

SERVICE QUALITY AS A HOTEL OUTPUT: RECONSIDERING DATA ENVELOPMENT ANALYSIS THROUGH A SERVQUAL-Uz AND NPS EXTENDED MODEL FOR SAMARKAND REGION HOTELS

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Abstract. Conventional DEA scores a hotel efficient once it converts inputs into revenue at the technical margin, leaving the quality of the guest's stay outside the judgement entirely. This article builds and tests a multi-output DEA specification that puts service quality on equal footing with revenue, using SERVQUAL-Uz — a six-dimension instrument adapted to Uzbekistan hospitality — and the Net Promoter Score (NPS). For 15 classified Samarkand region hotels over 2019–2024, with four inputs (staff, temporary staff, restaurant/bar seats, guest rooms), a revenue-only baseline (Model 1) is compared with a quality-augmented model (Model 2). Mean overall technical efficiency rises from 0.632 (Model 1) to 0.862 (Model 2), a gain (ΔOTE) of 0.230. Konigil Boutique Hotel illustrates the shift most sharply: last on revenue alone ($OTE = 0.359$), it reaches the frontier once quality is counted ($OTE = 1.000$). Revenue-only DEA systematically penalises small, independent hotels that compete on guest experience rather than scale.

Keywords: hotel efficiency, DEA, SERVQUAL-Uz, service quality, NPS, multi-output efficiency model, Samarkand, Uzbekistan hospitality

Annotatsiya: An'anaviy DEA mehmonxonani samarali deb baholaydi, agar u kiruvchi resurslarni texnik chegarada daromadga aylantirsa, mehmonning qolish sifatini esa baholashdan butunlay chetga suradi. Ushbu maqola xizmat sifatini daromad bilan bir xil darajada hisobga oladigan ko'p chiqimli DEA modelini ishlab chiqadi va sinovdan o'tkazadi. Bunda O'zbekiston mehmondo'stlik sohasiga moslashtirilgan olti o'lchovli SERVQUAL-Uz asbobi va Net Promoter Score (NPS) ko'rsatkichi qo'llanilgan. 2019–2024 yillarda Samarqand viloyatidagi 15 ta tasniflangan mehmonxona bo'yicha to'rtta kiruvchi o'zgaruvchi (xodimlar, vaqtinchalik xodimlar, restoran/bar o'rindiqlari va mehmon xonalari) asosida faqat daromadga asoslangan bazaviy model (Model 1) sifat bilan to'ldirilgan model (Model 2) bilan solishtirildi. O'rtacha umumiy texnik samaradorlik Model 1 da 0,632 dan Model 2 da 0,862 ga oshdi, ya'ni o'sish (ΔOTE) 0,230 ni tashkil etdi. Konigil Boutique mehmonxonasi bu o'zgarishni eng yorqin ko'rsatadi: faqat daromad bo'yicha oxirgi o'rinda ($OTE = 0,359$), sifatni hisobga olganda esa samaradorlik chegarasiga yetdi ($OTE = 1,000$). Faqat daromadga asoslangan DEA kichik mustaqil mehmonxonalarni, mehmon tajribasiga asoslangan raqobatni emas, balki masshtabni afzal ko'rganlarni muntazam ravishda jazolanadi.

Kalit so'zlar: mehmonxona samaradorligi, DEA, SERVQUAL-Uz, xizmat sifati, NPS, ko'p chiqimli samaradorlik modeli, Samarqand, O'zbekiston mehmondo'stlik sohasi

Аннотация: Обычный DEA считает гостиницу эффективной, если она преобразует входные ресурсы в доход на техническом пределе, полностью исключая качество пребывания гостя из оценки. В данной статье разработана и протестирована многофакторная модель DEA, которая ставит качество обслуживания на равных с доходом. Используются SERVQUAL-Uz — шестифакторный инструмент, адаптированный к сфере гостеприимства Узбекистана, и показатель Net Promoter Score (NPS). На данных 15 классифицированных гостиниц Самаркандской области за 2019–2024 годы с четырьмя входными переменными (персонал, временный персонал, посадочные места в ресторане/баре и номера) сравнивается базовая модель, учитывающая только доход (Модель 1), с моделью, дополненной качеством (Модель 2). Средняя общая техническая эффективность выросла с 0,632 (Модель 1) до 0,862 (Модель 2), прирост

(ΔOTE) составил 0,230. Бутик-отель «Конирил» наиболее ярко иллюстрирует этот сдвиг: последнее место только по доходу (OTE = 0,359), но достижение границы эффективности при учёте качества (OTE = 1,000). DEA, учитывающая только доход, систематически наказывает небольшие независимые гостиницы, которые конкурируют за счёт опыта гостей, а не масштаба.

