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A Quantitative Comparative Analysis of Housing Market Developments in Tehran in Spring 2023 and 2024 Based on the Data Envelopment Analysis Approach

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Abstract

The present study is aimed at assessing and comparing the developments in Tehran's housing market during the Spring of 2023 and 2024. To this end, the efficiency of Tehran's 22 districts was determined using the output-oriented CCR ranking model through GAMS software and ranked using the Andersen and Petersen's model [1]. Given the public demand for insights into the characteristics of this market, this study seeks to provide reliable analyses using the Data Envelopment Analysis (DEA) method. The findings indicate that in Spring 2023, districts 10, 5, and 2 ranked highest and demonstrated the best efficiency. In Spring 2024, districts 10, 5, and 4 secured the top three ranks, showing the best efficiency. Furthermore, in Spring 2023, districts 20, 21, and 19 respectively had the lowest rankings and poorest efficiency, while in Spring 2024, districts 21, 20, and 19 exhibited the lowest rankings and weakest efficiency. The average super-efficiency in Spring 2023 and Spring 2024 was 0.407 and 0.4, respectively, indicating better efficiency in Spring 2023.

Keywords: Data envelopment analysis, Efficiency, Efficiency evaluation, Housing market developments, Tehran city.

1 | Introduction

Without exaggeration, the concept of housing, home, or any place representing a family's residence carries a profound and sacred meaning across all societies. Outside the home, humans engage in a constant and

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prolonged struggle for survival – facing threats from cold, heat, wind, and rain. It is only within the home, among loved ones, that a person truly feels at peace [2].

For many families worldwide, housing represents the largest expense and the most valuable asset, while also being the most crucial factor determining Quality of Life (QoL). Although in many developed and capitalist economies, the number of housing units meets demand, a significant portion of the global population still lacks access to adequate and financially attainable housing. According to a report from UN-Habitat, nearly one billion urban residents worldwide live in slums [3].

During the second United Nations conference on human settlements (1996) in Istanbul, adequate housing was defined as follows: "adequate shelter is not merely about having a roof over one's head; it entails appropriate comfort, sufficient space, accessibility, physical security, ownership security, structural durability, proper lighting, ventilation, and heating systems. It also includes essential infrastructure such as water supply, sanitation, education, waste management, environmental quality, health standards, and a location with access to employment and basic services – all of which must be provided in an affordable manner" [4].

However, in Iran, housing holds significance beyond its fundamental purpose as a shelter. It serves additional functions and provides financial benefits. The type of housing (rental or ownership), the neighborhood, the property's size, and its associated factors contribute to material investment for individuals and can transform into cultural capital – a concept described by Bourdieu [5] as symbolic capital. Symbolic capital has the potential to convert into other forms of capital throughout a person's life, thus playing a pivotal role in shaping individuals' lives [6].

Housing refers to one of the critical issues in developing countries. The lack of sufficient resources, weak economic management, the absence of comprehensive housing planning, and other deficiencies in the economic infrastructure of these countries, combined with the rapid growth of the urban population, have made the provision of shelter a complex and multidimensional challenge. Meeting the increasing demand for housing not only requires land, capital, construction materials, and a large workforce, but also necessitates a planning system to ensure coordination between the housing sector and other sectors, as well as between the essential components of housing – land, construction materials, and infrastructure, including public utilities, social services, and transportation systems [2].

Today, housing is a primary factor in social integration, a major commodity, and a decisive element in society, playing a significant role in shaping individual identity, social relationships, and collective goals [7].

It can be argued that the housing issue exists worldwide. However, in developing countries, due to rapid population growth and urbanization, internal migration, insufficient financial resources, land supply challenges, difficulties in securing construction materials, and a shortage of skilled labor – along with the absence of appropriate policies, strategies, and plans for land and housing – the problem has become severe and critical. The rapid pace of industrialization has driven rural populations toward cities. In many cases, the social aspect of industrialization does not translate into affordable housing, social services, or improved worker welfare. Consequently, the number of people living in slums and impoverished urban areas increases daily [2].

In these countries, budget allocation to the housing sector is generally lower than other economic sectors. There is little recognition of the crucial fact that investment in housing is an investment in the development of social and human resources, with a high potential for job creation. According to United Nations estimates, to address housing problems in developing countries, ten residential units per thousand people must be constructed annually. However, in reality, the number rarely exceeds two to three units per thousand people [8].

Based on this, the current study focuses on evaluating the efficiency of the 22 districts of Tehran, conducting a quantitative comparison of housing market developments in the Spring of 2023 and 2024 using the Data Envelopment Analysis (DEA) approach. It seeks to answer the question: how have housing market developments in Tehran evolved during this period?

