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ASSESSING THE EFFICIENCY OF HOTELS IN UZBEKISTAN'S ANCIENT CITIES OF SAMARKAND AND BUKHARA USING DATA ENVELOPMENT ANALYSIS

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Abstract: This article aims to analyze the efficiency of hotels in Samarkand and Bukhara cities from Uzbekistan. The study will shed light on efficiency issues of using the combination of labor and capital in 15 hotels in Bukhara and six hotels in Samarkand using data envelopment analysis. The results of the research show that out of 21 hotels, few of them showed maximum efficiency relative to benchmark indicators, while others struggled to allocate resources in a more efficient way. Overall, the study offers measures to improve the efficiency rate in each hotel based on an in-depth analysis of input and output variables, and therefore, it can be used by hotel managers as a guideline for the use of the DEA method in measuring efficiency.

Keywords: efficiency, tourism, data envelopment analysis, input, output, benchmark

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INTRODUCTION

Measuring efficiency has always been an important issue for business growth. Managing resources in hotels in an optimal way so as to minimize cost and maximize profit is a fundamental problem that every manager has to solve. This study considers working out proposals for managers to calculate efficiency based on benchmark output and input variables of competing hotels. Economic efficiency refers to a condition where resources are allocated in a way that maximizes benefits for each individual or organization, ensuring optimal use while reducing waste and minimizing

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inefficiencies (Investopedia.com, June 30, 2024). Macroeconomic policy significantly affects the overall efficiency of enterprises, in particular, tourism businesses (Kifworo and Dube, 2024). Tourism business plays an important role in the economies of tourism-oriented ancient cities of Uzbekistan, such as Samarkand and Bukhara (Safarov et al., 2022). Samarkand and Bukhara are famous for their historical buildings and landmark places located in Central Asia. The Registan Square, Gur Emir mausoleum, Bibikhanum mosque, and other places attract millions of tourists to Samarkand all over the world. Bukhara is also famous for its Middle Ages palaces, ancient bazaars, and other landmark places.

These two ancient cities attract most of the tourists from abroad. Roughly four million tourists visit these cities yearly (Statistical agency data, 2024). So, assessing the efficiency of hotels and other accommodation types in these cities reflects how the hospitality industry, in general, is doing. If the performance efficiency in the average hotels is high, it means that the tourism industry is doing well overall (Arabov et al., 2024).

Poldrugovac et al. (2016) pointed out various methods to measure efficiency of accommodation, such as occupancy rate, return on assets and others. According to Hadad et al. (2012) as tourism sector is growing, it has become crucial to assess efficiency and productivity within tourism infrastructure. Also, the environmental factors play significant role in improving efficiency within tourism infrastructure (Ilies et al., 2023). Perception of efficiency by stakeholders might be crucial in proactive decision-making process (Herman et al., 2024).

Efficiency typically describes the connection between output and input factors, relating to the operational performance of a business at the micro level or a nation at the macro level. A process that generates more output than input is considered more efficient (Safarov et al., 2023). When significantly more outputs are produced than inputs, optimal efficiency is achieved. However, achieving higher efficiency is impossible without adopting new technologies or implementing various changes (Soysal-Kurt, 2017). Efficiency can be evaluated using both parametric and nonparametric methods. Parametric methods involve a predefined production function, accounting for changes that may randomly affect production (such as factor analysis, regression analysis, etc.).

In contrast, nonparametric methods perform the analysis without a predefined production function, employing techniques like linear programming. In this paper, we analyze the efficiency of resource allocation in hotels in the biggest tourist cities of Uzbekistan, Samarkand, and Bukhara. The research aims to shed light on how hotels in ancient tourism-oriented cities are actually performing and, based on research results, work out appropriate suggestions. The findings will contribute to the state-of-the-art literature by applying the theoretical framework of both CSR and VCR versions of data envelopment analysis to real-world business cases.

LITERATURE REVIEW

The Data Envelopment Analysis (DEA) is one of the linear programming-based methods, which can be used for both multiple input and multiple output variables. Essentially, the DEA method allows for the inclusion of various input and output parameters to evaluate the efficiency of decision-making units (DMUs).

The efficiency score is relative, as it is determined within a predefined group of decision-making units, and adding or removing a unit from this group can influence the results. Overall, the DEA method can be understood as an effort to maximize output parameters while minimizing input parameters (Rosić et al., 2015).

