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**EMPLOYING DEA FOR RANKING HOTELS'
ADVERTISEMENT:
A CASE OF ANALYZING AN ADVERTISING
SUPPLEMENT OF HOTELS IN ISRAEL**

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Abstract. Data Envelopment Analysis (DEA) is employed in this study to rank hotel advertisements. The analysis is based on the assumption that when a hotel communicates attributes of quality in advertising, and manages to ask for a premium price for these attributes, then its advertisement will be efficient. The study provides different DEA models for ranking advertisements according to efficiency. The findings demonstrate that the inclusion of hotel attributes change the efficiency ranking of the advertisements.

* The authors wish to recognize the contribution of Abraham Mehrez to their personal and academic development. Professor Mehrez was a caring friend, a mentor, and a colleague. He passed away on February 5th, 2000 after a courageous struggle with cancer.

1. INTRODUCTION

The Israeli hospitality industry has been undergoing changes in recent years when the unstable political and economic environment has resulted in certain changes in consumption. The instability of the peace process with the Palestinians has had a negative impact on the Israeli economy, and especially on the tourism and hospitality industry. The number of tourists arriving in Israel is on a continuous decline and this fact forces the local industry to increase its reliance on the domestic market by offering a variety of package deals. Consequently, the decrease in foreign visitors was compensated for by an increase in domestic tourism, resulting in a change of consumer proportions. As a result, while in 1995, 55% of the guests in Israeli hotels were derived from the domestic market (Israeli Hotel Association 1999), the numbers since March 1999 suggest that this trend continues and peaks on December 2000 in which 80% of the guests in Israel were domestic tourists (Table 1). Due to the heavy reliance on domestic markets, revenues in the industry are also on a stagnant trend. These changes suggest that the domestic consumers' markets are gaining importance for Israeli hotels.

		Total number of guests in Israel (in thousands)	Total number of domestic guests in Israel (in thousands)	Proportion of domestic guests Israel	Total Revenues in Israel (in Millions N.I.S)
March	1999	571.30	317.00	55%	389.76
April	1999	526.80	268.70	51%	466.96
May	1999	549.40	309.50	56%	450.41
June	1999	596.30	397.50	67%	451.87
July	1999	704.10	482.90	69%	513.46
August	1999	786.00	548.50	70%	639.67
September	1999	554.20	354.70	64%	447.15
October	1999	692.80	308.40	45%	554.85
November	1999	642.60	287.20	45%	494.38
December	1999	545.90	357.30	65%	414.50
January	2000	445.40	246.00	55%	353.32
February	2000	578.10	281.60	49%	395.72
March	2000	700.40	310.20	44%	487.48
April	2000	645.60	315.20	49%	596.70
May	2000	677.70	286.60	42%	540.46
June	2000	722.30	412.90	57%	562.97
July	2000	777.30	493.10	63%	644.90
August	2000	798.40	525.80	66%	686.15
September	2000	636.00	336.00	53%	560.45
October	2000	437.80	249.90	57%	399.66
November	2000	405.20	297.10	73%	323.38
December	2000	473.30	377.90	80%	354.64
January	2001	417.20	299.00	72%	304.09
February	2001	443.40	331.00	75%	295.38
March	2001	542.80	414.60	76%	362.52

Table 1: Selected statistics on the Israeli hospitality industry, 1999 – 2001

The Israel Ministry of Tourism has recently conducted a study of guest expectations in Israeli hotel (Mehrez & Israeli 2000). The study reveals that hotel guests expect a variety of services including swimming pool and spa, children's activities, adult activities, sport facilities, etc. As part of the effort to attract different market segments hotels often communicate their services by using advertisements. However, it is important to note that the impact of advertisement is not always effective or efficient (Lewis & Chambers, 1989). To consider advertisement effective and efficient, a firm should be able to use what is being advertised (such as characteristics of the product or service) as a justification for the price it requests, and also to be able to secure a purchase from customers (Barta Myers and Aaker 1996).

To investigate the efficiency of using advertisements by hotels, this paper evaluates the efficiency of an advertising supplement used by newspapers for the domestic market by employing Data Envelopment Analysis (DEA) procedures for analyzing a case in point. In this context, hotel advertisements' efficiency using DEA assumes that when the hotel communicates attributes of quality in advertising, and manages to ask for a premium for these attributes its advertisement will be efficient.

The first part introduces the DEA procedures, which will be employed in the analysis. The second part briefly presents the concept of advertising and its relevance to the Israeli hospitality industry, which is investigated in the study. The third part provides information of the DEA models employed in the study, the setting in which they were employed, and the findings. Conclusions and recommendations are offered in the last part.

2. DATA ENVELOPMENT ANALYSIS

DEA is a procedure designed to measure the relative efficiency in situations when there are multiple inputs and multiple outputs and no obvious objective how to aggregate both inputs and outputs into a meaningful index of productive efficiency (Sexton Sleeper and Taggart 1994). DEA was developed by Charnes Cooper and Rhodes (CCR) (1978). The method provides a mechanism for measuring Decision-Making Unit (DMU) Pareto efficiency compared with other DMUs. The mechanism is extensively employed in diverse industries and environments (an extensive review of DEA applications is provided by Seiford 1996). In the service sector, applications of DEA include education (Sexton *et al.* 1994), recreation and health care management (Sherman 1984) to name just a few.