The structure of this paper is as follows: initially, the output-oriented CCR model is introduced, followed by input-free radial models in DEA, and then the input-free CCR model. The Andersen and Petersen's ranking model [1] is subsequently explained, followed by the AP-CCR input-free ranking model. Next, the selection of input and output variables is presented, followed by the research findings. The paper concludes with the references.

2 | Literature Review

Plebankiewicz [9] examined the main criteria for contractor evaluation. Tsenkova [10], in a study employing comparative analysis, investigated changes in housing efficiency during the transition from government control to private sector management of the housing market. She argued that the challenges in achieving efficiency in the housing sector could be examined from multiple dimensions, including technical, social, and financial aspects. She concluded that reducing government intervention and transferring housing market management to the private sector would enhance efficiency in the sector.

Gilbert [11] analyzed a Colombian government project aimed at constructing housing for 100,000 impoverished families. His study explored the rationale behind adopting public housing policies and assessed opportunities for the successful implementation of this project. Gilbert [11] questioned the effectiveness of government-led housing initiatives in addressing homelessness and noted that previous similar projects had failed to resolve the issue.

Sepehr Doust [12] presented a paper titled "a comparative study of housing production efficiency in the country". The objective of this study was to assess the technical efficiency of the housing construction sector in Iran and to determine the status and future outlook of this industry in the country. DEA and an input-oriented CCR model with the assumption of constant returns to scale were used to evaluate the technical efficiency of the housing sector and conduct a relative comparison at the provincial level during the period 2006 to 2009. Moreover, the supplementary BCC model, assuming variable returns to scale, was employed to decompose technical efficiency into managerial efficiency and scale efficiency. The findings indicated that the average efficiency of provinces in housing construction was 0.94, and relatively, only 37% of the provinces had technical efficiency in housing production. On the other hand, approximately 63% of the provinces were inefficient, with most of them exhibiting decreasing returns to scale. It was also found that other inefficient provinces suffered from managerial inefficiencies related to the suboptimal use of production inputs.

Vafadar Asghari et al. [13] published a paper titled "evaluating relative efficiency of Mehr housing projects via DEA technique (the case of cities of Sistan and Balouchestan province with population of more than 25000)". This study measured the relative efficiency of cities with populations exceeding 25,000 in Sistan and Baluchestan in executing Mehr housing projects from early 2008 to late 2011 using the output-oriented BCC model within the DEA framework. The input variables used in this study included human resources, physical resources, and financial resources. The number of constructed housing units and the employment generated by this project were considered as output variables. The findings showed that the Mehr housing projects were efficient in the cities of Chabahar, Khash, Zahedan, and Konarak, while they were inefficient in Iranshahr, Zabol, and Saravan.

Jafari et al. [14] identified opportunities and threats within the mass housing industry and formulated effective response strategies for each. The results indicated that the opportunities for mass housing development in Mazandaran province included an increase in the maximum amount of government-provided housing loans, an increase in the number of government-provided housing loans, a reduction in loan interest rates, a high rate of return on investment in the housing sector compared to other economic sectors, rising inflation in the housing market, increasing migration to cities, the adoption of new construction technologies, and the decline of substitute products such as single-unit houses.

3 | Research Methodology

Addressing housing at the societal level is one of the primary objectives of Iran's national programs. This is evident in the country's constitution, which, while emphasizing the comprehensive well-being of individuals, recognizes housing as one of the fundamental needs and obligates the government to mobilize all its resources, facilities, and capacities to provide housing. One of the key aspects of housing services management in Iran is the provision of housing loan services to various segments of society. This is further highlighted by the special attention given to housing in the country's development plans. Given that one of the most practical techniques for evaluating housing sector efficiency is DEA, this study employs this powerful mathematical approach to analyze the developments in Tehran's housing market transactions during the Spring of 2023 and 2024.

DEA consists of a set of techniques used to analyze production, cost, revenue, and profit data without parameterization and technological indexing. DEA is a non-parametric mathematical programming approach for estimating frontier functions. In general, the foundation of non-parametric methods for efficiency measurement was established in 1957 with the publication of a paper by Farrell [15]. Using a purely mathematical approach, he introduced a novel method for measuring modern efficiency as an alternative to parametric methods. Farrell [15] was the first to define the "Farrell efficiency frontier" as a non-parametric boundary. Based on mathematical methods and the distance of firms from the desired frontier, he was able to measure the efficiency frontier. Farrell's theories laid the groundwork for subsequent research in this field.

Farrell's theories attracted not only mathematicians but also management scholars and economists, who began exploring non-parametric structures for efficiency measurement instead of production functions and parametric methods.

Despite these efforts, the significance of this approach remained largely unnoticed for two decades after Farrell's influential paper [15] until, exactly 21 years later, in 1978, the paper by Charnes et al. [16] was published. These researchers introduced DEA for the first time, which subsequently led to extensive studies expanding and applying DEA methodology.