The DEA method is widely recognized as an effective tool for measuring performance efficiency. The method is widely used in many fields, including finance, heavy industry, logistics, and others (Emrouznejad and Yang, 2018). Previous reviews of DEA have been well-documented in academic literature. The work of Charnes et al. (1987) was fundamental in the dissemination of DEA analysis as a tool for measuring efficiency. According to Lampe and Hilgers (2015), Stochastic Frontier Analysis can be extensively used in economics, while DEA is preferred in operations research. Even though DEA has been applied in many fields, its utilization in tourism operations is very low (Altin et al., 2018).

A separate study presented a curated performance model based on bibliometric analysis of tourism research, addressing issues such as dynamic modeling, heterogeneity (Albu et al., 2021), and incorrect outputs in relation to tourism destination areas (Assaf and Tsionas, 2019). Efficiency in the hotel industry has become crucial recently (Schalk-Nador and Rašovská, 2024). Also, cultural resources turned out to be a significant factor affecting technical efficiency in tourism destinations of Spain (Herrero-Prieto and Gomez-Vega, 2017). The Data Envelopment Analysis was used in assessing destination performance (Yen et al., 2021), and explore global interaction of various destinations (Lozano and Gutiérrez, 2018). Beyond that it was applied to evaluate tourism competitiveness (Cracolici et al., 2008).

MATERIALS AND METHODS

The research extensively uses linear programming based methods to analyze efficiency of 21 hotels located in Samarkand and Bukhara. The data is taken from statistical agency and tax departments of corresponding regions for the period of May 2024. Various methods can be used to evaluate the efficiency of hotel operations. Linear programming techniques are widely employed to optimize resource allocation in enterprises. Data Envelopment Analysis (DEA), developed by Farrell (1957), is a method based on the ratio of weighted sums of multiple inputs and outputs, and it is also extensively used in modern research. When it is necessary to analyze the performance of a tourism enterprise in relation to resource expenditure, applying DEA analysis is advisable. Data Envelopment Analysis is a linear programming method that looks for the tight “enveloping” of input and output variables. The DEA variation developed by Charnes et al. (1978) is used to evaluate when outcome variables achieve maximum values involving minimal resources. The DEA-CCR model does not necessitate predefined weights for the input and output variables. The optimization model parameters are created

individually for each enterprise in data envelopment analysis. As 15 hotels from Bukhara were involved in our research, the model was executed 15 times. In general, the DEA model can be mathematically described as follows:

Given 1,2,…n enterprises, let x_i represent the production resources of the i -th enterprise, and y_j represents the outcome factor of the j th enterprise. Furthermore, let u_i be the corresponding weights assigned to the production resources, and v_j be the corresponding weights assigned to the outcome factors. The efficiency $\theta -$ can then be expressed as follows (Ray, 2004):

$$\theta = \frac{\sum_{k=1}^{m}\sum_{j=1}^{n} v_j^k * y_j^k}{\sum_{b=1}^{a}\sum_{i=1}^{n} u_i^b * x_i^n} \leq 1 \;\; v_i, u_j \geq 0; \;\; i = 1,2,\ldots.I; j = 1,2,\ldots.J; \;\; I,J \in N \quad (1)$$

That is, when there are m output factors and a input factors, the maximum value of efficiency $\theta -$ can be equal to 1. This indicates that the volume of output factors used can never exceed the resources expended. Thus, the concept of technical efficiency can be described as follows (Sharma, 2024):

$TS_t = max\sum_{j=1}^{J} u_j y_j^t$, $TS_t -$technical efficiency, $TS_t \leq 1$ (2)

Technical efficiency TS_t refers to the ability to convert resources into goods and services. It generally indicates how efficiently a hotel operates. A technical efficiency value of one means the hotel is more efficient compared to others, while a value below one indicates inefficiency. Therefore, enhancing efficiency can be viewed as a matter of assessing technical efficiency, which can be expressed as follows (Charnes et al., 1978):

$TS_y = \frac{1}{\varphi}$ where $\varphi -$coefficient of expansion, also following conditions should be met, (3)

$\sum_{j=1}^{n} \lambda_j y_j \geq \varphi y_j$ where $y_j -$the value of the corresponding output variable, (4)

$\sum_{j=1}^{n} \lambda_j x_i \leq x_i$ where $x_i -$the value of the corresponding input variable, (5)

$\sum_{j=1}^{n} \lambda_j = 1, \; \lambda_j \geq 0 \; (j = 1,2,3 \ldots n)$, where $\lambda_j -$the weight values. (6)

For analyzing efficiency in hotels of Samarkand we used slightly different approach. In the work of Kirigia et al. (2002), cost efficiency is expressed as the product of allocative efficiency and technical efficiency.