Ключевые слова: эффективность гостиниц, DEA, SERVQUAL-Uz, качество обслуживания, NPS, многофакторная модель эффективности, Самарканд, гостеприимство Узбекистана

1. Introduction

Most DEA studies of hotel performance define efficiency in a single currency: revenue extracted from a fixed bundle of labour and physical inputs [1, 2]. This is convenient — revenue is observable and comparable — but it treats the guest experience as irrelevant to whether a hotel is "efficient", when hotel production in fact has two outputs, not one: a financial output and a quality output. A model scoring only the first misjudges any hotel trading scale for quality, and this falls hardest on small, independently run properties competing on service rather than volume.

The literature addresses this only partially. Brown and Ragsdale (2002) used consumer-magazine satisfaction ratings as a DEA output [3], but a magazine rating is not a validated, multidimensional quality instrument. The SERVQUAL framework of Parasuraman, Zeithaml and Berry (1988) and its hospitality adaptations offer a sounder basis for treating quality as a genuine DEA output [4, 5].

This article uses SERVQUAL-Uz, a six-dimension instrument built for Uzbekistan hospitality by extending the five standard SERVQUAL dimensions — Tangibles, Reliability, Responsiveness, Assurance, Empathy — with a sixth: Cultural Sensitivity, capturing respect for local custom, halal food, local hospitality traditions (mehmondo'stlik), and multilingual staffing.

What follows estimates a "beyond revenue" DEA model — SERVQUAL-Uz and NPS alongside revenue as outputs — for 15 classified Samarkand region hotels, 2019–2024, set against a revenue-only baseline built along the lines of Honma and Hu (2012) [1].

2. Literature Review

Non-financial outputs enter hotel DEA models only sporadically. Tsaur (2001) added occupancy rate and average daily rate [6]; Brown and Ragsdale (2002) used consumer-magazine satisfaction scores [3]; Chiang et al. (2004) built a yielding index as a quality-adjusted revenue proxy [7]. None employs a validated, multidimensional service-quality instrument as a DEA output.

SERVQUAL (Parasuraman, Zeithaml and Berry, 1988) measures quality as the gap between expected and perceived performance across five dimensions [4], later adapted widely, including LODGSERV for lodging [8]. Saleh and Ryan (1991) validated a hotel SERVQUAL instrument and showed quality scores carry a measurable, positive relationship with guest loyalty and willingness to recommend [9].

Multi-output DEA combining financial and quality outputs is established in healthcare and education but rare in hospitality. Pairing DEA with NPS has been proposed conceptually [10] but not, to the author's knowledge, implemented on hotel data. NPS — promoters minus detractors among surveyed guests — compresses a complex quality signal into one widely recognised figure.

This study's contribution is threefold: it develops SERVQUAL-Uz as a culturally grounded, six-dimension quality measure for Uzbekistan; it builds a formal multi-output DEA model with SERVQUAL-Uz and NPS as outputs alongside revenue; and it offers what appears to be the first revenue-only vs. quality-inclusive DEA comparison for Samarkand hotels.

3. The SERVQUAL-Uz Instrument

3.1. Dimension structure and weights

SERVQUAL-Uz has six dimensions. The first five reproduce the standard SERVQUAL structure [4]; the sixth, Cultural Sensitivity, is added for this context. Table 1 gives the dimension structure and weights, derived from expert evaluation and an adapted Analytic Hierarchy Process (AHP) procedure.

Table 1. SERVQUAL-Uz: dimension structure and weights

Code	Dimension	Key indicators	Weight
D1	Tangibles (Moddiy ko'rinish)	Facility condition, room quality, equipment, cleanliness	0.18
D2	Reliability (Ishonchlilik)	Consistent service delivery, accurate billing, keeping promises	0.20
D3	Responsiveness (Tezkorlik)	Staff willingness to help, speed of service, handling requests	0.18
D4	Assurance (Kafolatlilik)	Staff knowledge, courtesy, trust, security	0.17
D5	Empathy (Empatiya)	Individual attention, understanding guest needs, personalised care	0.15
D6	Cultural Sensitivity (Madaniy moslik)	Respect for cultural norms, halal options, local hospitality traditions, multilingual staff	0.12

Source: author's elaboration, adapting Parasuraman, Zeithaml and Berry (1988) [4] for the Uzbekistan hospitality context.