Charnes et al. [16] initially proposed a model with an input-oriented nature, assuming "constant returns to scale". Later studies introduced more flexible assumptions, like the BCC model in 1984, which proposed a "variable returns to scale model" [17].

Today, DEA is recognized as a suitable method for evaluating firm efficiency. In this method, based on available data, the efficiency frontier is empirically estimated. Since all data points contribute to defining the frontier, the method is referred to as "DEA".

More than 47 years after the introduction of the first DEA model, numerous models have been developed in this field, and its practical applications have expanded to thousands of studies [18], [19].

3.1 | Output-oriented CCR Model

The CCR model belongs to the class of "constant returns to scale" models. In 1978, Charnes et al. [16] introduced the CCR model, which became widely known due to the initials of their names. This DEA model evaluates the relative efficiency of units under the assumption of constant returns to scale. The "output-oriented CCR model" is formulated as *Model (1)*.

$$\text{Min} \ \sum_{i=1}^{m} v_i x_{io} - \sum_{r=1}^{s} u_r y_{ro},$$

$$\sum_{i=1}^{m} v_i x_{ij} - \sum_{r=1}^{s} u_r y_{rj} \leq 1, \quad j = 1, \dots, n, \tag{1}$$

$$u_r \geq 0, r = 1, \dots, s,$$

$$v_i \geq 0, i = 1, \dots, m.$$

A secondary form of this model is referred to as the output-oriented CCR envelopment model represented as follows [16]:

$$\text{Max } \phi,$$

$$\text{s.t.} \sum_{j=1}^{n} \lambda_j x_{ij} \leq x_{io}, \qquad i = 1, \dots, m,$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq \phi y_{ro}, \qquad r = 1, \dots, s, \tag{2}$$

$$\lambda_j \geq 0, \qquad j = 1, \dots, n,$$

$$\phi_{\text{free}}.$$

3.2 | Radial Data Envelopment Analysis Models without Inputs or without Outputs

The DEA methodology was initially developed for evaluating the relative efficiency of comparable production and service systems [20]. However, Adolphson et al. [21] suggested that a broader perspective could be adopted, allowing the methodology to be used for comparing any homogeneous set of units with multiple dimensions. This comprehensive approach was first employed by Thompson et al. [22] to determine the optimal locations for telecommunications equipment in Texas. These researchers considered six potential locations and used three input variables while assuming a fixed output of one unit per location. Since a fixed output does not affect the relative efficiency of units, Adolphson et al. [21] later attempted to reformulate this location problem as a model with only an input variable and no output variable. Following their work, researchers Lovell and Pastor [20], [23] examined the evolution of these models and documented their theoretical development. Given that input-free radial models are only expressed in an envelopment form, this study presents the envelopment formulation of these models as applied in the present research.

3.3 | Input-free CCR Model

It is evident that a DEA model with an output-oriented nature and no inputs, or an input-oriented nature and no inputs, is meaningless. Therefore, when analyzing a DEA model without inputs, it refers to an output-oriented model [20].

Lovell and Pastor [20] proved that if all inputs in *Model (2)* are set to one, the model simplifies to the following form:

$$\begin{aligned} &\text{Max } \phi, \\ &\text{s.t.} \sum_{j=1}^{n} \lambda_j y_{rj} \geq \phi y_{ro}, \quad r = 1, \ldots, s, \\ &\lambda_j \geq 0, \quad j = 1, \ldots, n, \\ &\phi_{\text{free}}. \end{aligned} \tag{3}$$

DEA is a management method that measures the relative efficiency of each decision-making unit and provides managerial solutions. To achieve this, a benchmark decision-making unit is identified, serving as a reference for inefficient units. These inefficient units can then improve their efficiency by adopting the benchmark model and moving toward the efficiency frontier. Decision-making units refer to an organizational unit or an independent entity managed by an individual such as a director, president, or supervisor, provided that the organization or unit (as the decision-making unit) follows a systematic process

The DEA technique is applicable to units or organizations considered decision-making entities. The model used in this study is a purely output-oriented model.

3.4 | Anderson and Petersen's Ranking Model

In 1993, Anderson and Petersen [1] introduced the complete ranking model, which provides a method for ranking efficient decision-making units. The core idea of this model is to compare the evaluated unit with a linear combination of all other units in the sample while excluding the unit under evaluation. Basic models for evaluating decision-making units utilize the evaluated unit itself as a reference unit. Since inefficient units do not contribute to forming the efficiency frontier, their removal does not affect the efficiency boundary, meaning their technical efficiency remains unchanged even in the Anderson and Petersen's model [1]. However, efficient units that shape the efficiency frontier cause a shift in the frontier when removed. In this model, the efficiency score assigned to efficient units is equal to or greater than one. In output-oriented models, the difference between the efficiency score obtained from the Anderson and Petersen's model [1] and one represents the reduction in input that allows the decision-making unit to remain efficient. Therefore, in this model, a decision-making unit that receives a lower efficiency score among the efficient units exhibits superior efficiency.

