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A Post-Occupancy Evaluation Framework for Enhancing Resident Satisfaction and Building Performance in Multi-Story Residential Developments in Saudi Arabia

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Abstract: This paper presents a systematic post-occupancy evaluation (POE) of a gated apartment building in Onaizah, Qassim, Saudi Arabia, focusing on resident satisfaction and building performance. Employing a mixed-methods approach, the research combines quantitative data from questionnaires and qualitative data from walkthrough observations and interviews to assess various performance aspects, including thermal comfort, visual comfort, acoustic performance, and safety. Results indicate that residents generally expressed satisfaction with thermal comfort, visual comfort, and indoor air quality. However, concerns were highlighted in areas such as safety and security, design adequacy, and construction support services. These findings reveal that while the building meets many occupant needs, there are critical areas requiring improvement. This study underscores the importance of incorporating POE as a valuable tool for assessing building performance and informing future design and management strategies in residential developments. Finally, this study's methodology excelled in analyzing the quality and performance of residential building elements, which contributes to enriching the literature related to facilities management. It explains the research strategy followed to provide an organized and reliable framework that can be used to evaluate performance and quality in residential buildings.

Keywords: post-occupancy evaluation; residential buildings; user satisfaction; performance elements; gated communities; indicators

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1. Introduction

Buildings are designed and constructed to fulfill the needs, preferences, and aspirations of the people who will inhabit them. Unsuitable housing environments can adversely affect residents' satisfaction, comfort, productivity, and well-being. It may also lead to social, psychological, and physical issues, ultimately resulting in a decline in the quality of life [1,2].

Post-occupancy evaluation (POE) is a general approach for gathering feedback on a building's performance during actual use, including its energy efficiency, indoor environmental quality (IEQ), productivity, and occupant satisfaction [3]. POE is also recognized as a method of evaluating a building after construction and following a period of use [3,4]. POE data collection methods can be either objective or subjective. Subjective data includes resident surveys, interviews, and walkthroughs. Guidelines are an effective way to identify obvious problems in building systems.

Interviews with experts and residents are suitable methods to understand tenants' feelings towards the building under study [5]. Occupant questionnaires are the most reliable way to assess their overall perception of building performance. According to the United Nations Human Settlements Program (2023), eight out of ten Saudi citizens live in urban areas, making Saudi Arabia one of the most urbanized countries in the world. It is clear that to accommodate future population expansion, development patterns must be improved.

This study addresses a significant knowledge gap in the field of post-occupancy evaluation (POE) by focusing on gated residential buildings in Saudi Arabia, an area where comprehensive evaluations have been scarce. Unlike the existing literature, which often emphasizes general performance metrics or is primarily drawn from Western contexts, this research presents a systematic methodology tailored to the unique cultural and environmental conditions of the region. By integrating both qualitative and quantitative methods, this study captures nuanced occupant experiences alongside measurable satisfaction scores, thereby enriching the understanding of how various performance elements impact resident satisfaction.

This research introduces a novel standardized assessment tool for evaluating resident satisfaction in gated apartment complexes in Onaizah, Qassim, Saudi Arabia. This tool systematically identifies performance issues and their underlying causes across technical, functional, and behavioral dimensions. Integrating qualitative and quantitative methodologies enhances the accuracy of post-occupancy evaluations (POEs) and provides actionable insights for improving residential design and management practices.

In conclusion, this study offers novel contributions to the field of post-occupancy evaluation (POE) in residential buildings. It focuses on the impact of cultural factors on occupant satisfaction in Saudi Arabia, addressing a gap in the current literature. A standardized assessment tool was developed for evaluating resident satisfaction in gated apartment complexes, providing a culturally sensitive approach to POE. Additionally, a mixed-methods approach was employed to provide a comprehensive understanding of resident satisfaction.

2. Literature Review

This literature review examines recent post-occupancy evaluation (POE) studies in multi-story residential buildings, focusing on identifying technical, functional, and behavioral performance standards. Recent POE research on multi-story family housing has been the focus of the authors' identification and analysis. Our review covers research published between 2020 and 2024, sourced from various databases using keywords such as "residential", "apartments", "multi-story housing", and "POE". The results reveal a diverse range of studies with a global geographic distribution, highlighting the growing interest in understanding and improving the performance of residential buildings.

One of the recent post-occupancy evaluation (POE) studies of residential buildings was conducted to consider using cool roofs to reduce cooling demand and enhance thermal comfort in residential buildings [6]. Thermal comfort levels of twelve multi-story houses in Biskra, southern Algeria, were assessed using an on-site measurement campaign and POE survey. According to the household survey, 54% of the 43 participants considered indoor

thermal conditions "hot" during the summer, and 79.33% turned on HVAC equipment day and night. Survey results showed strong satisfaction with cool surfaces and tiles, with more than 100% and 90% of respondents strongly agreeing, respectively. In addition, a dynamic simulation using TRNSYS software demonstrated the potential benefits of cool roofs in terms of thermal comfort and energy efficiency. The study emphasized measuring residents' satisfaction to improve future building designs [6].