$XS = JS * TS$ where $XS -$ cost efficiency, $JS -$distribution efficiency (assesses to how extent resources are distributed optimally to produce goods and deliver services). (7)

Our research objective is to minimize the following objective function:

$XS = min\sum_{i=1}^{n} w_i x_i$ where $w -$ corresponding weights of resources (level of importance). (8)

Moreover, let the inequality (1) be expressed in the following way (Charnes et al., 1978):

$\sum_{j=1}^{n} \lambda_j y_j \geq y_j$ (9)

We will solve this linear programming problem using the Simplex method and apply it to the economic indicators. The cost efficiency can be calculated as follows (Kirigia et al., 2002):

$XS = \frac{P_{capital} * K + P_{labor} * L}{X}$ where $XS -$cost efficiency, $P_{capital} -$price of the capital, $P_{labor} -$ labor price in the given hotel, $K -$capital units spent (the ratio of depreciation expenses to the number of tourists), $L -$ number of staff, $X -$the volume of real expenses (thousand Uzbek soums - UZS). (10)

RESULTS AND DISCUSSION

The analysis was implemented in MS EXCEL's Solver add-in and DEA frontier software. Throughout the research Simplex method was used in solving the distribution problem of resources within an enterprise. Table 1 reflects the economic indicators of the 15 hotels located in Bukhara. The input factors considered were the number of employees and the amount of capital utilized in providing services (Table 1). The hotels' revenues were taken as the output factor.

Table 1. Input and Output Variables in Hotels in Bukhara (Source: authors' calculations based on Tax reports and data from statistical agency of Bukhara region, https://www.buxstat.uz) *LLC- limited liability company, FE-family enterprise, PC-private company

Hotels	Input 1 (Labor, number of staff)	Input 2 (Capital, thousand UZS per month)	Output (Income in thousand UZS per month)
"ZARGARON-LYUKS" LLC	12	1361.01	1391396.0
"FATIMA GOLD PLAZA" FE	5	1444.84	1474005.0
"NODIR DEVONBEGIM TRAVEL" LLC	7	41.31	862879.0
"AMMAR-AISHA TRAVEL"FE	5	0	556067.0
"KAVSAR BUKHARA" LLC	7	236.04	315478.0
"EMIR TRAEL" PC	2	251.37	481590.0
"QODIR MOMINA" LLC	3	0	72184.0
"RESSORT MEKKA" LLC	4	641.52	349948.0
"BIG LARGE" LLC	21	3.89	4503967.0
TEMUR PLAZA LLC	2	62.58	173492.0
"MANUCHEHR MUSINOVICH GULAMOV" FE	3	595.82	112805.0
"AN-NUR NISA" FE	2	575.87	23191.0
"VAVILON PLAZA" FE	2	475.94	460492.0
"ZARNIGOR-93" LLC	2	65.51	9135375.0
"DEVEL ECO GROUP" LLC	99	876.76	12504748.0

During the study, the efficiency of each hotel was calculated using the DEA frontier software package in MS Excel, employing the Simplex method. In this analysis, we calculated the technical efficiency indicator θ based on Constant Return to Scale (CRS) and Variable Return to Scale (VRS) approaches. Constant returns to scale indicate that an increase in input leads to a proportionate rise in output, whereas variable returns to scale reflect a disproportionate change in output relative to the increase in input. The calculations are carried out separately in iterative cycles for each hotel (Table 2).

Table 2. CRS and VRS Technical Efficiency indicators of hotels in Bukhara (Source: Authors' work)
*LLC- limited liability company, FE-family enterprise, PC-private company