The complete Anderson and Petersen's ranking model [1], based on the CCR model, evaluates decision-making units while excluding the unit under assessment and is formulated as follows:

$$\begin{aligned} &\text{Max } \phi, \\ &\text{s.t.} \sum_{j=1, j\neq o}^{n} \lambda_j x_{ij} \leq x_{io}, \quad i = 1, \ldots, m, \\ &\sum_{j=1, j\neq o}^{n} \lambda_j y_{rj} \geq \phi y_{ro}, \quad r = 1, \ldots, s, \\ &\lambda_j \geq 0, \quad j = 1, \ldots, n, j \neq o, \\ &\phi_{\text{free}}. \end{aligned} \tag{4}$$

3.5 | CCR-AP Ranking Model without Input

The CCR-AP ranking model without input can be expressed as follows [20]:

$$
\begin{aligned}
&\text{Max } \phi,\\
&\text{s.t.} \sum_{j=1, j\neq o}^{n} \lambda_j = 1, \qquad i = 1, \dots, m,\\
&\textstyle\sum_{j=1, j\neq o}^{n} \lambda_j y_{rj} \geq \phi y_{ro}, \; r = 1, \dots, s,\\
&\lambda_j \geq 0, \qquad j = 1, \dots, n, j \neq o.
\end{aligned} \tag{5}
$$

4 | Research Findings

4.1 | Selection of Input and Output Variables

Perhaps the most crucial step in using the DEA technique to measure the relative efficiency of any company or institution is selecting appropriate and homogeneous inputs and outputs. This requires examining all aspects of the available inputs and outputs. In the present study, based on expert interviews, reviews of internationally recognized academic papers in this field, and consideration of the existing research literature, the inputs and outputs were determined as follows:

The output variables selected for evaluating the efficiency of Tehran's 22 districts in Spring 2023 were:

I. Number of transactions in April 2024 (y_1).

II. Number of transactions in May 2024 (y_2).

III. Number of transactions in June 2024 (y_3).

The output variables selected for evaluating the efficiency of Tehran's 22 districts in Spring 2024 were:

IV. Number of transactions in April 2024 (y_1).

V. Number of transactions in May 2024 (y_2).

VI. Number of transactions in June 2024 (y_3).

The housing market developments in Tehran for the years 2023 and 2024, derived from the raw data of the National Real Estate and Housing Transactions Registration system, were compiled and published by the Central Bank's Economic Research and Policies Department.

Tables 1 and *2* present the output data for the 22 districts of Tehran for Spring 2023 and 2024.

Table 1. Output data for the 22 districts of Tehran in 2023.

Urban District	Number of Transactions in April 2023	Number of Transactions in May 2023	Number of Transactions in June 2023
District 1	95	259	216
District 2	157	418	296
District 3	71	226	170
District 4	147	372	323
District 5	225	555	432
District 6	76	169	144
District 7	102	262	168

Table 1. Continued.

Urban District	Number of Transactions in April 2023	Number of Transactions in May 2023	Number of Transactions in June 2023
District 8	76	208	162
District 9	47	95	56
District 10	189	348	266
District 11	85	195	180
District 12	53	138	109
District 13	40	126	104
District 14	93	260	179
District 15	90	180	150
District 16	29	88	80
District 17	30	100	75
District 18	44	129	86
District 19	18	29	36
District 20	33	64	65
District 21	22	69	45
District 22	37	69	52
Total of the city	1757	4359	3394

Table 2. Output data for the 22 districts of Tehran in 2024.

Urban District	Number of Transactions in April 2024	Number of Transactions in May 2024	Number of Transactions in June 2024
District 1	66	239	156
District 2	123	340	298
District 3	67	189	175
District 4	130	400	294
District 5	189	667	524
District 6	52	164	156
District 7	93	298	223
District 8	80	263	192
District 9	72	102	103
District 10	161	446	381
District 11	73	267	180
District 12	37	118	103
District 13	50	131	127
District 14	89	335	267
District 15	89	254	202
District 16	27	88	87
District 17	38	121	91
District 18	49	154	108
District 19	15	39	33
District 20	18	71	52
District 21	22	84	64
District 22	13	105	61
Total of the city	1508	4875	4872

Regarding the developments in Tehran's housing market transactions during the Spring of 2023 and 2024, it can be stated that the market was characterized by the continued increase in the average price per square meter of residential units sold, along with a significant decline in transaction volume.