The efficiency in DEA is termed Technical and Scale Efficiency (TSE) and the relative efficiency of a DMU is defined as the ratio of its total weighted output to its total weighted input. The question is how to select the weights if no unit values can be assigned to the inputs and outputs? Here lies the seed of DEA procedure. DEA permits each DMU to select any weight that it wants for each input and output, provided that they satisfy certain reasonable conditions: first that no weights can be negative, and second that the weights must be universal, which means that the resulting ratio should not exceed 1. The BCC model, named after Banker, Charnes and Cooper (1984) allows the production function to exhibit non-constant return to scale (Banker and Chang, 1995) while the CCR model imposes the additional assumption of constant returns to scale on the production function.

DEA does not rank DMUs but instead separate them to two different groups: efficient (with efficiency ratio of 1), and inefficient (with a ratio less than 1). If ranking is needed for DMUs, there are several procedures that can be employed. These procedures include CCA/DEA (Friedman and Sinuany-Stern 1997), CE/DEA (Friedman and Sinuany-Stern 1998), DDEA (Sinuany-Stern et al 1994), DR/DEA (Sinuany-Stern and Friedman 1998), and AHP/DEA (Sinuany-Stern Mehrez and Barboy 2000). These ranking procedures provide a ranking of all DMUs, including the efficient and inefficient. There are also other procedures which rank the efficient DMUs and inefficient DMUs separately (Anderson & Peterson 1993, Sueyoshi 1999).

In this paper, the efficiency of hotel advertisement will be tested by using the CCR and BCC models. Then, the DMUs will be ranked according to their efficiency. The ranking will employ the CE/DEA (see detailed formulation in Friedman et al 1998) and AHP/DEA (see detailed formulation in Sinuany-Stern Mehrez and Haddad 2000) ranking procedures. CE/DEA ranks DMUs by using a Cross Efficiency matrix. AHP/DEA uses Saaty's Analytical Hierarchical Process (AHP) (Saaty 1980) and uses pairwise comparisons to rank order the DMUs. In the first step, the efficiency of each DMU is computed and the ratio between each pair is computed. Then, in the second step, the correspondence between the own eigenvector and the maximum eigenvalue provides the ranking for each DMU (Sinuany-Stern et al 2000). Finally, the analysis will also test if there is a relationship between the quality ranking of hotels (as measures by their star rating) and their advertising efficiency.

The Technical and Scale Efficiency (TSE) with constant return to scale is computed according to the CCR model (Charnes, Cooper & Rhodes 1978). Consider n DMUs, when each DMU j ($j=1, \dots, n$) uses m inputs $X_j = (X_{1j}, X_{2j}, \dots, X_{mj})^T > 0$ for producing s outputs $Y_j = (Y_{1j}, Y_{2j}, \dots, Y_{sj})^T > 0$. The CCR model is as follows:

$$\begin{aligned}
 &\text{maximize } E_K = \sum_{r=1}^s U_r Y_{rk} \\
 &\text{subject to } \sum_{i=1}^m V_i X_{ik} = 1 \\
 &\quad \sum_{r=1}^s U_r Y_{rj} - \sum_{i=1}^m V_i X_{ij} \leq 0 \quad j=1, 2, \dots, n \\
 &\quad U_r \geq \varepsilon \quad r=1, 2, \dots, s \\
 &\quad V_i \geq \varepsilon \quad i=1, 2, \dots, m
 \end{aligned} \tag{1}$$

When ε is defined as an infinitesimal constant (a non-Archimedean quantity).

According to the model, E_K^* denotes the TSE efficiency for DMU_K. If $E_K^* = 1$ DMU_K is defined efficient and if $E_K^* < 1$ then DMU_K is not efficient.

The dual to (1) is:

$$\begin{aligned}
 &\text{minimize } \theta_K - \varepsilon \left(\sum_{r=1}^s S_{rK}^+ + \sum_{i=1}^m S_{iK}^- \right) \\
 &\text{subject to} \\
 &\quad \sum_{j=1}^n X_{ij} \lambda_j + S_{iK}^- = \theta X_K \quad i=1,2,\dots,m \\
 &\quad \sum_{j=1}^n Y_{rj} \lambda_j - S_{rK}^+ = Y_{rK} \quad r=1,2,\dots,s \\
 &\quad \lambda_j \geq 0 \quad j=1,2,\dots,n \\
 &\quad S_{rK}^+, S_{iK}^- \geq 0 \quad r=1,2,\dots,s, \quad i=1,2,\dots,m
 \end{aligned} \tag{2}$$

The BCC model computes Technical Efficiency (TE) with increasing return to scale. It can be defined by introducing the constraint $\sum_{j=1}^n \lambda_j = 1$.

In the next section we introduce the significance of advertisement for organizations, and demonstrate how an advertisement campaign was evaluated using DEA procedures.

3. ADVERTISING IN THE HOSPITALITY INDUSTRY

Advertising is considered a strategically important sphere of managerial decision-making, which may have a significant impact on a firm's financial performance. It represents one section of the organization's communication mix, which also includes promotion, merchandising, public relations and personal selling. Advertising is primarily aimed at making a service (or product) tangible to potential customers by promising a benefit or providing a solution to a problem, differentiating a product or a service from that of the competition, or capitalizing on word of mouth (Parasuraman, Zeithaml and Berry, 1988). Textbooks of advertising and marketing provide anecdotal evidence of effective (and ineffective) advertisements and provide some guidelines on do's and don'ts in advertising (see, for example, Hart & Troy, 1996; Batra, Myers & Aaker, 1996; Lewis & Chambers, 1989; Farris & Albion, 1980). In the hospitality industry, firms investment in advertisements is relatively low compared with other sectors of the tourism industry such as air travel and car rental (Lewis & Chambers, 1989), since it is difficult, at times, to identify an efficient form or media for advertising in this industry. Lewis & Chambers (1989) argue that "if a firm cannot make an impact upon the market with advertising, other than to create awareness and provide information, it might be better to save these dollars and put them to a better use".

