current operating scales, with about 45% of the hotels identified as efficient. Near 66% of the efficient hotels are located in Muscat, due probably to the high concentration of hotels (62% of the country's lodging capacity) besides the attractiveness of the city as the capital of the country and the key business place. Such facts suggest more investment policies decentralized towards boosting the hospitality industry other regions rather than the capital and its peripherals. ,

Potential sources of inefficiency are initially investigated through an analysis of scale economies, which indicated that the optimal size of a hotel should be, on average, 73 rooms, with \$3.13m/year expected revenue and an occupancy rate of 68.07%. Moreover, 76.2% of the total number of hotels exceeds the scale efficiency level of 0.90 for an average of 0.85. With a sample representing 54.20% of the population of hotels (58 out of 107), these are enough indicators that most hotels are operating near the optimal size, endorsing, as a matter of fact, previous investment choices and discarding hotel size as a key factor of inefficiency. Based on the slack analysis, it appeared important to perform a performance evaluation using disaggregated input variables so that to discern precisely the inefficiency sources.

At an advanced stage, the effect of environmental factors on efficiency has been explored using Tobit and log-linear regression models with, for the first time, destination attractiveness quantified by more than one variable. Failure of both models to achieve statistical significance prompted the idea of developing a new production model that incorporates both controllable and uncontrollable variables. The new model revealed that *Type of ownership* (independent or chain dependent), *Nature and Activities* have no impact on the choice of a hotel, whilst *Hotel size*, *Star rating* and *Culture* appear as the most influential factors. The variable *Culture* is particularly interesting as a factor translating that hotels' visitors belong to a specific category of customers. As a result, marketing strategies ought to be adjusted so that the profiles of targeted tourists fit within the scope of other attractions, like *nature* and *activities*.

Regarding methodology, this study enhanced the importance of using different analytical methods to build credible inferences. Future research could consider incorporating all of the variables into the same model using extended DEA models (e.g. Banker and Morey, 1986a,b). In addition, the effect of the variable selection on decision outcomes may suggest enriching future studies with more input and output variables, together with a horizon extension covering more than one year, so that to capture the efficiency's dynamics.

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**Table 1**. Summary statistics of Input and Output variables

| Variables | Unit | Mean | SD | Min. | Max. |
|---|---|---|---|---|---|
| **Output** | | | | | |
| Annual revenue | $ /year | 6,911,989 | 13,731,079 | 3,004 | 78,795,452 |
| Number of guests | | 17,864 | 20,273 | 597 | 96,877 |
| Number of nights | | 23,882 | 28,091 | 669 | 147,084 |
| Occupancy rate | % | 55 | 24 | 2 | 87 |
| **Inputs** | | | | | |
| Number of beds | | 135 | 138 | 23 | 937 |
| Number of rooms | | 91 | 97 | 13 | 640 |
| Number of employees | | 111 | 191 | 4 | 1,193 |
| Salary of employees | $ /year | 1,040,976 | 2,197,535 | 14,344 | 11,704,068 |