4.2 | Efficiency Results Using the Input-free CCR Model

To assess the efficiency of housing market developments in Tehran during the Spring of 2023, three output indicators were considered: 1) the number of transactions in April 2023, 2) the number of transactions in May 2023, and 3) the number of transactions in June 2023. Similarly, for the Spring of 2024, the same three indicators were used: 1) the number of transactions in April 2024, 2) the number of transactions in May 2024, and 3) the number of transactions in June 2024. Since all these indicators are output-oriented, the input-free CCR model was employed for evaluation. The results were computed using GAMS software and presented in *Table 3*.

Table 3. Efficiency results of housing market developments in Tehran's 22 districts in Spring 2023 and 2024.

Urban District	Efficiency Spring 2023	Efficiency Spring 2024
District 1	2	2.791
District 2	1.328	1.537
District 3	2.456	2.821
District 4	1.337	1.454
District 5	1	1
District 6	3	3.359
District 7	2.118	2.032
District 8	2.667	2.363
District 9	4.787	5.087
District 10	1.190	1.174
District 11	2.4	2.498
District 12	3.963	5.087
District 13	4.154	3.78
District 14	2.135	1.963
District 15	2.5	2.124
District 16	5.4	6.023
District 17	5.55	4.974
District 18	4.302	3.857
District 19	12	12.6
District 20	6.646	9.394
District 21	8.043	7.940
District 22	6.081	6.352
Average efficiency	3.866	4.1

As shown in *Table 3*, during both Spring 2023 and 2024, only district 5 achieved full efficiency, while all other districts were inefficient. This indicates that over the two-year period, only 4.55% of the districts were efficient, while the rest were inefficient. In addition, the average efficiency in the Spring of these two years was 3.866 and 4.1, respectively, demonstrating a decline in efficiency in Spring 2024 compared to the same period in 2023. Districts 7, 8, 10, 13, 14, 15, 17, 18, and 21 showed improvements in efficiency, meaning that 41% of the districts performed better in Spring 2024 compared to the same period in 2023. Although their efficiency levels remained relatively low, improvements were observed. Overall, it can be concluded that the 22 districts performed better in Spring 2023 compared to Spring 2024.

The efficiency trend of Tehran's housing market in the 22 districts for Spring 2023 and 2024 is illustrated in the following *Figs. 1-5*.

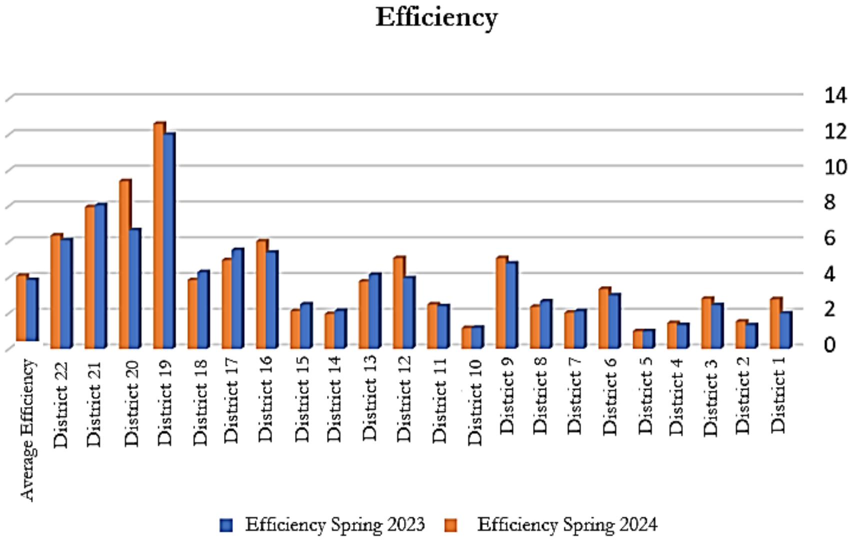

Fig. 1. Efficiency trends in Tehran's housing market in the 22 districts for Spring 2023 and 2024.