To determine the main variables influencing occupant satisfaction and sustainable design approaches in older residential buildings, Ref. [7] carried out a POE. The study used standardized questionnaires with 19 assessment metrics. The findings indicated that occupants were most satisfied with the local services available in their communities, but not with the internal living conditions. Factors like fitness facilities, neighborhood relationships, communal space, and community activities significantly impacted residents' satisfaction. The study proposed improvements to fully utilize the resources available in the surrounding area, including establishing community self-organization, implementing mobile service stations, and improving the quality of community life. These practical suggestions aim to increase resident satisfaction and improve old residential environments.

Regarding the standardization of POE methods, a systematic review by Ref. [8] examined POE practices in residential buildings in the EU between 2011 and 2021. The study aimed to enhance the understanding of POE research's most used techniques. It investigated seven POE identifiers: data analysis, research objectives, data collection methods, case studies, collected data, research approaches, and monitoring details. The findings indicated a lack of uniformity in reporting, tools, techniques, and data gathered for POE studies. The study provided valuable insights leading to a proposed roadmap for effective implementation of POE technologies in residential buildings to achieve a more standardized POE strategy.

To study the impact of retrofits on building performance, researchers conducted a POE study of seven apartments in northern Italy [8]. By comparing the performance of retrofitted apartments with unmodified conditions, the study aimed to understand aspects of indoor environmental quality (IEQ) and tenant satisfaction. The study took a mixed approach, including comparing energy bills, measuring indoor temperature and humidity, and surveying occupant satisfaction. The results showed that the retrofits reduced energy use for heating and increased thermal comfort for tenants. However, some participants experienced unintended side effects such as mold growth and noise from the mechanical ventilation system. The study demonstrated that using advanced digital monitoring techniques can reduce the difficulties associated with performing POE in converted residential buildings.

To identify short-, medium-, and long-term residential complexes with the highest levels of tenant satisfaction based on POE components, the general satisfaction level of these residential complexes was assessed through surveys [9]. The sample size was 379 citizens due to the random cluster sampling method used to select the statistical population. According to the findings, 41% of residents were satisfied overall. Furthermore, studies have revealed that short-term housing complex occupants are more confident than long-term complex occupants [10]. On the other hand, compared to long-term complex occupants, those living in medium-term housing complexes expressed lower levels of contentment. In the same context, a number of previous studies have explained how the length of stay can affect the satisfaction of residents and post-occupancy evaluations (POEs). Ref. [11] studied satisfaction levels in Chinese buildings and made a comparison for both long-term residents and new residents, and Refs. [12,13] explained a study that focused primarily on energy-efficient housing. The study showed that long-term residents view energy efficiency differently than new residents. On the same side, Ref. [14] explores the importance of

demographic factors and different periods of residence in shaping the true satisfaction of post-occupancy evaluations.

Another endeavor on the performance evaluation of neo-vernacular architecture in Jordan discussed the necessity of conducting a POE to investigate the benefits and drawbacks of The Royal Academy for Nature Conservation's neo-vernacular architectural style [10]. Based on input from staff members, the study sought to assess the building's overall quality, considering its spaces, design, and materials. Descriptive statistics were used to evaluate the data as part of an approach that combined quantitative and qualitative techniques. Multiple linear regression was also used to determine if there was a significant correlation between building design quality and demographics. The findings indicated that the overall quality of the building design was excellent, and the general quality of the building spaces was assessed as good. However, the odor and navigational sign systems were rated as poor. Employees ranked environmental quality as the most significant design feature and suggested adding a children's daycare center and play area. The study provided valuable suggestions for improving the performance of educational centers.

In another study, Ref. [9] employed a mixed-methods approach to identify performance components in a multi-story residential building. Through literature review, site visits, user surveys, and focus group interviews, the researchers identified 74 performance elements categorized as technical, functional, and behavioral.

2.1. Performance Elements of Residential Buildings

This section shows the technical, functional, and behavioral performance factors and the associated indicators. Table 1 shows the performance metrics for residential facility environments.

2.1.1. Technical Performance Elements

Technical performance factors are critical survival components that enable residents to inhabit a safe and healthy built environment. The building's technical systems primarily influence these performance components. The authors have reviewed the existing literature on the technical performance components of residential facilities. This study emphasizes five key performance elements: thermal comfort, acoustic comfort, visual comfort, indoor air quality, and safety and security.