**Table 2**. Hotel specific efficiency scores using DEA

| Hotel | $\theta^*_{CCR}$ | $\theta^*_{BCC}$ | SE | $\sum_{k=1}^{K} \lambda^*_k$ | Status |
|---|---|---|---|---|---|
| H1 | 0.72 | 0.76 | 0.96 | 3.70 | *decr.* |
| H2 | 0.86 | 0.87 | 0.99 | 3.68 | *decr.* |
| H3 | 1.00 | 1.00 | 1.00 | 1.00 | *const.* |
| H4 | 1.00 | 1.00 | 1.00 | 1.00 | *const.* |
| H5 | 0.67 | 1.00 | 0.67 | 6.36 | *decr.* |
| H6 | 0.79 | 0.81 | 0.97 | 1.20 | *decr.* |
| H7 | 0.73 | 1.00 | 0.73 | 1.90 | *decr.* |
| H8 | 0.96 | 1.00 | 0.96 | 2.34 | *decr.* |
| H9 | 0.87 | 1.00 | 0.87 | 2.61 | *decr.* |
| H10 | 0.50 | 0.51 | 0.99 | 0.92 | *incr.* |
| H11 | 0.89 | 1.00 | 0.89 | 1.74 | *decr.* |
| H12 | 0.74 | 0.93 | 0.79 | 1.55 | *decr.* |
| H13 | 0.39 | 0.40 | 0.99 | 1.05 | *decr.* |
| H14 | 1.00 | 1.00 | 1.00 | 1.00 | *const.* |
| H15 | 1.00 | 1.00 | 1.00 | 1.00 | *const.* |
| H16 | 1.00 | 1.00 | 1.00 | 1.00 | *const.* |
| H17 | 0.80 | 0.80 | 0.99 | 1.01 | *decr.* |
| H18 | 0.48 | 1.00 | 0.48 | 1.22 | *decr.* |
| H19 | 0.46 | 0.52 | 0.89 | 1.08 | *decr.* |
| H20 | 0.50 | 0.51 | 0.99 | 0.97 | *incr.* |
| H21 | 0.51 | 0.51 | 0.98 | 0.87 | *incr.* |
| H22 | 0.41 | 0.46 | 0.89 | 0.86 | *incr.* |
| H23 | 0.75 | 0.77 | 0.98 | 0.90 | *incr.* |
| H24 | 0.69 | 1.00 | 0.69 | 1.35 | *decr.* |
| H25 | 1.00 | 1.00 | 1.00 | 1.00 | *const.* |
| H26 | 1.00 | 1.00 | 1.00 | 1.00 | *const.* |
| H27 | 0.25 | 1.00 | 0.25 | 0.15 | *incr.* |
| H28 | 1.00 | 1.00 | 1.00 | 1.00 | *const.* |
| H29 | 0.93 | 0.95 | 0.98 | 1.13 | *decr.* |
| H30 | 1.00 | 1.00 | 1.00 | 1.00 | *const.* |
| H31 | 1.00 | 1.00 | 1.00 | 1.00 | *const.* |
| H32 | 1.00 | 1.00 | 1.00 | 1.00 | *const.* |
| H33 | 0.74 | 0.81 | 0.92 | 1.51 | *decr.* |
| H34 | 0.22 | 0.23 | 0.94 | 0.75 | *incr.* |
| H35 | 0.75 | 0.80 | 0.94 | 1.69 | *decr.* |
| H36 | 0.11 | 0.37 | 0.30 | 0.16 | *incr.* |
| H37 | 0.50 | 1.00 | 0.50 | 0.30 | *incr.* |
| H38 | 0.47 | 1.00 | 0.47 | 0.17 | *incr.* |
| H39 | 0.84 | 0.99 | 0.85 | 1.31 | *decr.* |
| H40 | 1.00 | 1.00 | 1.00 | 1.00 | *const.* |
| H41 | 0.95 | 1.00 | 0.95 | 0.68 | *incr.* |
| H42 | 0.67 | 0.76 | 0.88 | 1.14 | *decr.* |
| H43 | 0.74 | 0.75 | 1.00 | 0.98 | *incr.* |
| H44 | 0.62 | 0.65 | 0.95 | 0.83 | *incr.* |
| H45 | 0.61 | 0.90 | 0.68 | 0.53 | *incr.* |
| H46 | 0.11 | 0.63 | 0.17 | 0.10 | *incr.* |
| H47 | 0.53 | 0.53 | 0.98 | 0.81 | *incr.* |
| H48 | 0.32 | 0.32 | 0.99 | 1.05 | *decr.* |
| H49 | 0.41 | 0.77 | 0.53 | 0.31 | *incr.* |
| H50 | 0.50 | 0.50 | 0.99 | 0.87 | *incr.* |
| H51 | 0.88 | 0.92 | 0.96 | 1.15 | *decr.* |
| H52 | 0.92 | 1.00 | 0.92 | 1.09 | *decr.* |
| H53 | 0.76 | 0.94 | 0.81 | 1.27 | *decr.* |
| H54 | 0.89 | 1.00 | 0.89 | 0.77 | *incr.* |
| H55 | 0.22 | 0.59 | 0.37 | 0.19 | *incr.* |
| H56 | 1.00 | 1.00 | 1.00 | 1.00 | *const.* |
| H57 | 0.17 | 1.00 | 0.17 | 0.14 | *incr.* |
| H58 | 0.97 | 0.99 | 0.99 | 1.13 | *decr.* |

**Table 3.** Quantification of attraction categories

| Region | Nature | Culture | Activities |
|---|---|---|---|
| Muscat | 16 | 16 | 13 |
| Dhofar | 19 | 8 | 13 |
| Al Buraymi | 5 | 5 | 13 |
| A'Dakhiliyah | 11 | 12 | 12 |
| A'Sharqiyah | 2 | 6 | 3 |
| Al Batinah | 1 | 3 | 0 |
| Musandam | 4 | 1 | 9 |