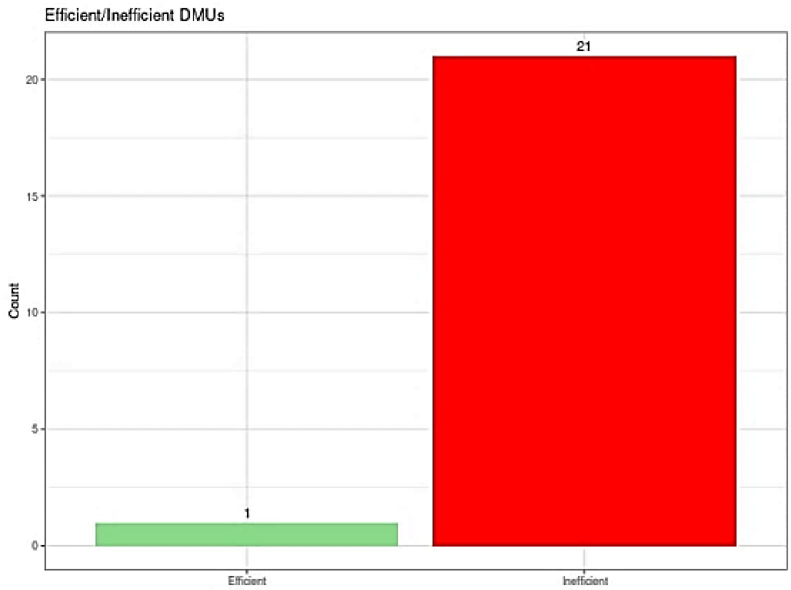

Fig. 2. Number of efficient and inefficient units in Spring 2023.

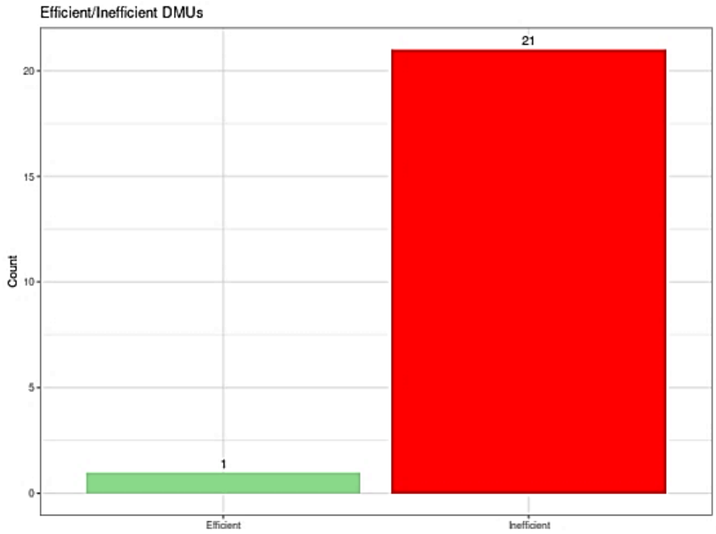

Fig. 3. Number of efficient and inefficient units in Spring 2024.

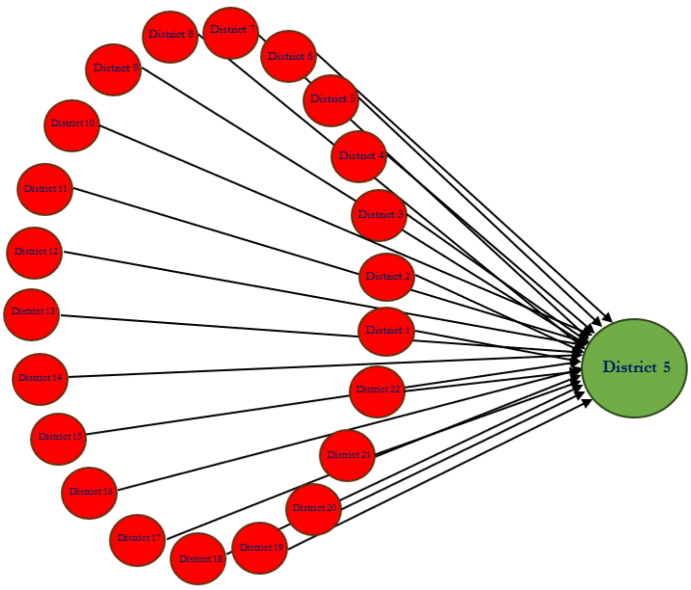

Fig. 4. Reference districts for other districts in Spring 2023.

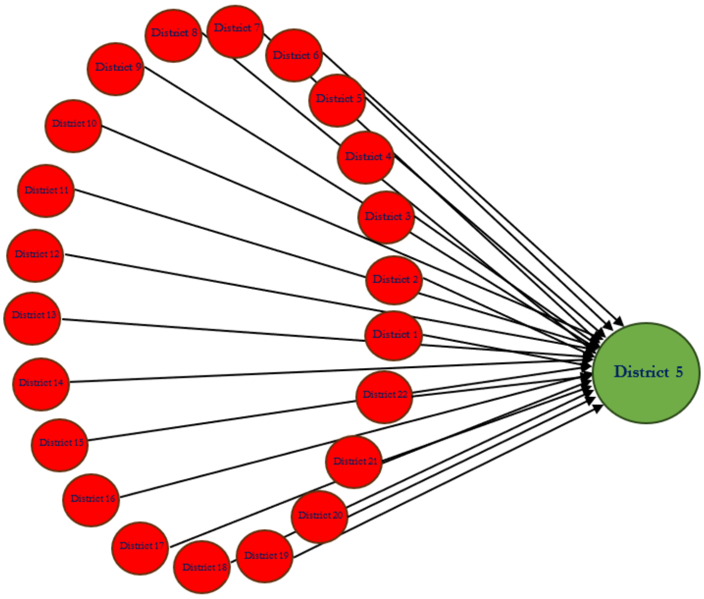

Fig. 5. Reference districts for other districts in Spring 2024.