- Thermal comfort. The first recognized category is the criteria for studying building thermal comfort. This category includes five main criteria: temperature in summer and winter, personal control of cooling and heating, relative humidity level, air movement throughout all spaces, and overall perception of thermal comfort in the apartment. Table 1 cites studies that investigated building thermal comfort criteria. Thermal comfort is defined by Ref. [15] as "the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation". The primary focus of thermal comfort is how occupants feel about and are satisfied with the thermal environment in their workspace. Another definition of thermal comfort is "that state of mind which indicates happiness with the thermal surroundings and is determined through subjective assessment" [16]. According to Ref. [17], air temperature, movement, air quality, and relative humidity influence how comfortable occupants feel in the workplace. The ideal temperature range for occupants to experience a comfortable thermal environment during work is between 20 and 25 °C, with an average relative humidity between 30 and 55%.
- Acoustical comfort. The primary goal of acoustic comfort in constructed environments is to ensure occupants' satisfaction with noise levels and sound quality [18]. It is primarily concerned with minimizing unpleasant sounds and promoting occupants'

well-being concerning the acoustic environment. Acoustical comfort encompasses various aspects of acoustic performance, such as sound propagation, speech intelligibility, communication privacy, and the absence of acoustic anomalies. Prolonged exposure to loud noises can lead to various health issues, including mental strain, irritability, and hearing loss [19].

- Visual comfort refers to the overall perception of the occupants of the built environment regarding adequate lighting. Visual comfort primarily focuses on light's quantity, distribution, and quality. Achieving visual comfort in a building involves providing appropriate illumination levels and controlling glare. Several factors influence visual comfort, including environmental, occupant, and sociocultural factors [15]. Visual comfort is key to determining indoor environmental quality in buildings, particularly in lighting design, as it supports occupants' activities. Sufficient lighting, whether from artificial or natural sources, facilitates interaction among occupants, reduces the risk of headaches and eye strain, and enables the safe performance of tasks [14].
- Indoor air quality directly affects building occupants' comfort and well-being. Many pollutants, such as dust, particles, carbon dioxide (CO_2), carbon monoxide (CO), tobacco smoke, and volatile organic compounds (VOCs), can impair the quality of the air [16]. The concentration of these parameters should not exceed 1000 ppm for CO_2, 9 ppm for CO, and 0.005 ppm for VOCs, according to the "Ventilation for Acceptable Indoor Air Quality" standard. Burning food, painting fumes, cleaning and maintenance supplies, and the smell of building materials are a few examples of the origins of air pollution. Sufficient ventilation systems replenish the air in buildings, remove offensive odors, and lessen the chance of exposure to dangerous contaminants [17].
- Safety and security. Community safety and security involve protecting individuals and their belongings from potential risks and hazards, conducting criminal investigations, and addressing the underlying causes of crime. Evaluating safety building requirements is crucial to safeguarding property value and human life [18]. To effectively enhance fire safety, various code requirements should be implemented, including fire sprinkler systems, fire alarms, alternative exit arrangements, evacuation plans, smoke detectors, fire extinguishers, availability of clear unlocked exits, and fire exits [20]. Facilities managers are responsible for regularly assessing facilities to ensure that the specified level of fire safety is maintained. These responsibilities include managing and minimizing fuel and fire loads in residential buildings, such as paper, plastic products, curtains, and furniture [9].

2.1.2. Functional Performance Elements

The functional performance elements are essential for occupants' ability to carry out their daily tasks within a building. These elements primarily relate to whether the workplace suits occupants' specific functions. The authors have reviewed the published literature on the functional performance elements of residential buildings. They highlighted five important performance elements: design adequacy, finishing, furnishings, fittings, and equipment, building location, and building support services.

- Design adequacy. Design adequacy in residential buildings is an essential element that directly influences the quality of living spaces. Adequate design encompasses functionality, aesthetics, sustainability, and user comfort. A well-designed residential building should meet the basic needs of its occupants and enhance their overall living experience [14]. The effectiveness of the design and the comfort of the occupants is influenced by many factors, including the layout of the rooms, the quantity and width of the corridors, and the placement of vertical and horizontal circulations [19]. Functionality involves optimizing space utilization, ensuring efficient layouts, and in-

tegrating practical features. Additionally, user comfort entails addressing ergonomics, ensuring proper ventilation, and promoting well-being. Striking the right balance among these elements results in a residential design that fulfills practical requirements and elevates the quality of life for its residents [20].

