International Journal of Engineering Trends and Technology
ISSN: 2231-5381/ https://doi.org/10.14445/22315381/IJETT-V74I11P126

Volume 74 Issue 11, 414-424, November 2026
© 2026 Seventh Sense Research Group®

Original Article

Assessing Spatial Performance of Educational Facilities in Gated Residential Communities: A Post-Occupancy Evaluation in Erbil, Iraq

Tazra Kamaran Ismael[1], Abdulrazaq Zamil Menshid Al-saedi[2]

[1,2]*Department of Architectural Engineering, Faculty of Engineering, Koya University, Koya, Kurdistan Region-F.R. Iraq.*

[2]*Corresponding Author: abdulrazaq.zamil@koyauniversity.org*

Received: 30 April 2026 Revised: 20 August 2026 Accepted: 12 October 2026 Published: 25 November 2026

Abstract *- Educational service facilities are an essential part of the infrastructure of residential developments, yet their performance under actual conditions of use remains under-researched. This study examines the performance of educational facilities in gated residential communities in Erbil, Iraq, through a Post-Occupancy Evaluation (POE) approach, focusing on spatial adequacy, accessibility, and user-perceived performance rather than pedagogical outcomes. The study connects user experience with the physical spatial characteristics of educational service facilities within their residential context. The research is based on 312 valid responses from users of 16 educational facilities, comprising eight kindergartens and eight primary schools across eight gated residential communities. A multi-step analytical approach was employed, incorporating descriptive statistics, reliability analysis, Pearson correlation analysis, comparative analysis between facility types, and a physical spatial audit. The findings show that the overall level of perceived performance was moderate (mean = 3.41/5), with location suitability and accessibility receiving the highest ratings, while capacity and crowding and parking availability received the lowest ratings. The evaluation scale demonstrated good internal consistency (Cronbach's α = 0.86). Correlation analysis showed positive associations between accessibility, spatial adequacy, and outdoor environmental conditions and overall perceived performance, while capacity and crowding showed the strongest negative association (r = -0.57). Comparative analysis indicated significantly higher perceived performance among kindergartens than primary schools. The physical audit further identified variations in Plot Area/User and Floor Area/User and recurring limitations in parking provision and service coverage when compared with Iraqi planning benchmarks. These findings highlight the value of combining user-based POE with objective physical assessment and statutory benchmarks to support evidence-based planning and architectural design of educational facilities in gated residential communities.*

Keywords *- Accessibilities, Educational facilities, Gated communities, Post-Occupancy, User satisfactions.*

1. Introduction

In most of the urbanizing cities, residential compounds in large scale and gated communities are currently a leading development pattern that is not only transforming the housing delivery model, but it is also influencing the manner that ordinary urban services are provided and realized at the neighbourhood level. In this development, the quality of life in the city is not only in the dwelling units, but also in the functionality of the in-built neighborhood service amenities that facilitate day-to-day activities, accessibility, security, and socialisation.

The failure of these facilities to perform well in respect of location, accessibility, spatial adequacy or environmental quality results in direct impacts to users and cumulative effects to larger-scale planning and management problems. This is why the assessment of the real performance of neighborhood service facilities once occupied and in use is becoming one of the key tasks in modern urban planning and the study of the built environment [1, 2].

Post-Occupancy Evaluation (POE) has now become a mature technique of giving a systematic evaluation on the performance of buildings and facilities in actual conditions once the buildings have been put into use. In contrast to design-stage evaluations, POE is concerned with the performance of the built environment as it is lived, the opinions of users and how these views may be converted into measurable indicators that may be used to influence planning, design, and policy choices. According to the recent literature, POE is no longer solely a technical performance attribute, but it is starting to incorporate functional, spatial, and user-satisfaction attributes in order to offer a more holistic view of building and facility performance [1, 3, 4]. POE has been

This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)

extensively deployed in residential settings to unveil discrepancies between the planning standards and the real user experience as well as to detect the commonly occurring shortcomings in the provision of spaces, accessibility, and the quality of services [2, 5].

Simultaneously with the increased employment of POE, a body of urban literature has shown that the determination of the levels of residents satisfaction with their neighborhoods largely depends on the presence, access, and quality of local services and facilities. Research in various geographical settings has invariably indicated that closeness to services, sufficiency of open spaces, accessibility, and the general functionality of the neighborhood facilities is core in determining everyday urban experience and perceived quality of life [6-8]. The recent methodological advances also suggest that facility-user satisfaction relationships are frequently not linear and asymmetric, such that bad performance in one or two important dimensions may negatively impact total satisfaction in disproportionate amounts even when other dimensions are relatively well-performing [8, 9]. It underscores the need to have systematic and performance-based evaluation systems as opposed to descriptive ones.

Simultaneously, gated communities and extensive residential compounds present a certain planning and governance setting of the neighborhood service delivery. Though these developments are seen to promise greater degrees of comfort, security, and quality services, empirical studies indicate that their spatial structure and management paradigm may have a significant impact on access, equity in service delivery, and daily movement trends [10, 11]. Residential compounds have increased at a higher rate than the institutional capability of overseeing and appraising the efficiency of their inner service centers in most of the quickly growing cities, especially in the Middle East. Consequently, formally meeting planning standards in the design stage can, in reality, turn out to be insufficient to meet the expectations of users when delivered into practice, which leads to an increasing disparity between the planned delivery and experience. Although more and more attention to POE and neighborhood satisfaction is paid internationally, two significant gaps can be distinguished in the current literature. First, a prevalent percentage of POE research in residential settings remains largely concerned with single buildings or indoor environmental performance, but relatively little is considered regarding the performance of neighborhood-scale service facilities as part of the integrated residential setting [1, 3]. Second, there is a paucity of empirical data on the speeding up urbanizing cities in the Middle East, and especially in Iraqi cities, even though these settings are now experiencing sweeping changes in residential development patterns and housing production. Unlike studies that have primarily examined POE at the individual building level or assessed residential satisfaction without linking user perceptions to measurable facility characteristics, this study combines user-based POE with a physical spatial audit and comparison with Iraqi planning benchmarks. It also compares perceived performance between kindergartens and primary schools to identify differences in spatial and use-related performance. This combined approach provides a more direct basis for relating users' perceptions to the physical and planning conditions of educational facilities within gated residential communities.