4.3 | Ranking of Tehran's Housing Market Developments Using the Input-free AP-CCR Model

The results of the ranking of Tehran's housing market developments in the Spring of 2023 and 2024 using the input-free AP-CCR method, computed via GAMS software, are presented in *Table 4*.

Table 4. Super-efficiency and ranking of housing market developments in Tehran's 22 districts in Spring 2023 and 2024.

Urban District	Super Efficiency Spring 2023	Spring 2023 Ranking	Super Efficiency Spring 2024	Spring 2024 Ranking
District 1	0.5	5	0.358	10
District 2	0.753	3	0.651	4
District 3	0.407	9	0.354	11
District 4	0.748	4	0.688	3
District 5	1.427	1	1.496	1
District 6	0.333	12	0.298	12
District 7	0.472	6	0.492	6
District 8	0.375	11	0.423	8
District 9	0.209	16	0.197	16
District 10	0.84	2	0.852	2
District 11	0.417	8	0.400	9
District 12	0.252	13	0.197	17
District 13	0.241	14	0.265	13
District 14	0.468	7	0.510	5
District 15	0.4	10	0.471	7
District 16	0.185	17	0.166	18
District 17	0.180	18	0.201	15
District 18	0.232	15	0.259	14
District 19	0.083	22	0.079	22
District 20	0.150	20	0.106	21
District 21	0.124	21	0.126	20
District 22	0.164	19	0.157	19
Average super efficiency	0.407		0.4	

The results in *Table 4* indicate that in the Spring of 2023, districts 10, 5, and 2 ranked highest and demonstrated the best efficiency. In the Spring of 2024, districts 10, 5, and 4 secured the top three ranks, showing the best efficiency. Furthermore, in the Spring of 2023, districts 20, 21, and 19 had the lowest rankings and poorest efficiency, while in the same period in 2024, districts 21, 20, and 19 exhibited the lowest rankings and weakest efficiency. The average super-efficiency in the Spring of 2023 and 2024 was 0.407 and 0.4, respectively, indicating better efficiency in the Spring of 2023.

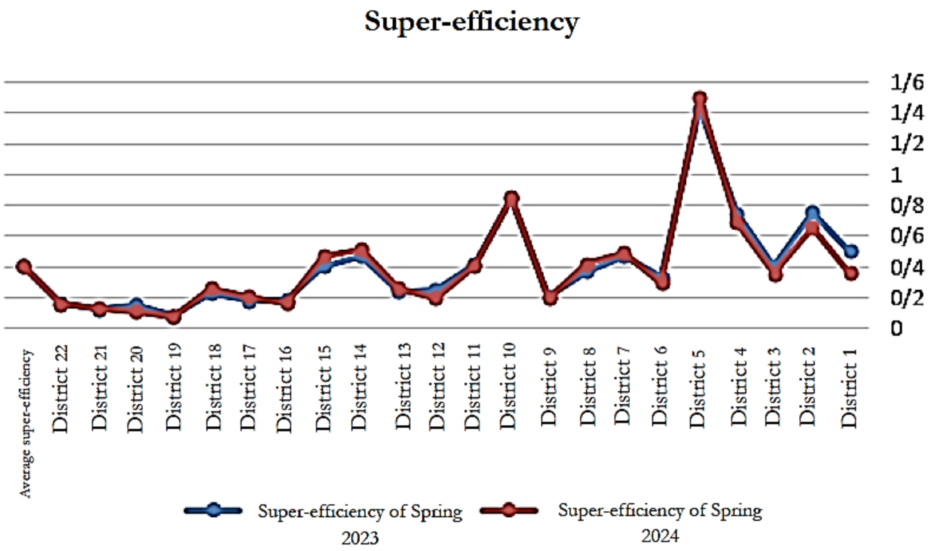

Fig. 6. Super-efficiency of housing market developments in Tehran's 22 districts for Spring 2023 and 2024.