- Finishing. Building finishing is critical in shaping residential spaces' aesthetic and functional aspects, significantly influencing occupants' satisfaction. The quality of finishes, such as flooring, wall treatments, cabinetry, and fixtures, contributes to the building's overall ambiance and visual appeal [21]. However, spalling, water and wind infiltration, and color fading often impact the finishing quality. Factors such as buckling, delamination, cracking, corrosion, surface consistency, and cleanability can affect the finishing quality. The utilization of sustainable materials for finishing can enhance the interior atmosphere and promote occupant health [22]. Thoughtfully chosen finishes can also improve acoustics, lighting, and thermal comfort, creating a more enjoyable and satisfying living environment [14].
- Furnishings, fittings, and equipment. Furniture shapes occupants' satisfaction within residential buildings, influencing functionality and aesthetics. Well-chosen and appropriately arranged furniture serves practical needs and contributes to a space's overall comfort and livability. Thoughtful selection of furnishings can optimize spatial layout, promoting ease of movement and efficient use of available areas. Moreover, the ergonomic design of furniture enhances the comfort and well-being of occupants, addressing their physical needs [23]. Quality and well-maintained equipment, from kitchen appliances to entertainment systems, further contributes to the convenience and contentment of occupants, making furniture and equipment significant factors in shaping the overall residential experience [4].
- Building location. The location of a building stands as a paramount factor influencing occupants' satisfaction and overall well-being. A well-chosen building site can significantly contribute to the quality of life for its residents. Proximity to essential amenities, such as schools, workplaces, shopping centers, and recreational spaces, is pivotal in enhancing convenience and accessibility [4,5].

A strategic location that considers factors like public transportation access and connectivity to major thoroughfares contributes to a seamless daily commute, reducing stress for occupants. Furthermore, a thoughtfully chosen site can offer scenic views, access to green spaces, and a sense of community, all of which contribute to a positive living experience [20].

- Building support services. Building services significantly impact residents' quality of life and satisfaction. These include electrical services, water supply, laundry facilities, restrooms, water closets, and information technology [4]. Moreover, responsive and effective support services provide a seamless and convenient living experience, allowing residents to focus on their daily activities without undue concerns. Thoughtful incorporation of services like concierge assistance, fitness facilities, and community spaces further enhances occupants' satisfaction by promoting community and social engagement [24].

2.1.3. Behavioral Performance Elements

Behavioral elements establish a connection between occupants' activities and the built environment. Further, occupants' comfort and social interaction are primarily influenced by various behavioral factors, including the size and number of people sharing a space, the functional distance between areas, frequency of use, and the arrangement of circulation [25].

- Features of Apartment Building (Elements). In this section, all aspects related to the design of residential apartments are evaluated, and the extent of their impact on the

residents' behavioral performance process is studied, including the visual and acoustic privacy of the apartment, the extent to which the residents feel privacy in the residence, and their experience in using the common and welcoming areas.

- Administrative and Practical Assistance. This section highlights the role of those responsible for managing and operating the building, the ease of communication between the administration and the housing residents, and the possibility of exchanging any information related to waste recycling, energy sustainability, and recreational activities within the building.

Table 1. Performance indicators of the built environment of residential facilities.

	Performance Indicators	References
	A. Technical performance elements	
	A1. Thermal comfort	
A1	Temperature in summer and winter	[4,6,8,12,19,20,26–33]
A2	Personal control of cooling and heating	
A3	Relative humidity level	
A4	Air movement throughout all spaces	
A5	Overall perception of thermal comfort in the apartment	
	A2. Acoustical comfort	
A6	Noise level from HVAC systems	[12,14,20,23,25–35]
A7	The level of noise resulting from exposure to external roads and parking	
A8	Noise level originating from neighbors	
A9	Personal control of noise level	
A10	Overall perception of acoustic privacy and comfort in the apartment	
	A3. Visual comfort	
A11	Adequacy of natural lighting reaching the bedrooms	[4,12,20,23,25–37]
A12	Adequacy of natural lighting reaching the kitchen.	
A13	Adequacy of natural lighting reaching guest reception/family living spaces	
A14	Adequacy of artificial lighting in all indoor spaces	
A15	Personal control of artificial lighting	
A16	Type and quality of artificial lighting	
	A4. Indoor air quality (IAQ)	
A17	The freshness and quality of indoor air throughout all the spaces	[4,8,12,14,20,23–26,38–44]
A18	Control of mechanical and natural ventilation levels in the apartment	
A19	Overall perception of Air quality in the apartment	
	A5. Safety and security	
A20	Fire sprinkler distribution and availability	[4,12,23,30,32,36,39–48]
A21	Ease of emergency exit	
A22	Ease to reach the fire alarm system	
A23	The extent to which the security system for the main doors is adequately available	
A24	Adequate external lighting	
A25	Adequacy of closed-circuit television (CCTV) for security monitoring	
	B. Functional performance elements	
	B1. Design adequacy	
B1	Adequacy of the guest reception area	[19,32,49–60]
B2	Privacy of the living space	
B3	Area of the living space	
B4	Availability of windows for providing views for outside	
B5	Arrangement of spaces within the apartment	
B6	Area of typical bedrooms	
B7	Availability of storage space	
B8	Adequacy of rooms for the household structure	
B9	The total number of restrooms, bathrooms, and toilets	
B10	Toilet area	
B11	Kitchen area	
B12	Availability of laundry rooms	
B13	Ceilings height	
B14	Aesthetic of entrance and lobby	
B15	Overall quality of the functional design of the apartment	
	B2. Finishing	
B16	Quality and durability of the paint of the apartment	[55–60]
B17	Quality of floor tiles	
B18	Maintainability of walls and ceilings in the apartment	
B19	Protection against moisture	
B20	Protecting from termites and insects	