Hotels in Israel often participate in different advertisement efforts. An important question, from a supply-side perspective, is how do hotels decide what price to post for their service in the advertisement? The answer is significant because if the price is too high, it will negatively affect customers' intention to buy and willingness to pay. If the price were set too low, the hotel would not be able to receive adequate income for the services, which it

offers. Therefore, an efficient advertisement is considered as such if the asking price adequately explains the attributes, which will be provided to the guest.

Israeli and Uriely (2000) and Israeli, Adler, Mehrez, and Sundali (2001) investigated advertising of Israeli Hotels. Their studies were aimed at identifying the factors that support a request for a premium price. The findings suggest that quality rating (star rating) is a significant predictor of price premium. Corporate affiliation or brand name, however, was not a significant predictor of premium price in advertisement in areas where most of the competition was from corporately affiliated hotels. These studies employed linear regression procedures to evaluate the impact of hotel attributes on advertised price. Regression analysis has some drawbacks, which can be overcome by using DEA procedures. First, regression analysis deals with a single output, and therefore when multiple outputs are involved the DEA procedure should be preferred. Second, regression measures efficiency relative to average performance and not to best performance. Therefore, an evaluation according to DEA may provide a better understanding of efficiency gains. Lastly, regression analysis requires a parametric specification of the production function. In many cases, the production function is unknown and therefore, the DEA procedures may be superior.

This analysis focuses on the efficiency of using a certain advertising effort in order to ask for a price that will justify the attributes that are presented in the advertisement. The argument offered in this analysis suggests that some features can support a request for a premium price. Therefore, the attributes presented in the advertisement supplement (inputs) will support an ability to post prices for services (output) and if the advertisement is efficient, the price will be higher than an inefficient advertisement. It was noted before that in some cases, and especially in using DEA, there may be different interpretations as to what are the inputs and what are the outputs. The assumption in this study is that attributes that characterize the hotel support a request for a price, and not the other way around.

4. INVESTIGATING ADVERTISEMENT EFFORTS WITH DEA

The data set of this study included advertisements in an informative supplement of a popular national newspaper in Israel. The supplement was titled "Vacations and Hotels in Israel - December 1998, January 1999" (Rechtman, 27.11.98). It consisted of a uniform format with a 2" by 2.5" frame (16 ads per page). The top of each advertisement consisted of the hotel's name and its corporate affiliation (if any), in the middle a picture of the hotel was printed, and on the bottom was a statement giving the hotel's price per person in a double room and contact information (address, telephone). On the right-hand side of each advertisement were five small icons, which reported whether the hotel offered certain amenities or services. These included a swimming pool, children's activities, adult activities, sport facilities and handicap accessibility (which, in Israel, is not required by law in all public buildings). If the service was offered, the icon was included in the ad, otherwise the icon was left blank. The information on the hotels that elected to participate in the newspaper supplement was collected, generating a database consisting of 52 hotels. There are several important reasons for selecting this unique setting as the scope of our analysis. First, the setting enforces uniformity thus, the variations between the

advertisements cannot be attributed to the freedom and creativeness of using the media which may allow to communicate different attributes or any other factor of presentation. Furthermore, the documented effect of repetition in advertisements and its impact on liking is neutralized in this one-time advertisement. Secondly, the advertising supplement represents what is termed a "simultaneous game" in game theory in which all the players make their moves at the same time. Therefore, the advertisements are each judged individually and not as a response to another hotel's previous advertisement(s). Thirdly, the setting allows us to focus on a limited set of attributes that may be major sources of justifying a requested price and also may determine the efficiency of the advertisement (Israeli *et. al.* 2001, Israeli and Uriely 2000).

There are, however, some apparent shortcomings that originate from analysis in such settings. The limitations imposed on the freedom to communicate assets in an advertisement undoubtedly limit the effectiveness of this advertisement supplement and therefore also limit the ability, and will, of advertisers to use it as a tool for economic power. Hence, we do not expect the advertising supplement to be viewed as a primary tool for securing market power. Nevertheless, there may be a certain, detectable trend attempting to build market power by communicating the hotel's attributes, and justifying a certain price, even in this restricted setting.

An important issue in employing DEA is the selection of inputs and outputs. In this study, the selection was motivated by two factors. The first was the governing reasoning behind the use of advertisement. In advertising, a firm is communicating attributes in an effort to be able to charge or justify a certain (preferably premium) price. There are different perspectives and theories that explain how a firm prices products or services. Pricing decisions are a well-researched area of the marketing literature (Nagle 1987). Although there is no doubt that traditional marketing tools and techniques affect pricing decisions, this paper focuses on a supply-side perspective and posits that an advertisement will be considered efficient if it supports the advertiser wish for posting a premium price. Therefore, prices are considered as outputs. The second factor that motivated the selection of inputs and outputs was the availability of information to the consumer. The inputs, or the hotel attributes, were included in the advertisement supplement that was analyzed. The outputs were the room prices as advertised in the hotel association guide. The data sources were reliable public and official publication and therefore they were considered suitable for the analysis.