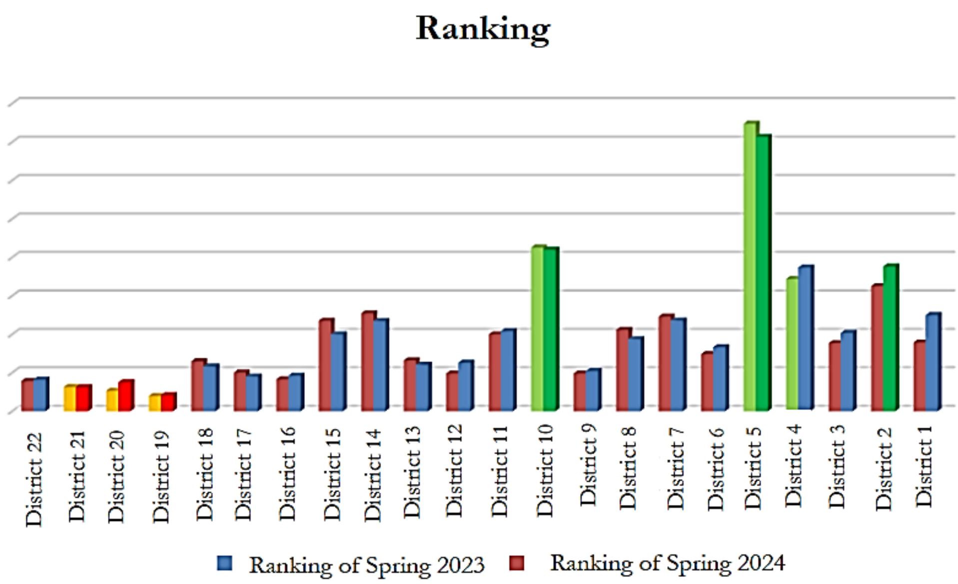

Fig. 7. Ranking of housing market developments in Tehran's 22 districts for Spring 2023 and 2024.

5 | Conclusion

As stated in the findings, the evaluation indicators for Tehran's 22 districts were extracted through a review of previous research and literature studies. One of the key considerations in real estate investment is recognizing that decision-making in this market follows a multi-variable process. Various factors, including demographic structure, government economic policies, the price of housing sector inputs, business cycles affecting the housing sector, housing tax regulations, land ownership laws, urban planning projects, and investment conditions in other economic sectors, all influence real estate investment decisions.

The volatile nature of the housing sector on both the supply and demand sides, coupled with the numerous internal and external factors affecting it, has created a profitable environment for economic players. While investors seek to capitalize on market fluctuations, individual homebuyers purchase housing primarily for personal use and family residence.

According to *Table 4*, buyers in Districts 19 and 22, after ensuring that purchasing a home meets the minimum economic and investment justifications, proceed with their purchase, focusing primarily on the well-being it provides for their families. In this demand-driven process, the motivation for investment strengthens when the return on investment surpasses the general inflation rate or the risk-free investment return rate (such as bank deposits). This segment of demand is mainly shaped by risk-averse households, seek to preserve their wealth and assets in the long term, and, given their long-term perspective on homeownership, do not consider investment liquidity a major concern.

This type of investment-oriented demand materializes within the real estate asset market. According to *Table 4*, districts 10, 5, and 3 recorded the highest transaction volumes, driven mainly by investors who purchase residential units to benefit from capital gains resulting from housing price appreciation. It must be acknowledged that what distinguishes housing market developments from those in other sectors and leads to unique price fluctuation patterns is primarily the influence of investment-oriented housing demand. In such conditions, districts 5 and 10 registered the highest transaction volumes. Economic entities that specialize in and focus on real estate investment strategically plan their future investment activities by analyzing market history, monitoring current indicators, and considering key market-driving factors to maximize market opportunities while minimizing risks.

Evidence suggests that, in general, policymakers are dissatisfied with speculative housing demand. The primary reasons for this dissatisfaction include the complexity of evaluation processes and shortcomings in a comprehensive assessment system. As mentioned previously, subjective methods alone cannot fully reflect market realities, and a more objective approach must be considered when evaluating the 22 districts of Tehran. Various objective methods exist for ranking market efficiency, with DEA being one of the most advanced and effective techniques. Given that DEA is one of the most practical tools for efficiency assessment, the present study applied this powerful mathematical technique to calculate the housing transaction volume across Tehran's 22 districts.

It is recommended that inefficient districts in Tehran's housing market transformations take their reference districts as benchmarks for structuring, utilizing, and managing input resources. Moreover, attention should be given to other significant housing market indicators, and future research should incorporate these factors to yield findings more aligned with housing market realities. Furthermore, the application of hybrid DEA models integrated with multi-criteria decision-making techniques such as AHP, BWM, and SWARA is suggested for more precise weighting of indicators. Finally, the adoption of more advanced models, such as interval-based or fuzzy models, is recommended for achieving more accurate results.

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Data Availability

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Conflicts of Interest

No conflicts of interest are mentioned in the document.

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