Table 1. *Cont.*

	Performance Indicators	References
	B3. Equipment, fixtures, and furnishings	
B21	Quality and maintainability of kitchenette storage units	[12,30,31,57]
B22	Maintainability of toilet cabinets	
B23	Durability toilet fixtures	
B24	Durability of bedroom furniture	
B25	Sufficiency of bedrooms' furniture and adequate furniture in bedrooms	
B26	The standard of furnishings in living rooms	
B27	Sufficiency of living room furniture	
B28	Doors and window competency	
B29	Matching guest room furniture	
B30	Quality and durability of guest room furniture	
B31	Quality of drinking water	
B32	Water heater capacity and responsiveness to use	
B33	The location and adequacy of 110 V power outlets.	
B34	Adequacy of locations of 220 V power sockets.	
B35	The refrigerator quality	
B36	The capacity of stove, oven, and kitchen exhaust vent	
	B4. Building location	
B37	Proximity to supermarkets and shopping centers	[20,23,30,31]
B38	Proximity to restaurants	
B39	Proximity to ATMs and banks	
B40	Proximity to schools and workplaces	
B41	Proximity to the mosque	
	B5. Building support services	
B42	The effectiveness of the rubbish collection service and the condition of the collection sites	[4,20,23,30,31]
B43	Responsiveness and efficiency of maintenance services	
B44	Accessibility of the main entrances (taking trolleys and wheelchairs in to mind)	
B45	Accessibility of car parking (taking trolleys and wheelchairs in to mind)	
B46	Adequacy of the car parking spaces	
B47	Provision of car parking shades	
B48	Quality of plantation, vegetation, and landscaping	
	C. Components of behavioral performance	
	C1. Features of apartment building (elements)	
C1	The degree of acoustic, visual, and other privacy in the apartment	[19,20,24–26,50]
C2	Residents' feeling of involvement in the community	
C3	Experience the cozy and welcoming common areas.	
C4	Moving around inside the structure is easy.	
C5	Feeling of home (allowing for the accommodation of residents from various age groups or cultures)	
C6	Overall perception of building design for fostering social connections among residents	
C7	Overall perception of building design for promoting healthy behaviors among occupants.	
	C2. Administrative and practical assistance	
C8	Residents and building management can communicate and share information.	[20,23,37,47]
C9	Customization of living areas with paint schemes, accent pieces, or small adjustments	
C10	Activities for enjoyment that take place inside the structure	
C11	Availability of services for the elderly and disabled people	
C12	Facilitating sustainable activities (recycling plans and information on energy conservation)	

3. Materials and Methods

This study presents a post-occupancy evaluation (POE) of a gated apartment building in Onaizah, Qassim, Saudi Arabia, focusing on resident satisfaction and building performance. The methodology combined quantitative data from questionnaires and qualitative data from walkthrough observations and interviews to assess various performance aspects. As presented in Figure 1, the research process began with a comprehensive literature review to establish a theoretical framework and identify key performance indicators. Based on this, a survey instrument was developed and administered to occupants, coupled with walkthrough surveys and occupant interviews to gather both quantitative and qualitative data. The collected data were then analyzed to identify trends and patterns in occupant satisfaction. Finally, focus group discussions were conducted to gain further insights, culminating in the development of recommendations for improving building performance and occupant satisfaction.

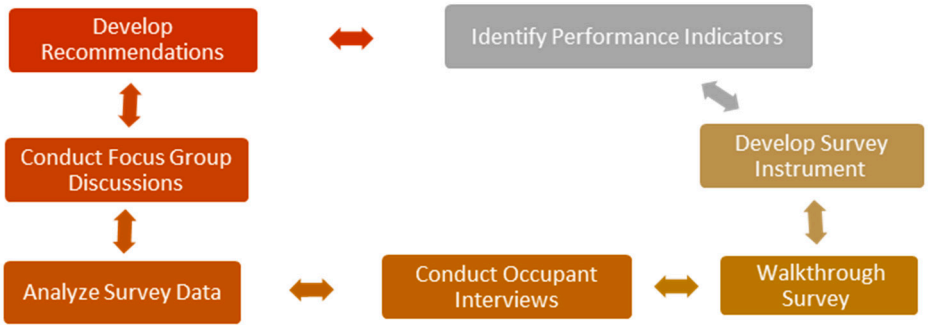

Figure 1. Flowchart of the research process.