The inputs that were collected from the advertisement supplement included a total of five attributes. The first four attributes were coded as binary variables, taking the value 1 if the hotel offered this attribute and 0 otherwise. These attributes were:

- x_1 swimming pool,
- x_2 kids activities,
- x_3 entertainment activities for adults,
- x_4 sport activities.

The fifth attribute x_5 was number of rooms. The output in the dataset included room prices for High Season (*HS*), Regular Season (*RS*) and Low Season (*LS*), which are published in the Israel Hotel Guide (Israel Hotel Association 1999).

The CE/DEA and AHP/DEA models were employed in four cases that differed in the selection of inputs and outputs. The first case (A) used number of rooms (x_5) as a single input and the average of the prices (*HS*, *RS*, and *LS*). The second case (B) employed

the same input, but the output was a vector of the three prices. In the third case (C) used all the inputs (x_1, x_2, \dots, x_5) and a vector of all the outputs (HS, RS , and LS). Due to the difficulties of DEA models with binary variables (and specifically with the value of 0) these inputs were changed such that their zero value was $\varepsilon = 10^{-10}$. In the forth and last case (D), all the inputs and outputs were used. This time, a different treatment was applied to the binary variables and they were changed to 1 if the attribute was not offered and to 2 if the attribute was present. This treatment is consistent with the procedure offered by Cooper Lawrence and Kaoru (2000) in cases where the variables have different ranges.

Table 2 provides information on the inputs and the outputs of the hotels, which were included in the dataset. In Table 3, the Technical and Scale Efficiency (TSE) according to CCR and the Technical Efficiency (TE) according to the BCC are provided for each case (A-D). Using the efficiency measures, ranking of advertisements' efficiency is conducted for each case (Tables 4a, 4b).

Name	Location	Pool x_1	Kids x_2	Adult x_3	Sport x_4	Rooms x_5	HS y_1	RS y_2	LS y_3
Edomit	Eilat	1		1		85	120	96	93
Ambassador	Eilat	1	1	1	1	216	242	196	178
Americana	Eilat	1	1	1	1	130	120	99	88
Moon Valley	Eilat	1	1	1		182	130	100	90
Dan Eilat	Eilat	1	1	1	1	378	535	345	270
Holiday Inn Patio	Eilat	1	1	1	1	115	145	115	115
King Solomon	Eilat	1	1	1	1	419	346	240	176
Princess	Eilat	1	1	1	1	420	588	307	281
Edom Mountain	Eilat	1	1	1	1	110	118	100	88
Vista	Eilat	1	1	1		84	144	115	104
Topaz	Eilat	1	1	1		81	120	110	97
Laguna	Eilat	1	1	1		256	234	213	175
Mercure	Eilat	1	1	1	1	159	130	110	100
Nova	Eilat	1	1	1	1	193	157	134	123
Sport	Eilat	1	1	1	1	327	229	188	143
Palmira	Eilat	1	1	1	1	195	235	196	167
Sheraton Eilat	Eilat	1	1	1	1	247	207	155	137
Sheraton Four Point	Eilat	1	1	1	1	282	217	185	165
Caesar Eilat	Eilat	1	1	1	1	241	182	167	133
Crown Plaza Eilat	Eilat	1	1	1	1	266	328	218	218
Raddisson Moria Plaza	Eilat	1	1	1	1	306	280	250	250
Royal Beach	Eilat	1	1	1	1	363	666	457	309
Reef	Eilat	1		1		79	155	132	127
Astoria	Tiberius	1				65	106	87	82
Holiday Inn Tiberius	Tiberius	1	1	1	1	246	238	180	173
Quiet Beach Tiberius	Tiberius				1	198	140	109	95
Tiberius Hotel	Tiberius	1			1	70	130	96	96
Raddisson Moria Plaza Tiberius	Tiberius	1	1	1	1	272	275	255	210
Royal Plaza Tiberius	Tiberius		1	1	1	160	194	162	162
Crown Plaza Dead Sea	Dead Sea	1	1	1	1	302	250	240	218
Carlton Dead Sea	Dead Sea	1	1	1	1	244	175	136	136
Raddisson Moria Dead Sea	Dead Sea	1	1	1	1	196	230	200	200
Raddisson Moria Plaza Dead Sea	Dead Sea	1	1	1	1	220	290	250	250
Dvir	Haifa	1	1			30	69	69	69
Dan Carmel	Haifa	1	1	1	1	219	306	266	252
Dan Panorama	Haifa	1	1	1	1	266	242	232	207
Carmel Mountain	Haifa		1	1		99	70	70	70
Carmel Beach	Haifa	1	1	1	1	90	305	280	260
Ariel	Jerusalem					128	135	115	115
King David	Jerusalem				1	237	472	394	394
Mercur Jerusalem	Jerusalem					298	140	115	95
Dan Pearl	Jerusalem	1	1	1	1	104	423	311	311
Sheraton Jerusalem	Jerusalem	1	1	1	1	296	317	277	191
Raddisson Moria Plaza Jerusalem	Jerusalem	1	1	1	1	292	235	215	185
Royal Plaza Jerusalem	Jerusalem				1	300	200	144	144
Sheraton Plaza Jerusalem	Jerusalem	1	1	1	1	296	317	277	191
Dan Panorama Tel Aviv	Tel Aviv	1	1	1	1	500	261	222	222
Melody	Tel Aviv					34	125	117	113
Crown Plaza Tel Aviv	Tel Aviv	1	1	1	1	246	378	318	318
Carlton Tel Aviv	Tel Aviv	1			1	281	242	217	177
Raddisson Moria Plaza Tel Aviv	Tel Aviv	1	1	1	1	355	245	225	195
Ramada Continental	Tel Aviv	1	1	1	1	340	213	183	183