To address these gaps, this research will assess the effectiveness of the neighborhood service facilities in gated residential communities in Erbil, Iraq, based on a Post-Occupancy Evaluation methodology, which is founded on user satisfaction. The paper addresses a group of performance dimensions related to planning and design that are directly applicable to daily use and urban administration, such as location, accessibility, parking facilities, spatial sufficiency, provision of green and open areas, as well as capacity and overcrowding.

The study aims at offering empirical evidence that could be used to inform planning standards better, monitor residential developments, and offer more user-oriented provision of facilities by comparing performance across a range of facilities and identifying any recurring strengths and weaknesses.

2. Literature Review

2.1. Post-Occupancy Evaluation and Performance-based Assessment of Neighborhood Facilities

Post-Occupancy Evaluation (POE) has emerged as a significant method of evaluating building and facility performance after real use. In contrast to design-stage or compliance-based testing, POE is directly concerned with the real-life performance and the experiences of users, their perceptions, and needs as a valuable source of evidence [1, 2]. Over the years, POE has developed out of a tool that focused primarily on the indoor environmental quality into a larger assessment framework that incorporates functional performance, spatial adequacy, management concerns, and user satisfaction [1, 3]. POE has been found to be especially useful in residential and neighborhood settings, where it can be used to determine discrepancies between planning requirements, design intentions and the real user experience.

Empirical research reveals that facilities that satisfy technical or regulatory standards formally still can be underperforming in the aspects of accessibility, spatial sufficiency, usability, or capacity according to the perception of the users [4, 5]. Through the systematic gathering and evaluation of user feedback, POE offers a systematic way of converting daily experience into evidence that may be used to guide future planning guidelines, design choices and management practices [2]. Meanwhile, the assessment of the facilities of the neighborhood services is becoming more and

more comprehended as a multi-dimensional process extending beyond the material state of buildings. In perpetual studies of urban areas, accessibility, spatial distribution, capacity, and relationships between supply and demand have been noted to be essential elements of facility performance [6, 7].

The latest studies of spatial accessibility and distribution of services also prove that despite the fact that planning standards can be fulfilled, facilities may be actually used differently based on their location, their catchment areas and their spatial structure [12, 13].

Methodologically, a large number of relatively recent studies are using indicator-based and multi-criteria paradigms that integrate measures of accessibility, spatial adequacy, environmental quality, and capacity in an attempt to capture the complexity of facility performance [14, 15]. Simultaneously, it is increasingly becoming clear that user-based assessments are needed, since perceived performance is not necessarily directly related to technical or quantitative performance.

Surveys conducted with the combination of spatial measurements and the satisfaction survey provide evidence that the user feedback can expose some latent issues regarding crowding, usability, or functional organization that may otherwise be invisible [7, 8]. These observations confirm that POE is an appropriate framework that can be used to assess the actual performance of the neighborhood service facilities.

2.2. Residential Satisfaction, Gated Communities, and the Neighborhood Context

Gated residential communities represent a distinctive form of urban development in which housing and neighborhood services are planned and managed within relatively controlled spatial environments. The provision, location, and accessibility of local facilities therefore play an important role in shaping residents' everyday experiences and perceptions of neighborhood quality.

Research on neighborhood satisfaction has consistently identified the availability and quality of local facilities, accessibility, and the surrounding built environment as relevant components of residential satisfaction [6, 7, 9]. Within gated communities, however, the spatial organization of facilities may create specific accessibility and service-provision challenges. Recent evidence indicates that gated development can affect the spatial coverage and accessibility of urban services [10].

This suggests that evaluating neighborhood facilities after occupation is important for identifying discrepancies between planned provision and actual user experience. Meanwhile, the assessment of neighborhood service facilities is becoming more and more perceived as a multi-dimensional process that transcends the physical state of buildings. In the research of urban studies, it is always emphasized that accessibility, spatial distribution, capacity, and supply-demand relationship are the essential elements in the performance of the facilities [6, 7]. More recent studies of spatial accessibility and service allocation illustrate further that despite the provision of facilities based on planning requirements, their actual utilization may be largely differentiated based on the location, catchment areas and spatial arrangement [12, 13].

Despite the growing literature on POE and neighborhood satisfaction, limited empirical evidence is available on the post-occupancy performance of educational service facilities embedded within gated residential communities in Iraqi cities. This study addresses this gap by evaluating eight spatial and use-related performance dimensions across kindergartens and primary schools in eight gated residential communities in Erbil.

3. Materials and Methods

3.1. Study Area, Case Studies, and Data Collection

The research was carried out in the fast developing city of Erbil in the Kurdistan Region of Iraq, where gated residential neighbourhoods are a leading type of housing and where most of their daily services, such as educational institutions, are located within the compounds. The empirical study area included eight gated residential communities, (see Figure 1): Lana City, Atlantic City, Ashti 2 City, Lawan City, Hiwa City, Andazyaran City, Aynda City, and Ganjan City.