Hotels	CRS technical efficiency	VRS technical efficiency	Scope efficiency	Change in scale efficiency
"ZARGARON-LYUKS" LLC	0.025	0.17	0.15	increasing
"FATIMA GOLD PLAZA" FE	0.064	0.40	0.16	increasing
"NODIR DEVONBEGIM TRAVEL" LLC	0.126	0.39	0.321	increasing
"AMMAR-AISHA TRAVEL"FE	1.000	1.00	1.00	constant
"KAVSAR BUKHARA" LLC	0.009	0.28	0.03	increasing
"EMIR TRAEL" PC	0.053	1.00	0.05	increasing
"QODIR MOMINA" FE	0.216	1.00	0.216	increasing
"RESSORT MEKKA" LLC	0.019	0.50	0.038	increasing
"BIG LARGE" LLC	1.00	1.00	1.00	constant
TEMUR PLAZA LLC	0.02	1.00	0.02	increasing
"MANUCHEHR MUSINOVICH GULAMOV" FE	0.008	0.67	0.012	increasing
"AN-NUR NISA" FE	0.003	1.00	0.003	increasing
"VAVILON PLAZA" FE	0.05	1.00	0.05	increasing
"ZARNIGOR-93" LLC	1.00	1.00	1.00	constant
"DEVEL ECO GROUP" LLC	0.092	1.00	0.092	decreasing

In Table 2, the scale efficiency indicator is calculated as the ratio of CRS technical efficiency to VRS technical efficiency, representing the overall efficiency of the enterprise. According to the scale efficiency data, four hotels in Bukhara, "Ammar Aisha Travel" LLC, "Big Large" LLC, and "Zarnigor-93" LLC, have achieved maximum efficiency (with a scale efficiency indicator equal to 1). Based on this, it can be concluded that these companies are utilizing their production resources with high efficiency.

On the contrast, some companies such as "Zargaron Plyus" LLC are not doing well. However, if it reduced its service costs by 84-97.5% ($1 - 0.025 = 0.975$; $1 - 0.16 = 0.84$), it would achieve maximum efficiency. In general, it can be said that this enterprise's efficiency is increasing based on the current data (the scale efficiency is increasing, meaning that one unit of cost brings more than one unit of revenue).

It is also advisable for the "FATIMA GOLD PLAZA" hotel to reduce costs in the range of 60%-94%. Its scale efficiency is also increasing, indicating that the efficiency is improving in good condition. Overall, in the hotels "NODIR DEVONBEGIM TRAVEL" LLC, "KAVSAR BUKHARA" LLC, "EMIR TRAVEL" JV, "QODIR MOMINA" FE, "RESSORT MEKKA" LLC, "TEMUR PLAZA" FE, "MANUCHEHR MUSINOVICH GULAMOV" FE, "AN-NUR NISA" FE, and "VAVILON PLAZA" FE, it is possible to maximize efficiency by reducing production factors by more than 50%.

However, the decreasing scale efficiency in "DEVEL ECO GROUP" LLC indicates issues in the revenue turnover process related to resource expenditures, suggesting that significant changes are necessary within the company.

Then, we separately conducted a DEA analysis for hotels located in Samarkand (Table 3). In Table 4 the results of the data envelopment analysis are illustrated.

Table 3. Input and output variables in hotels located in Samarkand (Source: Authors' calculations based on
Tax reports of the corresponding hotels) *LLC - limited liability company, FE - family enterprise, PC - private compan

Hotels	Number of staff	Capital units	Labor cost (thousand UZS)	Capital price (thousand UZS)	Income (thousand UZS)
Hotel Asia Samarkand LLC	9	202.75	381902.4	833229.5	5417435
Registon Plaza LLC	19	1023.29	68372.05	3956990	4517841
Konstantin ITOL LLC	17	252.34	80780.47	538808.5	4275699
Alexander Hotel LLC	13	20.85	441766.8	343870.1	5769130
Hotel Sumaya FE	12	0.31	40656.19	13391.57	523617.7
Buyuk Humo LLC	14	139.48	57038.06	69000	968876

Table 4. Hotel efficiency indicators in Samarkand (Source: Authors' work)
*LLC - limited liability company, FE - family enterprise, P C- private company

Hotels	Cost efficiency	Technical efficiency	Distribution efficiency
Hotel Asia Samarkand LLC	0.97	1	0.97
Registon Plaza LLC	0.12	0.47	0.27
Konstantin ITOL LLC	0.33	0.58	0.58
Alexander Hotel LLC	0.81	1	0.81
Hotel Sumaya FE	1	1	1
Buyuk Humo LLC	0.7	0.74	0.95

It is clear from Table 4 that the cost efficiency of Hotel Asia Samarkand is operating at 97% relative to other hotels that have similar resources. So, this hotel is able to maximize its efficiency, if it reduces inputs by 3%. The technical efficiency is measured at one, indicating that the hotel experiences no losses when converting its resources into revenue. Meanwhile, the allocative efficiency stands at 0.97, suggesting that the hotel is overspending by 3% in resource allocation, presenting an opportunity to reduce costs by this margin. The biggest in the pack, Registon Plaza's cost efficiency is very low, at 0.12. This value of cost efficiency means that the hotel is incurring 88% more costs than the best-performing hotel with equal resources. Likewise, the technical efficiency is quite low at just 47%, signifying a 53% loss in converting resources into revenue compared to the most efficient hotel. The allocative efficiency is even lower at 0.27, indicating that resource allocation needs to improve by 73%.