Table 2: Inputs and the outputs of hotels participating in the advertising campaign

DMU	Case A		Case B		Case C		Case D	
	TSE	TE	TSE	TE	TSE	TE	TSE	TE
Ambassador	0.273	0.280	0.286	0.289	0.290	0.353	0.515	0.617
Americana	0.226	0.252	0.238	0.259	0.238	0.259	0.303	0.500
Ariel	0.273	0.274	0.278	0.284	0.287	1.000	0.584	1.000
Astoria	0.405	0.490	0.419	0.502	0.444	0.523	0.532	1.000
Caesar Eilat	0.192	0.195	0.204	0.213	0.204	0.237	0.422	0.567
Carlton Dead Sea	0.176	0.178	0.181	0.188	0.187	0.188	0.357	0.542
Carlton Tel Aviv	0.217	0.222	0.230	0.244	0.234	0.382	0.551	1.000
Carmel Beach	0.899	0.930	0.914	1.000	0.922	1.000	1.000	1.000
Carmel Mountain	0.203	0.304	0.213	0.304	0.213	0.343	0.379	1.000
Crown Plaza Dead Sea	0.225	0.231	0.231	0.253	0.231	0.429	0.585	0.665
Crown Plaza Eilat	0.275	0.284	0.303	0.307	0.322	0.500	0.614	0.701
Crown Plaza Tel Aviv	0.395	0.410	0.403	0.468	0.403	0.735	0.807	0.848
Dan Carmel	0.360	0.373	0.368	0.392	0.368	0.593	0.695	0.745
Dan Eilat	0.291	0.447	0.348	0.591	0.374	0.766	0.840	0.881
Dan Panorama	0.245	0.252	0.254	0.276	0.254	0.431	0.568	0.654
Dan Panorama Tel Aviv	0.135	0.139	0.138	0.145	0.139	0.325	0.564	0.658
Dan Pearl	0.962	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Dvir	0.661	1.000	0.692	1.000	0.692	1.000	0.692	1.000
Edom Mountain	0.266	0.297	0.279	0.305	0.279	0.305	0.318	0.500
Edomit	0.348	0.385	0.359	0.396	0.384	0.400	0.545	1.000
Holiday Inn Patio	0.312	0.313	0.321	0.337	0.321	0.337	0.362	0.517
Holiday Inn Tiberias	0.230	0.236	0.241	0.246	0.252	0.313	0.472	0.610
King David	0.509	1.000	0.520	1.000	0.542	1.000	1.000	1.000
King Solomon	0.174	0.180	0.203	0.205	0.219	0.408	0.545	0.697
Laguna	0.233	0.239	0.246	0.262	0.249	1.000	0.999	1.000
Melody	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Mercur Jerusalem	0.113	0.114	0.121	0.126	0.128	1.000	0.541	1.000
Mercure	0.205	0.211	0.213	0.221	0.213	0.221	0.319	0.500
Moon Valley	0.168	0.182	0.179	0.193	0.194	0.228	0.489	1.000
Nova	0.205	0.207	0.213	0.215	0.213	0.215	0.366	0.526
Palmira	0.294	0.301	0.312	0.318	0.312	0.368	0.395	0.517
Princess	0.268	0.441	0.344	0.666	0.371	0.854	0.897	0.927
Quiet Beach Tiberias	0.166	0.170	0.178	0.190	0.192	0.216	0.336	1.000
Raddisson Moria Dead Sea	0.308	0.316	0.313	0.330	0.313	0.391	0.543	0.637
Raddisson Moria Plaza	0.244	0.252	0.247	0.269	0.247	0.471	0.635	0.699
Raddisson Moria Plaza Dead Sea	0.344	0.355	0.350	0.330	0.350	0.543	0.652	0.726
Raddisson Moria Plaza Jerusalem	0.208	0.214	0.214	0.232	0.217	0.359	0.513	0.631
Raddisson Moria Plaza Tel Aviv	0.179	0.184	0.186	0.200	0.186	0.354	0.539	0.645
Raddisson Moria Plaza Tiberias	0.261	0.269	0.274	0.299	0.274	0.498	0.620	0.688
Ramada Continental	0.163	0.167	0.166	0.173	0.166	0.251	0.465	0.600
Reef	0.502	0.506	0.512	0.520	0.534	1.000	0.652	1.000
Royal Beach	0.378	1.000	0.451	1.000	0.484	1.000	1.000	1.000
Royal Plaza Jerusalem	0.156	0.158	0.164	0.172	0.181	0.260	0.424	1.000
Royal Plaza Tiberias	0.310	0.316	0.317	0.321	0.330	0.361	0.505	1.000
Sheraton Eilat	0.194	0.197	0.208	0.216	0.218	0.245	0.395	0.570
Sheraton Four Point	0.193	0.197	0.201	0.206	0.201	0.274	0.448	0.593
Sheraton Jerusalem	0.254	0.262	0.283	0.303	0.283	0.359	0.654	0.718
Sheraton Plaza Jerusalem	0.254	0.262	0.283	0.303	0.283	0.547	0.654	0.718
Sport	0.164	0.168	0.180	0.182	0.184	0.264	0.429	0.600
Tiberias Hotel	0.441	0.473	0.458	0.503	0.505	0.528	0.549	1.000
Topaz	0.387	0.410	0.399	0.415	0.403	0.415	0.634	1.000
Vista	0.414	0.414	0.436	0.458	0.466	0.744	0.655	1.000