Both a kindergarten and a primary school are available in each of these communities to take care of the compound residents. In this regard, the paper examines a total of 16 educational service buildings (8 kindergartens and 8 primary schools) that are considered neighborhood-level educational service facilities that are integrated into gated residential settings.

The survey was conducted by a structured questionnaire survey which were administered on-site to real users of these facilities. A total of 360 questionnaires were sent out to the 16 facilities. Following data screening and cleaning, 312 valid responses were included in the analysis, which is equivalent to a response rate of about 86. Different days of the week and time of the day were used to conduct the survey to represent various usage conditions.

The questionnaire was divided into two major sections (1) basic background information about respondents and frequency of use, and (2) an evaluation part where the respondents were asked to rate the performance of the facility on a five-point Likert scale (1 = very poor, 5 = very good). One facility was used to do a pilot test to make sure that the questions were clear, and some slight changes were done before the actual survey.

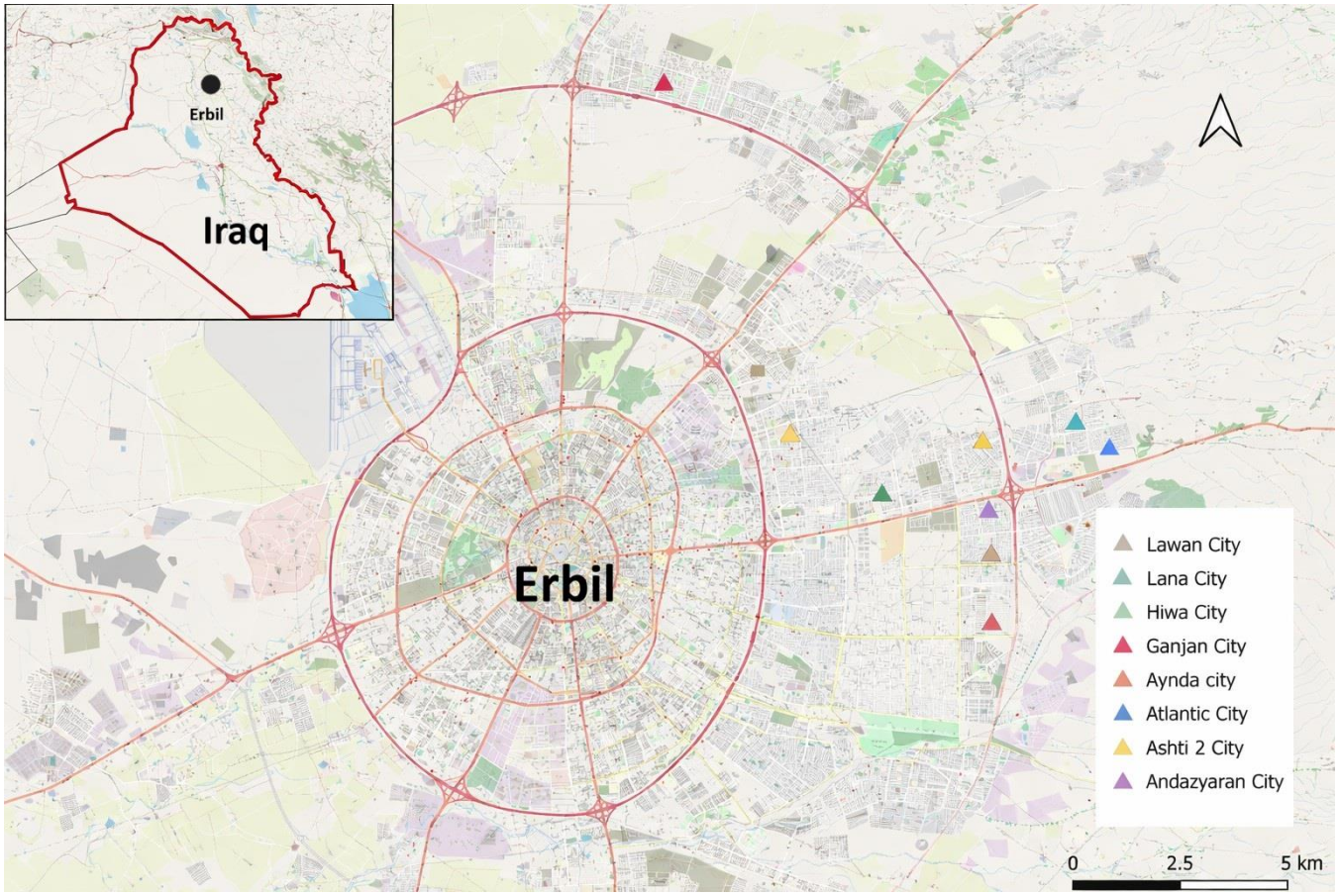

Fig. 1 Spatial distribution of investigated gated residential communities in Erbil city

3.2. Evaluation Framework and Data Analysis

The study adopts a Post-Occupancy Evaluation (POE) approach combined with a performance-based and user-centered evaluation framework in order to assess how educational service buildings perform in real-life use conditions. The evaluation is based on eight performance indicators:

1. Location suitability
2. Accessibility
3. Parking availability
4. Plot size adequacy
5. Building size adequacy
6. Availability of open spaces
7. Availability of green areas
8. Capacity and crowding level

These indicators capture both spatial-planning aspects and use-related aspects of educational service buildings within gated communities. Data analysis was carried out in four main steps. First, descriptive statistics (means, standard deviations, and rankings) were calculated to assess overall performance levels. Second, the reliability of the measurement scale was tested using Cronbach's alpha. Third, correlation analysis was performed to examine relationships between performance indicators. Finally, comparative analysis was conducted to compare performance between kindergartens and primary schools and across different residential communities. Based on these analyses, performance profiles and rankings of the studied facilities were developed.