**Table 4.** Summary statistics of hotel contextual factors

| Variables | Unit | Mean | SD | Min. | Max. |
|---|---|---|---|---|---|
| Type of ownership | categorical | 0.33 | 0.47 | 0 | 1 |
| Hotel size | categorical | 1.33 | 0.51 | 1 | 3 |
| Star rating | categorical | 2.81 | 1.41 | 1 | 5 |
| Attractions: | | | | | |
| • Nature | | 12.36 | 6.37 | 1.00 | 19.00 |
| • Culture | | 11.55 | 5.33 | 1.00 | 16.00 |
| • Activities | | 10.53 | 4.81 | 0.00 | 13.00 |

**Table 5.** Outputs of the Tobit regression analysis

| Coefficients | Value | t value | p-value |
|---|---|---|---|
| $\beta_0$ | 0.82295 | 7.60844 | 0.00000 |
| $\beta_a$ | -1.53399 | -16.52044 | 0.00000 |
| $\beta_1$ | 0.03740 | 0.45247 | 0.65184 |
| $\beta_2$ | 0.02129 | 0.24326 | 0.80827 |
| $\beta_3$ | -0.02448 | -0.73774 | 0.46227 |
| $\beta_4$ | -0.00963 | -0.93575 | 0.35149 |
| $\beta_5$ | 0.00309 | 0.34920 | 0.72762 |
| $\beta_6$ | 0.01141 | 0.89478 | 0.37289 |

**Table 6.** Outputs of the log-linear regression analysis

| Coefficients | Value | t value | p-value |
|---|---|---|---|
| $\beta_0$ | -0.25896 | -1.45439 | 0.15197 |
| $\beta_a$ | 0.02714 | 0.19950 | 0.84267 |
| $\beta_1$ | 0.01808 | 0.12552 | 0.90061 |
| $\beta_2$ | -0.02848 | -0.52129 | 0.60442 |
| $\beta_3$ | -0.01905 | -1.12428 | 0.26616 |
| $\beta_4$ | 0.01005 | 0.68996 | 0.49335 |
| $\beta_5$ | 0.01830 | 0.87160 | 0.38751 |
| $\beta_6$ | -0.25896 | -1.45439 | 0.15197 |

**Table 7.** Outputs of the OLS regression analysis

| Coefficients | Value | t value | p-value |
|---|---|---|---|
| $\ln \beta_0^*$ | 0.93309 | 0.39000 | 0.69847 |
| $\delta_1$ | -0.49528 | -1.43300 | 0.15899 |
| $\delta_2$ | **0.87407** | **2.05700** | **0.04566** |
| $\delta_3$ | 0.07020 | 0.17700 | 0.86014 |
| $\delta_4$ | 0.46564 | 1.25400 | 0.21661 |
| $\delta_5$ | 0.27801 | 1.26900 | 0.21129 |
| $\delta_6$ | -0.08005 | -0.28700 | 0.77557 |
| $\delta_7$ | **0.68396** | **3.58300** | **0.00084** |
| $\beta_1$ | 0.12153 | 0.47400 | 0.63752 |
| $\beta_3$ | **0.38520** | **2.01700** | **0.04982** |
| $\beta_4$ | -0.00232 | -0.07100 | 0.94361 |
| $\beta_5$ | **0.07194** | **2.42100** | **0.01968** |
| $\beta_6$ | -0.02413 | -0.62300 | 0.53630 |
| *R-square* | 0.9464 | | |
| *R-square adjusted* | 0.9306 | | |
| *Overall significance* | $1.43 \times 10^{-23}$ | | |

Figure 1. Map of Oman

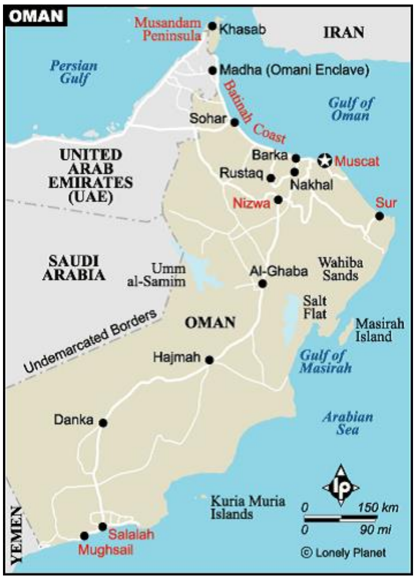


Figure 2. Conceptual model for performance analysis