Table 3: Technical and Scale Efficiency (TSE) and the Technical Efficiency (TE) for cases A-D

DMU	A		B			
	$E_j(\text{CCR})$	Rank	AHP/DEA		CE/DEA	
			W_j	Rank	\bar{h}_j	Rank
Ambassador	0.273	31	0.299	31	0.280	30
Americana	0.226	20	0.255	20	0.232	20
Ariel	0.273	30	0.296	29	0.274	29
Astoria	0.405	44	0.426	44	0.412	43
Caesar Eilat	0.192	11	0.223	12	0.196	11
Carlton Dead Sea	0.176	9	0.206	8	0.179	8
Carlton Tel Aviv	0.217	18	0.247	18	0.222	18
Carmel Beach	0.899	50	0.919	50	0.898	50
Carmel Mountain	0.203	14	0.236	16	0.198	13
Crown Plaza Dead Sea	0.225	19	0.253	19	0.223	19
Crown Plaza Eilat	0.275	32	0.300	32	0.289	31
Crown Plaza Tel Aviv	0.395	43	0.413	43	0.396	42
Dan Carmel	0.360	40	0.380	41	0.362	40
Dan Eilat	0.291	33	0.309	33	0.319	37
Dan Panorama	0.245	24	0.272	24	0.244	24
Dan Panorama Tel Aviv	0.135	2	0.163	2	0.135	2
Dan Pearl	0.962	51	0.975	51	0.991	52
Dvir	0.661	49	0.635	49	0.643	49
Edom Mountain	0.266	28	0.293	28	0.272	28
Edomit	0.348	39	0.368	40	0.355	39
Holiday Inn Patio	0.312	37	0.332	37	0.317	36
Holiday Inn Tiberias	0.230	21	0.260	21	0.237	22
King David	0.509	48	0.528	48	0.512	48
King Solomon	0.174	8	0.217	10	0.189	10
Laguna	0.233	22	0.263	22	0.237	21
Melody	1.000	52	1.000	52	0.989	51
Mercur Jerusalem	0.113	1	0.135	1	0.117	1
Mercure	0.205	15	0.234	14	0.208	15
Moon Valley	0.168	7	0.199	7	0.175	7
Nova	0.205	16	0.234	15	0.208	16
Palmira	0.294	34	0.319	34	0.303	33
Princess	0.268	29	0.296	30	0.299	32
Quiet Beach Tiberias	0.166	6	0.197	6	0.173	6
Raddisson Moria Dead Sea	0.308	35	0.328	35	0.307	34
Raddisson Moria Plaza	0.244	23	0.270	23	0.242	23
Raddisson Moria Plaza Dead Sea	0.344	38	0.363	39	0.344	38
Raddisson Moria Plaza Jerusalem	0.208	17	0.239	17	0.211	17
Raddisson Moria Plaza Tel Aviv	0.179	10	0.209	9	0.181	9
Raddisson Moria Plaza Tiberias	0.261	27	0.289	27	0.264	25
Ramada Continental	0.163	4	0.194	4	0.163	4
Reef	0.502	47	0.522	47	0.506	47
Royal Beach	0.378	41	0.359	38	0.416	44
Royal Plaza Jerusalem	0.156	3	0.188	3	0.161	3
Royal Plaza Tiberias	0.310	36	0.330	36	0.312	35
Sheraton Eilat	0.194	13	0.227	13	0.202	14
Sheraton Four Point	0.193	12	0.221	11	0.196	12
Sheraton Jerusalem	0.254	26	0.276	26	0.267	27
Sheraton Plaza Jerusalem	0.254	25	0.276	25	0.267	26
Sport	0.164	5	0.196	5	0.172	5
Tiberias Hotel	0.441	46	0.454	46	0.453	46
Topaz	0.387	42	0.406	42	0.389	41
Vista	0.414	45	0.434	45	0.426	45