3.3. Physical Spatial Audit and Iraqi Statutory Benchmark

3.3.1. Physical Spatial Audit

In addition to the user-based post-occupancy evaluation, a physical spatial audit was carried out for the 16 educational facilities (8 kindergartens and 8 primary schools) in the selected gated residential communities. Information gathered by the audit included Plot Area, Floor Area, Users, Classes, Users/Class, Plot Area/User, Floor Area/User, and Parking Spaces at each facility. Plot Area/User and Floor Area/User were calculated by dividing the respective area by the number of Users, and Floor Area/User was calculated from the number of Users and Classes recorded. The number of residential units within 400m and the maximum distance from which a dwelling was located were also measured to characterise the spatial extent of each facility. The indicators thus created are listed in Table 1 and will serve as the foundation for comparing them to the Iraqi planning benchmarks that follow.

Table 1. Physical spatial characteristics of the investigated educational facilities

Compound	Facility	Plot Area (m²)	Floor Area (m²)	Users	Classes	Users/Class	Plot/User (m²)	Floor/User (m²)	Parking	Houses within 400 m	Farthest Dwelling (m)
Ganjan City	Kindergarten	600	400	32	2	16	18.75	12.50	0	776	948
Ganjan City	Primary School	1,800	900	232	8	29	7.76	3.88	6	776	948
Hiwa City	Kindergarten	1,600	900	60	4	15	26.67	15.00	0	230	1,645
Hiwa City	Primary School	2,400	1,200	320	10	32	7.50	3.75	8	230	1,645
Andazyaran City	Kindergarten	2,000	1,200	72	4	18	27.78	16.67	0	420	734
Andazyaran City	Primary School	1,500	780	210	7	30	7.14	3.71	6	420	734
Lana City	Kindergarten	800	600	42	2	21	19.05	14.29	0	489	391
Lana City	Primary School	1,200	720	174	6	29	6.90	4.14	5	489	391
Lawan City	Kindergarten	650	300	45	3	15	14.44	6.67	0	536	825
Lawan City	Primary School	1,800	900	248	8	31	7.26	3.63	6	536	825
Ashti 2 City	Kindergarten	550	300	40	4	10	13.75	7.50	0	1,020	510
Ashti 2 City	Primary School	1,500	1,000	288	9	32	5.21	3.47	8	1,020	510
Aynda City	Kindergarten	480	250	32	4	8	15.00	7.81	0	775	530
Aynda City	Primary School	1,500	800	196	7	28	7.65	4.08	6	775	530
Atlantic City	Kindergarten	720	360	48	3	16	15.00	7.50	2	500	850
Atlantic City	Primary School	2,100	1,200	310	10	31	6.77	3.87	8	550	900

3.3.2. Iraqi Statutory Benchmark

The physical audit was compared to the Urban and Rural Housing Standards in Iraq (2018) that contains planning provisions for educational facilities. The standards for kindergartens are 15-16 m²/user for Plot Area, 7.25-8.00 m²/user for Floor Area and, 24 children per class as recommended group size and 32 children as maximum. The standards given in Table 2 also provide 300 m service radius, 60-72 m² classroom area and a maximum plot coverage of 0.45. The other benchmarks for primary schools are 500 m service radius, 48 to 54 m2 for classroom area, optimum class size of 30 pupils and a maximum of 40 pupils per class, 3.75 to 4.50 m2/user for floor area and a maximum of 0.40 for plot coverage. There are also requirements regarding outdoor space and parking, and parking requirements are dependent on the number of sections or classes.

Table 2. Iraqi planning benchmarks relevant to the physical spatial audit [16]

Indicator	Kindergarten	Primary School
Plot Area/User	15-16 m²/user	6.00-8.50 m²/user
Floor Area/User	7.25-8.00 m²/user	3.75-4.50 m²/user
Users/Class	24 recommended; 32 maximum	30 optimum; 40 maximum
Classroom Area	60-72 m²	48-54 m²
Number of Classes	2-6	Minimum 6
Maximum Plot Coverage	0.45	0.40
Service Radius	300 m	500 m
Parking Spaces	1/section + 1-2 additional	1/class + 1-2 additional + disabled spaces
Outdoor Provision	Covered/shaded play area and green provision	Open paved yards, green areas, and play/sport fields

4. Results

4.1. Descriptive Statistics and Overall Performance Levels

Data from the 312 valid responses have first been used for summarizing the perceived post-occupancy performance of the educational facilities by descriptive statistics. The overall mean scale score, as per the 5-point Likert scale, was 3.41, showing moderate level of perceived performance across eight performance indicators. The greatest mean rating (M = 3.78, SD = 0.58) was given to location suitability, followed by accessibility (M = 3.65, SD = 0.61). Capacity and crowding had the lowest mean score (M = 2.94, SD = 0.71); parking availability had the next lowest score (M = 3.02, SD = 0.74). Moderate levels of perceived performance were seen for the remaining indicators: plot size adequacy, building size

adequacy, open space availability and green area availability. Descriptive results showed overall facilities were rated as moderately performing, and there were more concerns about capacity, crowding and parking than about location and accessibility. The detailed descriptive statistics are provided in Table 3.