This research utilizes a triple combination of qualitative and quantitative methods. A selected group of experts analyzed the collected data to develop a plan of action. The data collection process included a literature review, survey guidelines, interviews with occupiers, and a structured questionnaire to measure satisfaction levels.

By reviewing studies related to this topic, rules, standards, and guidelines for the design and performance of residential facilities have been established. This activity facilitated identifying and describing the functional performance and technical performance indicators (PIs) of residential facilities. A total of 85 key residential amenity indicators were identified and grouped into 12 categories, including thermal, acoustic, and visual comfort, indoor air quality, safety and security, suitability of design, finish, furniture, and fittings, building location, building support services, residential building characteristics, and logistical and administrative support.

3.1. Walkthrough Tour

A thorough tour of the building, lasting more than an hour, was undertaken to evaluate how well each component of the case study performed. The tour aimed to assess quality planning, space utilization, adherence to plumbing, health, and safety standards, and site preparation. During the walkthrough, several performance issues with various construction components were identified. Identifying these deficiencies facilitated the development of technical, functional, and behavioral performance components, which were later incorporated into the user satisfaction survey.

3.2. Case Study Building

A study area was conducted on a gated community apartment building in the Alshifa neighborhood of Onaizah, located in Saudi Arabia's Qassim region, which is a city rich in cultural heritage and historical significance, approximately 330 km northwest of Riyadh. Known for its traditional Najdi architecture, Onaizah features mud-brick buildings that reflect its history. The building is constructed with a reinforced concrete frame that provides strength and flexibility suitable for its desert climate. The exterior walls are clad in soft plaster with beige and peach tones, which not only enhances the aesthetic appeal, but also helps reflect sunlight, reducing heat absorption. The facade features small, evenly distributed windows to optimize natural lighting while minimizing solar gain. The building consists of two floors, with parking spaces conveniently located at the front of the building. The city experiences a hot desert climate, with summer temperatures often exceeding 45 °C (113 °F) and mild winters. Rainfall is scarce, primarily occurring from November to April. Despite its arid environment, Onaizah thrives agriculturally, particularly in date farming. The vibrant community life and growing educational institutions make it an appealing location for families seeking modern residential options in this culturally rich setting. The study was conducted in 2024 during the summer months.

The building comprises two floors, with twenty-two apartments. Two of the twenty-two apartments were vacant at the time the surveys were distributed. The building has a central courtyard, and a swimming pool in the central area. Figure 2 shows the ground level, while Figure 3 depicts the first-floor plan. Figure 4 presents the case study apartment building, highlighting its facades and interior design. Onaizah Colleges rents this facility to provide accommodation for professors working there. The building features a main stairwell for vertical circulation. Its gross area is 2162 M^2 (23,297 square feet), with a floor area of 1351 M^2 (14,540 square feet). There are two entrances: the main entrance faces the main elevation, while the other entrance is at the back of the building. Each apartment is designed with a toilet, a shared kitchen, and a main hall. The ground-floor apartments have individual doors leading to the central courtyard. The building offers two typical apartment models: the family model, which includes three bedrooms, a kitchen, and a main hall (with varying bedroom dimensions), and the single model, consisting of one room, a bathroom, and a main hall. The master bedroom is located on the second floor.