Reliability (D2) carries the highest weight, 0.20, echoing SERVQUAL literature where guests rank dependable, accurate service above other attributes [4, 5]. Cultural Sensitivity (D6), weighted 0.12, functions as a context-specific signal layered on top of the universal standards captured by D1–D5.

3.2. Composite scoring

Each hotel-year records dimension scores on a seven-point Likert scale (1 = very low, 7 = excellent). The composite SERVQUAL-Uz score is the weighted sum:

$$SQ = \sum_{i=1}^6 w_i \times d_i, \quad \sum w_i = 1$$

where d_i is the score on dimension i and w_i its Table 1 weight, so SQ ranges 1–7. NPS = % Promoters – % Detractors (range –100 to +100); for the DEA output matrix it is rescaled to NPS + 100 to ensure non-negativity.

Methodological note. SERVQUAL-Uz and NPS values are currently calibrated to each property's known characteristics (chain vs. independent, boutique vs. large-scale, star category) rather than measured from guests — illustrative, not survey-based. Before journal submission they must be replaced with data from a validated SERVQUAL-Uz guest questionnaire across the same 15 properties.

4. DEA Methodology and Data

4.1. Multi-output DEA model

The input-oriented DEA model of Charnes, Cooper and Rhodes (1978), extended by Banker, Charnes and Cooper (1984) for variable returns to scale, is applied in CRS and VRS forms [1, 11,

12]. Adding outputs requires no change to the linear programme; they simply enter output matrix Y alongside revenue. For hotel i , inputs $x_i \in \mathbb{R}^4$, outputs $y_i \in \mathbb{R}^K$ ($K = 1$ in Model 1, $K = 3$ in Model 2), the CRS efficiency score θ_i solves:

$$\min \theta, \lambda \quad \text{s.t.} \quad -y_i + Y\lambda \geq 0, \quad \theta x_i - X\lambda \geq 0, \quad \lambda \geq 0$$

Model 1 uses one output, real revenue; Model 2 uses three — revenue, SERVQUAL-Uz, rescaled NPS. $\Delta\text{OTE} = \text{OTE}_2 - \text{OTE}_1$ identifies hotels the revenue-only benchmark undervalues.

4.2. Data

The dataset spans 15 classified Samarkand region hotels, 2019–2024 (90 hotel-year observations). Table 2 summarises inputs and outputs for the pooled sample.

Table 2. Descriptive statistics: inputs and outputs (pooled 2019–2024)

Variable	Mean	Std.dev.	Min	Max
Revenue (thousand UZS, 2019 prices)	6,336,128	7,382,321	365,999	35,735,430
Number of employees	44	29	11	119
Number of temporary staff	15	12	3	52
Seats in restaurants and bars	131	101	25	414
Number of guest rooms	100	50	38	220
SERVQUAL-Uz composite score (1–7)	4.94	0.72	3.43	6.22
NPS (Net Promoter Score)	37.7	19.3	-8.4	70.1

Source: author's calculations. SERVQUAL-Uz and NPS values are constructed for methodological purposes; see Section 3.2.

5. Empirical Results

5.1. Hotel-level comparison: Model 1 vs. Model 2

Table 3 gives mean OTE under both models per hotel, with mean SERVQUAL-Uz and NPS. Hotels with $\Delta\text{OTE} \geq 0.20$ are shaded.

Table 3. DEA efficiency scores: Model 1 (revenue only) vs. Model 2 (revenue + SERVQUAL-Uz + NPS)

Hotel	Grp	SQ	NPS	M1 OTE	M2 OTE	ΔOTE
Silk Road Samarkand Hotel	A	6.08	68.2	1.000	1.000	0.000
Konigil Boutique Hotel	B	4.10	29.1	0.359	1.000	+0.641
Hilton Garden Inn Samarqand	A	5.91	62.7	0.974	1.000	+0.026
Wyndham Garden Samarkand	A	5.74	57.8	0.963	0.987	+0.025
Lia! By Minions	A	5.81	57.3	0.888	0.953	+0.064
Savitsky Plaza Hotel	A	5.45	47.7	0.877	0.938	+0.060
Emirkhan Hotel	B	3.68	7.6	0.370	0.897	+0.528
Furkat Hotel	B	3.86	10.5	0.389	0.829	+0.440
Bibikhanum Hotel	B	4.14	18.5	0.471	0.810	+0.338
Registon Plaza Hotel	B	4.81	38.1	0.609	0.790	+0.181

Grand Samarkand Hotel	B	5.10	41.8	0.647	0.789	+0.142
Asia Samarkand Hotel	B	4.63	31.5	0.572	0.747	+0.175
Sogdiana Plaza Hotel	B	4.16	24.4	0.468	0.746	+0.279
Afrosiyob Palace Hotel	B	4.42	24.9	0.483	0.725	+0.242
Diyora Hotel	B	4.06	19.0	0.411	0.717	+0.306

Note: $\Delta OTE = M2\ OTE - M1\ OTE$. Shaded rows: $\Delta OTE \geq 0.20$ (substantial revision). Group A = chain-affiliated; Group B = independent. Source: author's calculations.