Table 3. Descriptive statistics of performance indicators (n = 312)

Performance Indicator	Mean	Standard Deviation	95% CI
Location suitability	3.78	0.58	3.72-3.84
Accessibility	3.65	0.61	3.58-3.72
Parking availability	3.02	0.74	2.94-3.10
Plot size adequacy	3.42	0.63	3.35-3.49
Building size adequacy	3.48	0.59	3.42-3.55
Open space availability	3.36	0.66	3.29-3.43
Green area availability	3.18	0.69	3.10-3.26
Capacity and crowding level	2.94	0.71	2.86-3.02

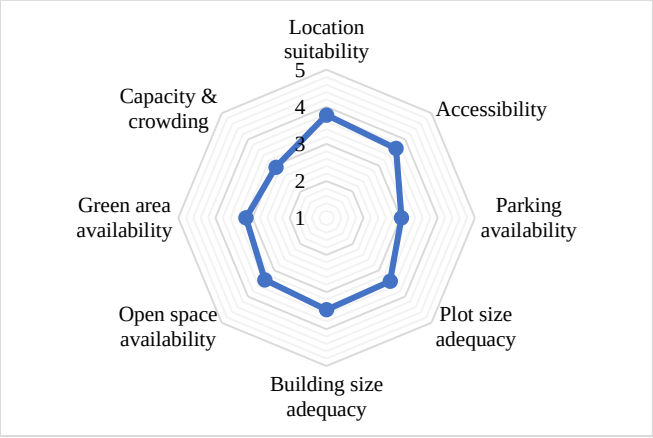

Fig. 2 Performance profile of educational service facilities

4.2. Reliability Analysis

After the descriptive analysis, the internal consistency of the performance evaluation scale was analyzed by Cronbach's alpha. The reliability analysis was performed after the 312 questionnaires were received and with the eight performance indicators that were used to assess the performance of the educational facilities after the construction. Cronbach's alpha was chosen to explore how well the indicators respond as a whole. There are no firm guidelines, but a coefficient of 0.70 or greater is generally considered acceptable for internal consistency for a measurement scale, though the value could vary depending on the context and purpose of the study.

The results revealed high internal consistency of the eight indicators; Cronbach's alpha coefficient was 0.86, which is higher than the prevailing value of 0.70. The result indicates that the indicators show a good level of consistency in measuring the dimensions of perceived performance measured in this study.

The reliability result gives, therefore, support for the use of the eight indicators as a coherent set in the subsequent statistical analyses, in this case the correlation and comparative analyses.

4.3. Correlation Analysis between Performance Indicators

A Pearson correlation analysis was performed on the 312 valid responses to look at the relationships among the eight performance indicators and overall perceived performance. The analysis was employed to find the direction and degree of the links among the different facets of the educational facility performance. The results indicated that there were a number of positive relationships between results and overall performance.

The most positive association was with accessibility (r = 0.48), and the next strongest was with building size adequacy (r = 0.46), plot size adequacy (r = 0.44), open space availability (r = 0.43), location suitability (r = 0.41), and green area availability (r = 0.39).

The results show that the more positive the respondents were about conditions in relation to accessibility, spatial adequacy and provision of outdoor environment, the higher the total evaluation of the educational facilities was.

Parking availability, on the other hand, had a negative correlation with overall performance (r = -0.36), with capacity and crowding level having the highest negative correlation (r = -0.57).

The pattern shows that perceived capacity was negatively associated with overall performance ratings, as was crowding problems. The negative association found for parking also indicates a link between poorer levels of parking provision and poorer overall performance.

At the overall level, the correlation pattern indicates that the perceived capacity of the facility was correlated negatively with the accessibility and spatial and environmental conditions, while the perceived facility performance correlated positively.

These results, shown in Table 4, enable the dimensions most closely related to the overall perceived performance to be identified; however, correlation coefficients only reflect statistical associations and do not imply direct causal relationships.

Table 4. Correlation coefficients between selected performance indicators and overall performance

Performance Indicator	Correlation with Overall Performance (r)
Location suitability	0.41
Accessibility	0.48
Parking availability	-0.36
Plot size adequacy	0.44
Building size adequacy	0.46
Open space availability	0.43
Green area availability	0.39
Capacity and crowding level	-0.57

4.4. Comparative Analysis: Kindergartens vs. Primary Schools

The differences between kindergartens and primary schools with regard to perceived post-occupancy performance were compared. The overall mean performance score in kindergartens exceeded that of primary schools (3.56 and 3.27, respectively), as shown in Table 3. The differences were pronounced in adequacy of plots, adequacy of building size, open space and capacity and crowding. The difference between kindergartens and primary schools was slightly greater for location suitability and accessibility, with mean scores of 3.15 and 3.06, respectively, for kindergartens compared to primary schools. Mean score differences were also greater for the facility type for the items of parking availability and availability of toilet facilities, with scores of 3.15 and 3.06 for kindergartens, respectively, compared to 2.89 and 2.89 for primary schools.

An independent-samples t-test was conducted to determine if there was a significant difference between the two facility types with regard to perceived overall performance. The overall performance scores of the kindergartens were significantly higher than those of the primary schools ($M = 3.56$, $SD = 0.47$ vs. $M = 3.27$, $SD = 0.52$; $t = 4.72$, $p < 0.001$, Cohen's $d = 0.58$), representing a moderate effect size. The greatest differences were in plot size adequacy, building size adequacy, open space availability, and capacity and crowding at the indicator level, while the comparatively smaller differences were in location suitability and accessibility.

Overall, the comparison shows that there is a clear difference between the two types of facilities on the eight indicators, with a higher rating for the kindergartens. Lower ratings for the primary schools, in particular for their capacity and crowding, their parking availability and their spatial adequacy, suggest more perceived pressure for the use of these schools. The results are shown to illustrate that there are differences between facility types in perceived post-occupancy results and help to interpret the physical spatial aspects being considered in the following benchmarking comparison, Table 5.