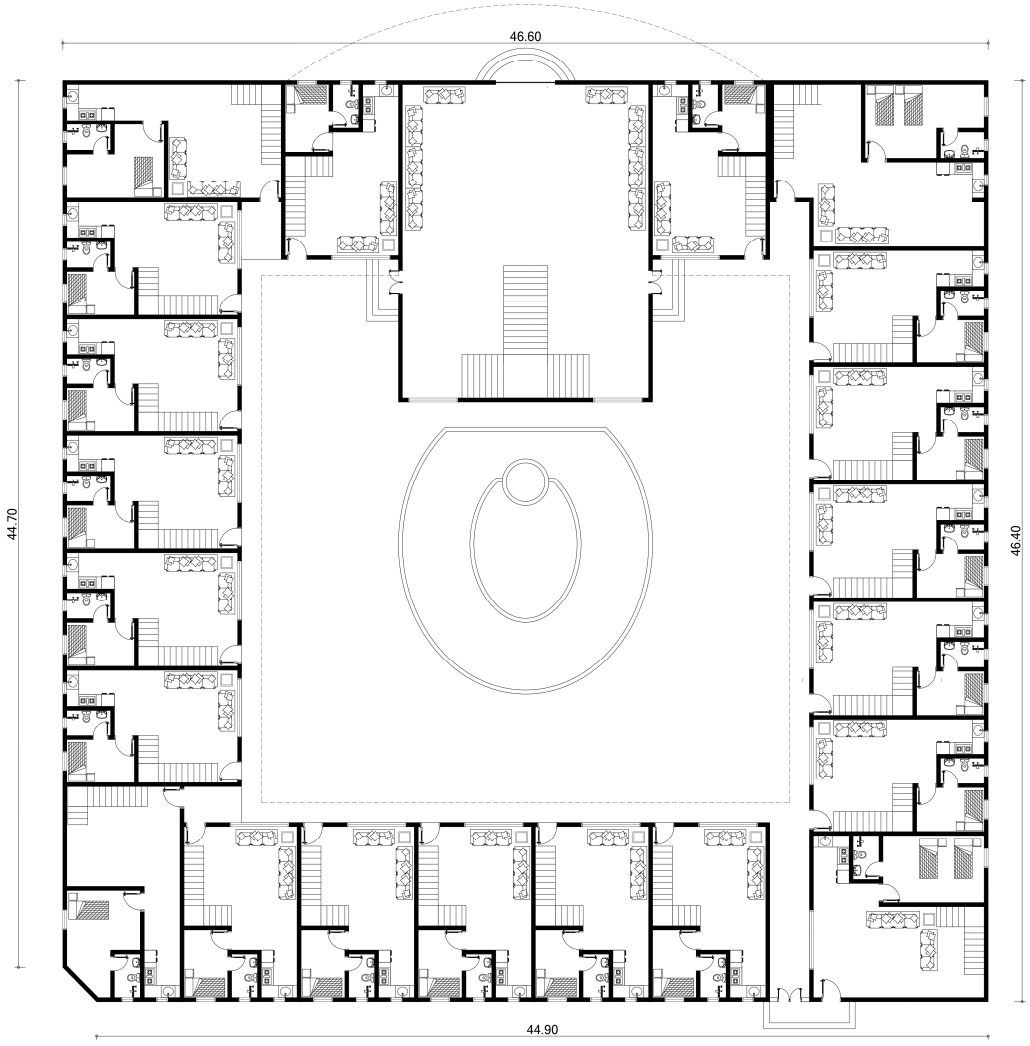

Figure 2. Ground-floor plan of the case study building.

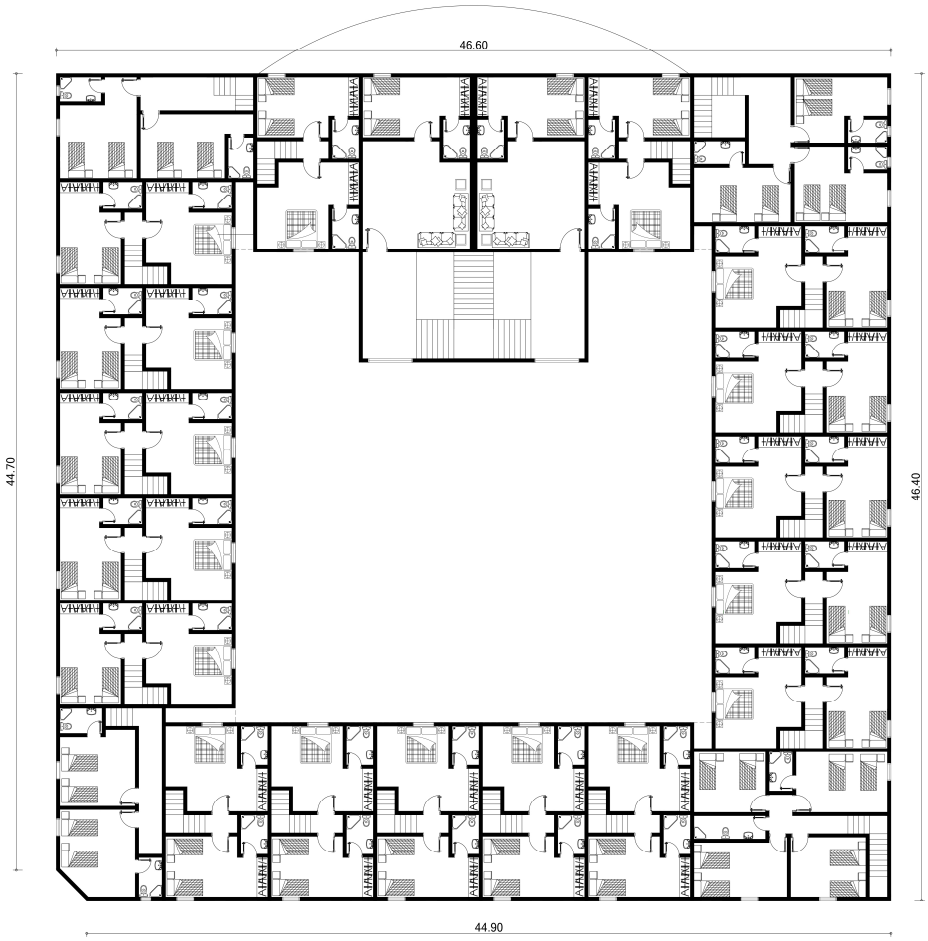

Figure 3. First-floor plan of the case study building.