Table 4a: Ranking by AHP/DEA and CE/DEA for cases A and B

DMU	C				D			
	AHP/DEA		CE/DEA		AHP/DEA		CE/DEA	
	W_j	Rank	\bar{h}_j	Rank	W_j	Rank	\bar{h}_j	Rank
Amnassador	0.281	28	0.285	30	0.600	32	0.456	32
Americana	0.251	8	0.232	20	0.537	7	0.265	4
Ariel	0.323	46	0.281	29	0.588	25	0.346	16
Astoria	0.285	34	0.426	44	0.587	24	0.313	11
Caesar Eilat	0.247	4	0.197	11	0.533	4	0.362	20
Carlton Dead Sea	0.238	2	0.182	9	0.515	2	0.312	10
Carlton Tel Aviv	0.279	26	0.226	19	0.602	33	0.468	34
Carmel Beach	0.374	49	0.867	50	0.797	50	0.820	49
Carmel Mountain	0.274	20	0.195	10	0.535	5	0.210	1
Crown Plaza Dead Sea	0.274	21	0.222	18	0.592	27	0.492	36
Crown Plaza Eilat	0.290	38	0.303	32	0.620	42	0.502	38
Crown Plaza Tel Aviv	0.354	48	0.399	42	0.775	49	0.719	48
Dan Carmel	0.320	45	0.363	39	0.690	47	0.614	45
Dan Eilat	0.300	43	0.342	37	0.653	45	0.682	47
Dan Panorama	0.278	25	0.243	23	0.597	31	0.492	37
Dan Panorama Tel Aviv	0.259	11	0.137	2	0.572	16	0.399	24
Dan Pearl	0.421	50	0.991	51	0.926	51	0.913	51
Dvir	0.291	40	0.632	49	0.594	28	0.288	8
Edom Mountain	0.261	12	0.269	26	0.555	12	0.278	5
Edomit	0.281	29	0.366	40	0.585	23	0.310	9
Holiday Inn Patio	0.272	19	0.315	34	0.577	18	0.326	13
Holiday Inn Tiberias	0.270	17	0.244	24	0.578	19	0.411	25
King David	0.534	51	0.527	48	1.000	52	0.962	52
King Solomon	0.268	16	0.202	13	0.583	21	0.446	30
Laguna	0.272	18	0.238	21	0.583	22	0.454	31
Melody	1.000	52	1.000	52	0.620	43	0.517	39
Mercur Jerusalem	0.267	15	0.122	1	0.566	13	0.254	3
Mercure	0.244	3	0.208	14	0.525	3	0.279	6
Moon Valley	0.224	1	0.178	6	0.486	1	0.246	2
Nova	0.248	5	0.209	16	0.535	6	0.321	12
Palmira	0.284	32	0.300	31	0.606	36	0.463	33
Princess	0.292	41	0.329	36	0.633	44	0.633	46
Quiet Beach Tiberias	0.276	24	0.182	7	0.568	14	0.282	7
Raddisson Moria Dead Sea	0.285	35	0.306	33	0.612	37	0.482	35
Raddisson Moria Plaza	0.284	33	0.243	22	0.613	38	0.524	40
Raddisson Moria Plaza Dead Sea	0.310	44	0.344	38	0.668	46	0.583	44
Raddisson Moria Plaza Jerusalem	0.265	14	0.211	17	0.573	17	0.443	29
Raddisson Moria Plaza Tel Aviv	0.261	13	0.182	8	0.570	15	0.436	28
Raddisson Moria Plaza Tiberias	0.288	37	0.265	25	0.619	40	0.532	41
Ramada Continental	0.251	7	0.164	3	0.548	10	0.373	22
Reef	0.296	42	0.517	47	0.619	41	0.431	27
Royal Beach	0.332	47	0.444	45	0.718	48	0.881	50
Royal Plaza Jerusalem	0.274	22	0.170	4	0.594	29	0.336	15
Royal Plaza Tiberias	0.291	39	0.319	35	0.618	39	0.427	26
Sheraton Eilat	0.251	9	0.209	15	0.541	8	0.349	19
Sheraton Four Point	0.254	10	0.199	12	0.550	11	0.392	23
Sheraton Jerusalem	0.282	31	0.273	28	0.605	35	0.550	43
Sheraton Plaza Jerusalem	0.282	30	0.273	27	0.605	34	0.550	42
Sport	0.250	6	0.177	5	0.543	9	0.372	21
Tiberias Hotel	0.287	36	0.476	46	0.595	30	0.347	17
Topaz	0.275	23	0.375	41	0.581	20	0.329	14
Vista	0.280	27	0.419	43	0.589	26	0.349	18

Table 4b: Ranking by AHP/DEA and CE/DEA for cases C and D

5. DISCUSSION OF FINDINGS AND CONCLUSIONS

The study focused on advertisements that are geared to the domestic consumer in Israel. This focus is motivated by the fact that the majority of the guests in the Israeli hotel industry are locals and that the reliance on domestic markets is expected to intensify in light of the current affairs in the Middle East. Since the potential consumer has some knowledge about the industry and about specific hotels, it is interesting to know what contributes to an advertisement's efficiency.

The data suggests that the ranking of advertisement efficiency changes with the inclusion of additional attributes. However, Table 5 provides the Spearman Correlation measure for the different models and suggests that a positive and significant correlation exists between the different models.

	AHP (B)	CE (B)	AHP (C)	CE (C)	AHP (D)	CE (D)
AHP/CE (A)	0.999	0.997	0.814	0.992	0.721	0.423
AHP (B)		0.996	0.815	0.990	0.722	0.421
CE (B)			0.821	0.997	0.734	0.445
AHP (C)				0.831	0.932	0.663
CE (C)					0.747	0.462
AHP (D)						0.841

Table 5: Spearman Correlation between ranking methods

Ranking of hotel advertisements' efficiency using DEA assumes that when the hotel communicates attributes of quality in advertising, and manage to ask for a premium for these attributes, then its advertisement will be efficient. Testing this idea could be conducted by correlating the DEA-based advertising ranking and another ranking of quality. Therefore, the DEA rankings of the hotel advertisements according to each model (A-D) were correlated to the ranking of hotels according to the star-rating system that prevails in the Israeli industry (a summary of the rankings and the corresponding star rating are presented in Table 6). Under the star rating system hotels receive up to 5 stars according to the level of service offered, as monitored by the special code published by the Ministry of Tourism. The star rating system is no longer advocated by the Ministry due to mounting difficulties in applying it and in monitoring compliance with its demands. Nevertheless, it is still popular in the industry and hotels report their rating under the system despite the fact that it is not active any more. Israeli and Uriely (2000) have demonstrated that the star rating is a significant predictor of "asking price" among hotels in Israel. Their analysis provided evidence suggesting that much of the price variation in room prices can be explained by the hotels' indication of quality as measured by their star rating. It is important to note that on the industry level, high star rating is an asset that consistently supports an advertisement of a price premium. This finding is not surprising since the star rating system is a well-established and long lasting standard, which has been used historically to rate hotels in Europe and other parts of the world.