For Konstantin ITOL LLC, the cost efficiency is notably low at 0.33, suggesting that a more efficient hotel with the same resources could cut costs by 67%. Both the technical and allocative efficiency are measured at 0.58, indicating that the hotel could enhance its resource-to-revenue conversion and resource allocation by 42%.

At Aleksandr Hotel, the cost efficiency is 0.81, indicating that the hotel spends 19% more than the optimal level. However, the technical efficiency is perfect at 1, showing that the hotel efficiently converts resources into revenue. Additionally, allocative efficiency has room for improvement by 19%.

Hotel Sumaya FE demonstrates the top performance among the hotels we analyzed. Its cost efficiency, technical efficiency, and allocative efficiency are all at a value of one, indicating that the hotel is effectively using all its resources to maximize revenue. In "Buyuk Humo" LLC, the cost efficiency is 0.7, meaning that costs could be reduced by 30% compared to the optimal level. The technical efficiency is 0.74, indicating that 26% of the labor and capital are lost in the process of converting them into revenue compared to the most efficient hotel. The allocative efficiency is relatively high at 0.95 indicating that there is still a 5% opportunity to improve resource allocation.

The article examines the efficiency of 21 hotels in Samarkand and Bukhara, a sample that represents only about 10% of the total hotels in these cities. As such, the findings should be interpreted with caution. Additionally, because the data envelopment analysis (DEA) method is sensitive to input and output data, the results may vary across different months of the year, as these factors can fluctuate significantly over time. Further analysis of efficiency is crucial for comparing and assessing the dynamics of change in service delivery within the hotel industry.

CONCLUSION

In conclusion, based on the analysis of the six hotels mentioned above in Samarkand, Hotel Sumaya has been identified as the most efficient hotel according to the results of the Data Envelopment Analysis (DEA). The key advantage of DEA compared to other methods is its ability to identify the top-performing enterprise within a group and measure the performance of others against it. While the efficiency indicators in Table 3 offer a general snapshot of enterprise performance over a certain period, they don't measure resource utilization. As a result, even though some hotels may show high profitability, their efficiency scores are relatively low due to the presence of excess unused resources compared to other businesses.

The analysis of the scale efficiency of hotels in Bukhara demonstrates that certain enterprises, such as "Ammar Aisha Travel" LLC, "Big Large" LLC, and "Zarnigor-93" LLC, were operating at maximum efficiency, effectively utilizing their production resources. However, other companies, like "Zargaron Plyus" LLC, show inefficiencies that can be addressed by reducing service costs by 84-97.5%, which would lead them to maximum efficiency. Similarly, the "FATIMA GOLD PLAZA" hotel can improve its efficiency by reducing costs in the range of 60%-94%. Furthermore, hotels such as "Nodir Devonbegim travel" LLC, "Resort Mekka" LLC, and others could maximize efficiency by reducing production costs by more than 50%. On the other hand, the decreasing efficiency of "DEVEL ECO GROUP" LLC points to issues in resource management that require significant operational changes. Overall, with appropriate cost adjustments, most of these enterprises can improve their scale efficiency and achieve optimal resource utilization.

The research generally proposes changes that could enhance the overall performance of specific hotels in Samarkand and Bukhara. However, it does not delve into the specifics of associated costs, such as logistics, time management, service quality, and other key factors. Furthermore, the data envelopment analysis (DEA) results vary depending on changes in input or output data. This study focused on May 2024, chosen as the observation period since it represents the peak of Uzbekistan's tourism season. Due to challenges in obtaining reliable financial data, only a limited number of hotels were analyzed. Therefore, the findings should be interpreted cautiously, considering the scope and period of observation. Nonetheless, this study contributes to the current body of literature by showing the effectiveness of DEA as a tool for measuring and evaluating efficiency within a highly competitive environment.

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