Table 5. Comparison of mean performance scores between kindergartens and primary schools

Performance Indicator	Kindergartens	Primary Schools
Location suitability	3.82	3.74
Accessibility	3.69	3.61
Parking availability	3.15	2.89
Plot size adequacy	3.61	3.23
Building size adequacy	3.66	3.31
Open space availability	3.54	3.18
Green area availability	3.31	3.05
Capacity and crowding level	3.12	2.76

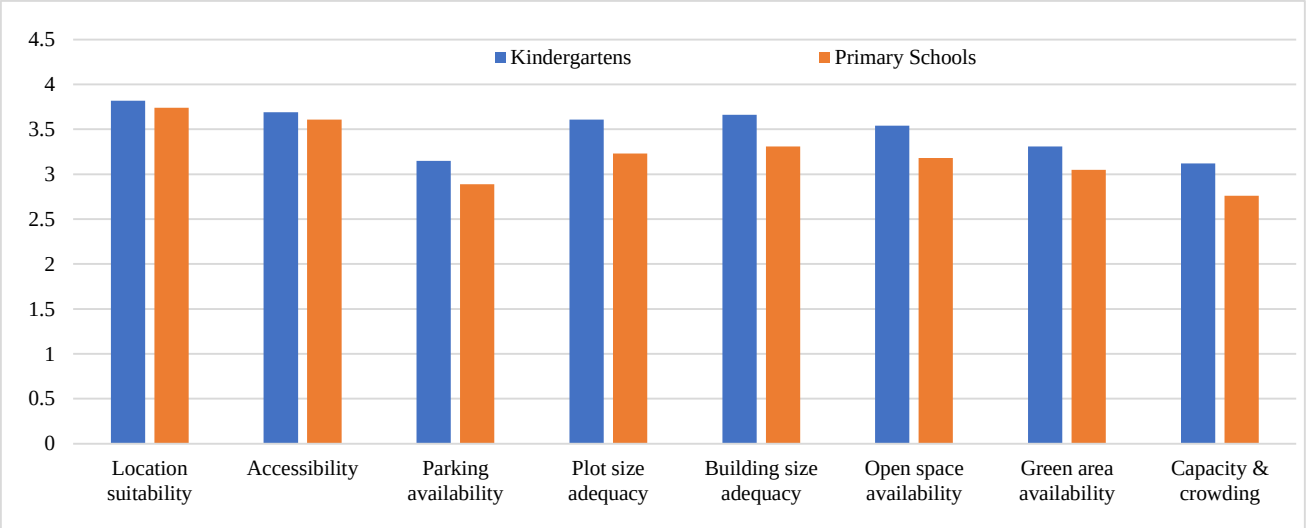

Fig. 3 Comparison of performance between kindergartens and primary schools

4.5. Physical Audit and Iraqi Benchmark Comparison

The physical attributes of the 16 educational facilities examined were compared to the Iraqi physical planning standards listed in Table 5. There was a significant spatial variation in the comparison. Of the kindergartens, 4 had values for their Plot Area/User higher than the acceptable range, 2 were within the range, and 2 were lower than the range.

In the case of Floor Area/User, there were four that exceeded, two that matched, and two that were below the specified range. Seven of the primary schools were in the Plot Area/User range, and one school was below the Plot Area/User range, while five schools were in the Floor Area/User range and three schools were below the lower Floor Area/User range.

There were also differences in the Users/Class results, with the performance of the facilities of the same type varying. The number of children per class in all kindergartens was below the recommended amount of 24, and none of the classes had more than 32. In primary schools, the number of pupils per class ranged from 28 to 32, with the majority of classes not deviating too far from 30 pupils per class, and all still under the maximum of 40. The number of classes in all kindergartens was within the range specified, and the minimum for primary schools of six classes was met in all schools.

The minimum required parking per number of classes or sections is the least consistent among the facilities, as all 16 facilities had a shortfall. This also showed that the farthest dwelling was outside of the recommended service radius in all kindergartens and 7 of the primary schools.

Overall, physical audit indicates that several facilities have adequate or above benchmark spatial provision, but there are specific concerns about spatial provision, including parking and Floor Area/User in some facilities, and service coverage.

Table 6 provides a summary of the comparison of the standards. The results of these analyses offer an objective physical basis for the user-based POE results, especially the lower ratings for parking availability and capacity and crowding.

Table 6. Summary of physical audit against Iraqi planning benchmarks

Indicator	Kindergarten	Primary School
Plot Area/User	4 Above; 2 Within; 2 Below	7 Within; 1 Below
Floor Area/User	4 Above; 2 Within; 2 Below	5 Within; 3 Below
Users/Class	All below recommended; none above maximum	6 within optimum; 2 above optimum but below maximum
Number of Classes	8 within required range	8 meet minimum requirement
Parking Spaces	Below minimum in all 8	Below minimum in all 8
Farthest Dwelling vs. Service Radius	8 exceed 300 m	7 exceed 500 m; 1 within

5. Discussion

5.1. Interpretation of Overall Performance Levels

The results show a moderate level of perceived post-occupancy performance in overall educational facilities, and significant differences between the measured P.O.P dimensions.

The highest rating was given for location suitability and accessibility, indicating the general perception of the educational facilities that they are suitably located and accessible within their residential compounds. This is similar to other studies that highlight the critical role of proximity and accessibility on users' perception of neighborhood facilities [6, 7].

The lowest ratings were given to parking availability and the level of crowding and capacity. The comparatively lower rating of these indicators indicates that the use-related and spatial pressures are still significant issues, especially when demand is high. Similar issues have been noted in the research on neighborhood facilities in more populated residential settings, where increased demand for facilities can lead to problems if facilities were designed for lower levels of use [7, 9]. The results thus indicate that, under the premise of limited internal capacity, parking and space conditions, satisfactory location and accessibility does not guarantee a high overall level of perceived performance.