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	A	B		C		D		Star Rating
		AHP	CE	AHP	CE	AHP	CE	
Ambassador	31	31	30	28	30	32	32	4
Americana	20	20	20	8	20	7	4	2
Ariel	30	29	29	46	29	25	16	4
Astoria	44	44	43	34	44	24	11	2
Caesar Eilat	11	12	11	4	11	4	20	4
Carlton Dead Sea	9	8	8	2	9	2	10	4
Carlton Tel Aviv	18	18	18	26	19	33	34	5
Carmel Beach	50	50	50	49	50	50	49	4
Carmel Mountain	14	16	13	20	10	5	1	3
Crown Plaza Dead Sea	19	19	19	21	18	27	36	5
Crown Plaza Eilat	32	32	31	38	32	42	38	5
Crown Plaza Tel Aviv	43	43	42	48	42	49	48	5
Dan Carmel	40	41	40	45	39	47	45	5
Dan Eilat	33	33	37	43	37	45	47	5
Dan Panorama	24	24	24	25	23	31	37	5
Dan Panorama Tel Aviv	2	2	2	11	2	16	24	5
Dan Pearl	51	51	52	50	51	51	51	5
Dvir	49	49	49	40	49	28	8	3
Edom Mountain	28	28	28	12	26	12	5	3
Edomit	39	40	39	29	40	23	9	3
Holiday Inn Patio	37	37	36	19	34	18	13	4
Holiday Inn Tiberias	21	21	22	17	24	19	25	4
King David	48	48	48	51	48	52	52	5
King Solomon	8	10	10	16	13	21	30	5
Laguna	22	22	21	18	21	22	31	4
Melody	52	52	51	52	52	43	39	4
Mercur Jerusalem	1	1	1	15	1	13	3	4
Mercure	15	14	15	3	14	3	6	4
Moon Valley	7	7	7	1	6	1	2	2
Nova	16	15	16	5	16	6	12	4
Palmira	34	34	33	32	31	36	33	4
Princess	29	30	32	41	36	44	46	5
Quiet Beach Tiberias	6	6	6	24	7	14	7	3
Raddisson Moria Dead Sea	35	35	34	35	33	37	35	5
Raddisson Moria Plaza	23	23	23	33	22	38	40	5
Raddisson Moria Plaza Dead Sea	38	39	38	44	38	46	44	5
Raddisson Moria Plaza Jerusalem	17	17	17	14	17	17	29	5
Raddisson Moria Plaza Tel Aviv	10	9	9	13	8	15	28	5
Raddisson Moria Plaza Tiberias	27	27	25	37	25	40	41	5
Ramada Continental	4	4	4	7	3	10	22	5
Reef	47	47	47	42	47	41	27	3
Royal Beach	41	38	44	47	45	48	50	5
Royal Plaza Jerusalem	3	3	3	22	4	29	15	4
Royal Plaza Tiberias	36	36	35	39	35	39	26	4
Sheraton Eilat	13	13	14	9	15	8	19	5
Sheraton Four Point	12	11	12	10	12	11	23	4
Sheraton Jerusalem	26	26	27	31	28	35	43	5
Sheraton Plaza Jerusalem	25	25	26	30	27	34	42	5
Sport	5	5	5	6	5	9	21	4
Tiberias Hotel	46	46	46	36	46	30	17	3
Topaz	42	42	41	23	41	20	14	3
Vista	45	45	45	27	43	26	18	3

Table 6: Ranking and Star Rating of hotels

The findings suggest no significant correlation between advertising ranking according to DEA and star rating for case A-C. However, significant and positive correlation between the effectiveness of the advertisement and the hotel star rating was observed only for model D. In model D, all the attributes x_1 - x_5 were considered and the dichotomy of attributes x_1 - x_4 was treated when the value “no” was assigned the value 1 and “yes” was assigned 2 (as opposed to ε for “no” and 1 for “yes” in models B-C).

	Star Rating
AHP/CE(A)	-0.084*
AHP(B)	-0.085*
CE(B)	-0.061*
AHP(C)	0.239*
CE(C)	-0.046*
AHP(D)	0.452
CE(D)	0.762

*not significant at $p < .01$

Table 7: Spearman Correlation between ranking methods and hotel star rating

On the procedural level, the findings suggest that the inclusion of as many significant outputs as available increased the relevance of the DEA ranking. Also, overcoming the problematic definitions of dichotomies in the variables (yes/no for x_1 - x_4) by assigning them the values 1 and 2 for “no” and “yes” respectively may have increased the validity of the ranking. This finding suggests that in order to increase the efficiency of hotel advertisements, the ad should communicate most of the signals of quality. When these signals are not included or not present, the efficiency of the advertisement may be negatively affected.

Some of the issues that were presented in this case study should be further pursued in future research. First, the treatment of yes/no variables and its impact on DEA models should be further evaluated. In this analysis, we attempted to quantify them as ε and 1, and as 1 and 2. Future research should investigate other methods to distinguish between the dichotomies. With respect to the relevance of advertising efficiency and ranking, the focus of this study was on the ability to ask for a price, and not on the ability to actually receive a price. In future research attention should be given to hotel’s added revenues which follow what is measured as an efficient or inefficient advertising effort.

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