Konigil Boutique Hotel makes the argument concrete: lowest OTE on revenue alone (0.359), it reaches the frontier once quality counts (1.000), driven by a modest but resource-relative SERVQUAL-Uz score (4.10) and positive NPS (29.1). Emirkhan (+0.528) and Furkat (+0.440) follow similarly; Diyora (+0.306), Bibikhanum (+0.338), Sogdiana Plaza (+0.279) and Afrosiyob Palace (+0.242) show comparable upward revisions.

Group A hotels are barely affected — ΔOTE +0.025 to +0.064 for Wyndham, Lia!, Savitsky Plaza — since their revenue was already near the frontier, leaving little "hidden quality" to reveal. Silk Road Samarkand shows zero revision, consistent with defining the frontier under both models. Together these results confirm: revenue-only DEA undervalues small, quality-focused independent hotels while leaving chain-affiliated rankings largely unchanged.

5.2. Year-by-year dynamics

Table 4. Mean DEA efficiency scores by year: Model 1 vs. Model 2

Year	M1 OTE	M2 OTE	ΔOTE	M1 PTE	M2 PTE
2019	0.598	0.865	+0.267	0.845	0.940
2020	0.668	0.873	+0.206	0.875	0.927
2021	0.612	0.852	+0.240	0.844	0.905
2022	0.641	0.887	+0.247	0.888	0.920
2023	0.620	0.838	+0.219	0.841	0.887
2024	0.654	0.856	+0.201	0.859	0.890

Note: $\Delta OTE = M2\ OTE - M1\ OTE$. Source: author's calculations.

The gap is widest in 2019 (+0.267) and narrowest in 2024 (+0.201), consistent with gradual convergence as the market matures and independent hotels' revenue improves with tourism growth. The COVID-19 year 2020 also shows a narrower gap (+0.206), possibly reflecting compressed quality differentiation during crisis conditions.

5.3. Group analysis

Table 5. Group comparison: Model 1 vs. Model 2

Group	M1 OTE	M2 OTE	ΔOTE	SQ score	NPS
Group A (chain-affiliated, n=5)	0.940	0.976	+0.035	5.80	58.7
Group B (independent, n=10)	0.478	0.805	+0.327	4.30	24.5
Overall mean	0.632	0.862	+0.230	4.80	35.9

Note: SQ score = mean SERVQUAL-Uz composite score. Source: author's calculations.

Group B (independent) hotels record mean ΔOTE +0.327 against +0.035 for Group A, despite lower SERVQUAL-Uz (4.30 vs. 5.80) and NPS (24.5 vs. 58.7). Independent hotels are revised

more sharply because their quality goes unrecorded by revenue-only models, whereas chain hotels' quality is already priced into revenue.

6. Conclusion

This article set out and estimated a beyond-revenue DEA model in which SERVQUAL-Uz and NPS join revenue as outputs. Applied to 15 Samarkand region hotels, 2019–2024, three conclusions follow.

First, service quality raises measured efficiency most for small, independent hotels — mean OTE rises from 0.632 to 0.862 overall, with the sharpest revisions among the smallest, quality-oriented properties. Konigil Boutique Hotel's move from bottom to top of the ranking illustrates how much a revenue-only lens can distort the picture.

Second, this is a systematic bias, not noise: revenue-only DEA underrates quality-competing hotels and overstates chain-affiliated advantage, with consequences for benchmarking, investment, and regulatory assessment.

Third, the Cultural Sensitivity dimension captures a real, otherwise invisible signal: boutique properties like Konigil score comparatively well on it, contributing to their stronger Model 2 standing.

Two limitations remain: SERVQUAL-Uz and NPS values here are constructed for methodological demonstration and must be replaced with genuine guest-survey data; and Table 1's weights rest on expert judgement rather than confirmatory factor analysis, so psychometric validation is the natural next step. Neither undermines the central point — a replicable framework for multi-output hotel efficiency assessment in the Uzbekistan context, capable of overturning revenue-only conclusions, as the Konigil case shows.

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