5.2. Reliability and Consistency of User-based Evaluation

The reliability analysis provides support for the consistency of the user-based evaluation framework used in this study. The Cronbach's alpha coefficient of 0.86 implies a high internal consistency among the eight performance indicators, which provides a unified framework for measuring actual perceived post-occupancy performance levels of the built educational facilities that were investigated. This result was similar to previous investigations carried out under POE that have shown that structured, questionnaire-based assessments can be valuable tools in capturing users' perceptions of real-life building performance [1, 2].

The relatively high internal consistency might be especially significant for the present study, because it involves aspects of spatial planning and use, such as location suitability, accessibility, parking, spatial adequacy, outdoor environment, capacity and crowding. The results of these indicators are consistent, which makes them suitable as a set to analyze perceived performance, but also lets the separate dimensions be analyzed individually in the correlation and comparative analyses. The reliability coefficient must be seen as evidence of internal consistency only, however, and not as independent evidence of construct validity. The results of the study thus confirm the reliability of the user-based assessment, and the interpretation of the underlying performance dimensions should be based on the overall conclusions of the descriptive, correlation, comparative and physical audit analyses.

5.3. Significance of Correlation Patterns

The correlation analysis indicates that capacity and crowding produce the most significant negative impact on the overall performance, and the accessibility and the quality of the outdoor environment are positively correlated with the evaluation of users. These trends are in line with the results of recent urban and spatial research that deficiencies associated with use intensity are more likely to dominate locational benefits in the formation of perceived quality of neighborhood services [9, 13]. The beneficial impact of open and green spaces also indicates a larger agreement in the literature that outdoor spatial quality can be of much value in user satisfaction, especially in facilities used by children and families [13]. This strengthens the point that the post-occupancy performance is not solely influenced by how large or located the building is, but the quality of the spatial environment around it as well.

5.4. Differences between Kindergartens and Primary Schools

The comparative analysis demonstrates a consistent difference in perceived post-occupancy performance between kindergartens and primary schools, with kindergartens receiving higher overall performance ratings. Differences are especially noticeable in indicators of spatial adequacy and outdoor areas and capacity, and crowding. The trend is similar to the results of previous studies that contrasted smaller facilities with larger facilities and smaller user densities with larger user densities; smaller facilities could have better user perceptions because of lower user densities or greater flexibility in spatial arrangement [7].

Lower performance ratings for primary schools are found in the areas of capacity/crowding, parking space and spatial adequacy, suggesting that primary schools are operating under higher pressure due to their larger user loads and requirements. The finding is relevant to the planning of educational facilities in gated residential communities where population growth and the growing demand on the facilities could increase the demand for facilities originally planned for smaller numbers of users. The need for re-thinking facility sizing and land allocation in large residential developments that may experience population and demand fluctuations that impact service levels locally has been noted in previous research [10].

5.5. Policy and Architectural Design Guidelines

The results have a number of practical applications in the planning and design of educational facilities in gated residential communities. The results show that educational facilities should not only be located, but also planned according to the required spatial needs and the demand for them by the users. In particular, the relatively low scores for capacity, crowding and parking availability indicate that it is important to look at capacity, spatial provision and supporting facilities all together in the planning and design process.

For primary schools, the number of users, provision in the classroom and available floor space should be taken into account in particular. In planning and expanding educational facilities, the Iraqi benchmarks shown in Table 5 can be referred to when calculating the Plot Area/User, Floor Area/User and Users/Class. Comparing the differences between the kindergartens and primary schools also suggests that the two types of facilities should be treated separately, for their patterns of use and spatial requirements.

Education facility planning also needs to take parking into account as a part of the process. The user rating for parking availability is relatively low, and the physical audit result is that the parking provision is less than the benchmark requirements, suggesting that there is a need for adequate provision for parking and suitably organized arrival and drop-off areas. Also, pedestrian and vehicle traffic should be coordinated to ensure safe and convenient access, especially at peak arrival and departure times.

The findings provide several practical implications for the planning and design of educational facilities within gated residential communities. It is important that open and green areas can be integrated into the school environment to be used and become functional and, in light of the results of the service radius, that the distribution of the facilities is taken into account in relation to the population in the surrounding residential area. If POE is added as a regular part of planning and management, it can be useful to get feedback about issues that are beginning to arise and to inform future changes or additions. A user-based evaluation coupled with physical inspections and legislative standards can then give a more responsive planning basis for education facilities in gated residential areas.

6. Conclusion

This study used a Post-Occupancy Evaluation (POE) model to evaluate the educational service facilities (kindergartens and primary schools) in the gated residential

communities in Erbil, Iraq. Using user-based assessments of 312 participants (respondents) in 16 educational institutions, the study offers an empirical and performance-based insight into the way such institutions work under real-life use circumstances.

The findings show that, on average, educational service facilities have an intermediate level of performance. Although location suitability and accessibility tend to work well, there are ongoing issues of capacity and crowding, availability of parking space, and the sufficiency of outdoor spaces.

These shortcomings point to an absence of a match between planning assumptions and the actual use intensity, especially in peak periods. Comparative analysis indicates that there are systematic differences in facilities. Kindergartens always rank higher than primary schools in indicators of spatial adequacy, outdoor environments and crowding. The implication of this observation is that the scale and user density of a facility are key factors of post-occupancy performance and that the existing planning standards could be undervaluing the demand of the primary schools in gated residential developments.

The study highlights the need to shift out of compliance-based planning, built on minimal standards, and focus on performance-driven and user-centered approaches by identifying capacity and crowding as primary performance drivers, outdoor spatial quality, and accessibility. The incorporation of POE feedback in the design and development of educational facilities may greatly improve their future operational capacity and role in enhancing livability of the neighborhood. The results have a number of implications on urban planning and architecture in gated residential areas: Planning standards for educational facilities should place greater emphasis on capacity provision and peak-hour demand, particularly for primary schools.

- Outdoor spaces and green areas should be treated as essential functional components rather than secondary design elements.
- Accessibility and internal circulation within gated communities should be carefully considered to support safe and convenient daily use.
- POE-based feedback mechanisms should be institutionalized to inform future planning guidelines and development control processes.

There are a number of limitations to this study. It is analysed using perception of the users, which, although good, does not entail all the technical or operational issues in the performance of a facility. Moreover, the emphasis on the gated communities in Erbil restricts the generalizability of the results to other urban settings. Future studies may merge user-based POE data with objective spatial and operational measures, extend the analysis to other kinds of neighborhood facilities, or do cross-city comparative studies to further understand the impact of planning and development patterns on post-occupancy performance. The paper adds to the literature by proving the relevance of POE on the neighborhood level and by offering empirical research data on the effectiveness of educational service facilities in gated residential areas. The study provides an effective model of enhancing the quality and sustainability of learning institutions in fast-growing urban settings by balancing user-based assessment and planning and design issues.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Funding Statement

This research received no external funding.

Acknowledgments

The authors would like to express their sincere gratitude to the Department of Architectural Engineering, Faculty of Engineering, Koya University, for providing academic support and resources that facilitated this research. The authors also thank all colleagues and reviewers for their constructive comments, which helped improve the manuscript.

References

[1] Mohamed Elsayed et al., "Post-Occupancy Evaluation in Residential Buildings: A Systematic Literature Review of Current Practices in the EU," *Building and Environment*, vol. 236, pp. 1-14, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[2] Raul Castaño-Rosa, and Dara Nerweyi, "Bringing Post-Occupancy Evaluation up Front to Enhance Energy Efficiency in Residential Buildings," *Building Research and Information*, vol. 53, no. 8, pp. 1075-1091, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[3] Han Jiang, Miao Wang, and Xin Shu, "Scientometric Analysis of Post-Occupancy Evaluation Research: Development, Frontiers and main Themes," *Energy and Buildings*, vol. 271, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[4] Saleh Baharetha et al., "A Post-Occupancy Evaluation Framework for Enhancing Resident Satisfaction and Building Performance in Multi-Story Residential Developments in Saudi Arabia," *Architecture*, vol. 5, no. 1, pp. 1-26, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[5] Oliver Tannor, Williams Miller Appau, and Elvis Attakora-Amaniampong, "A Post-Occupancy Evaluation of in-House Facilities Management Service Quality and user Satisfaction in Multi-Tenanted Office Buildings in Ghana," *Facilities*, vol. 41, no. 13-14, pp. 801-818, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[6] Kostas Mouratidis, and Athena Yiannakou, "What Makes Cities Livable? Determinants of Neighborhood Satisfaction and Neighborhood Happiness in Different Contexts," *Land Use Policy*, vol. 112, pp. 1-13, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[7] Yu Dong, "What Neighborhood Factors are Critical to Resident Satisfaction with old Neighborhoods? An Integration of Ground Theory and Impact Asymmetry Analysis," *Cities*, vol. 141, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[8] Nuo Chen, and Dewei Fang, "Exploring Public Space Satisfaction in old Residential Areas based on Impact-Asymmetry Analysis and Machine Learning," *Sustainability*, vol. 16, no. 6, pp. 1-17, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[9] Jason Cao et al., "Prioritizing Neighborhood Attributes to Enhance Neighborhood Satisfaction: An Impact Asymmetry Analysis," *Cities*, vol. 105, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[10] Alfian Galih Nugroho, Yori Herwangi, and Keiichi Ogawa, "Will Gated Community Affect Public Transit Service Coverage?," *Transportation Research Interdisciplinary Perspectives*, vol. 24, pp. 1-21, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[11] Guiheng Si, Ye Zhang, and Weimin Zhuang, "Will Opening the Gated Community be Perceived Beneficial by Residents? A Comparative Study of Beijing and Singapore," *Habitat International*, vol. 57, pp. 1-11, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[12] Tong Xiao et al., "Spatial Accessibility to Sports Facilities in Dongguan, China: A Multi-Preference Gaussian Two-Step Floating Catchment Area Method," *Applied Spatial Analysis and Policy*, vol. 15, no. 4, pp. 1093-1114, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[13] Jingyuan Zhang, and Puay Yok Tan, "Assessment of Spatial Equity of Urban Park Distribution from the Perspective of Supply-Demand Interactions," *Urban Forestry and Urban Greening*, vol. 80, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[14] Wenchao Wang et al., "Evaluating Accessibility and Equity of Multi-Level Urban Public Sports Facilities at Neighborhood Scale," *Buildings*, vol. 15, no. 10, pp. 1-23, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[15] Xiping Yang et al., "Evaluating the Improvement of Healthcare Accessibility for Urban Residents via the Construction of new Hospitals: A case Study of Xi'an, China," *Applied Spatial Analysis and Policy*, vol. 18, no. 5, pp. 1-24, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[16] Ministry of Construction and Housing and Municipalities and Public Works, Directorate of Housing, and Planning Consultancy Bureau, University of Baghdad, Urban and Rural Housing Standards in Iraq. Baghdad, Iraq, 2018. [Online]. Available: https://iurp.uobaghdad.edu.iq/?p=811