Figure 4. Typical images of the case study apartment building, showcasing facades and interior design.

3.3. Facility Occupant's Interviews

A selected sample of the case study building's tenants was interviewed. These residents were chosen based on their stay in the building for more than two years, and with special emphasis on including individuals who work in the field of architecture and possess relevant experience. The period of residence of residents varied, as the percentage of old residents who lived more than two years was 65%, while the percentage of residents who lived more than a year was 21%, and new residents who lived less than a year and six months was 14%. The interviews aimed to collect the occupants' views on the observations made during the detailed investigation, considering their relevance to key indicators identified from the literature. This exercise documented additional flaws and assessed the appropriateness and validity of the PIs from the perspective of the building's occupants.

3.4. Occupants' Satisfaction Survey

A questionnaire was designed to gauge occupant satisfaction with the behavioral, functional, and technical performance elements. A random sample of residents from the 20 occupied units was selected, resulting in 67 participants representing 15 households out of a total population of 89 residents. Informed consent was obtained from all participants prior to the administration of the questionnaires and interviews.

The questionnaire had 85 technical, functional, and behavioral performance aspects. Using a 4-point Likert scale with the rating phrases "strongly satisfied", "satisfied", "dissatisfied", and "strongly dissatisfied", residents of the chosen building were asked to express their degree of satisfaction with the selected performance criteria. A pilot test survey was conducted to enhance the readability and clarity of questions. The questionnaire was then distributed to the residents of the residential building, including 20 housing units of the residential building. Since the total population of the complex is 89 individuals, responses were obtained from residents of fifteen units. Each participating household completed the questionnaire. Fifteen responses were received, resulting in a response rate of 75% of the total population of the complex, and these responses were analyzed for the study.

The responses of the 15 housing units, which represent the opinions of 67 residents out of the total population of these units, 89 residents, were collected and then analyzed and interpreted. The goal was to determine user satisfaction with the case study building's performance components. The average satisfaction for each performance indicator (PI) was then computed to ascertain and assess occupant satisfaction. Every satisfaction level was given a weight based on its classification. The following weights were applied to the satisfaction levels: "very satisfied" received four points; "satisfied" received three; "unsatisfied" received two; and "strongly dissatisfied" received one point. The margin of error for each performance indicator was calculated at a 95% confidence level. The calibration, matching weight, and satisfaction rate for every performance element are shown in Table 2. Equation (1) determined the average satisfaction (mean) for every performance measure.

$$S_j = \frac{\sum_{i=1}^{4} (W_{ij})(n_i)}{\sum_{i=1}^{4} (n_i)} \times 100 \quad (1)$$

where:

S_j: is the weighted mean response.
n_i: is the number of respondents who evaluated elements j of performance in the survey.
w_i: is the assigned weight to the satisfaction rate (i = 1, 2, 3, or 4).

Table 2. Satisfaction rates, along with their corresponding weight and calibration.

Satisfaction Rate	Corresponding Weight	Calibration
Strongly satisfied	4	3.5–4
Satisfied	3	2.5–3.49
Dissatisfied	2	1.5–2.49
Strongly dissatisfied	1	0–1.49

3.5. Focus Group Discussions

Following the data analysis, focus group discussions were conducted with a sample of four facility residents. These residents were chosen because they had lived in the building for more than two years, had experience in architectural design, and had experience relevant to the study subject. The goals were to review the POE data, get inputs, and solicit ideas for improving the case study building's performance.

The focus group discussions were designed to be interactive and conversational, encouraging participants to share their insights and suggestions openly. A moderator guided the conversation while ensuring that all participants had the opportunity to contribute. The data gathered from these discussions were analyzed to identify key themes and recommendations, which were then integrated with the quantitative findings to develop a comprehensive set of recommendations for enhancing the building's performance.

Recommendations were developed to improve the case study building's overall performance. These recommendations were based on a thorough analysis of data gathered through multiple stages of the study, including the results of the orientation tour, initial interviews with long-term residents, the resident satisfaction survey, and focus group discussions. The recommendations addressed identified deficiencies in the building's functional, technical, and behavioral performance aspects. Key proposals included optimizing the spatial layout to enhance usability, addressing technical shortcomings such as ventilation and lighting issues, and improving behavioral factors related to occupant comfort and convenience. Additionally, insights from focus group participants, particularly those with architectural expertise, informed suggestions for targeted design modifications and operational improvements to align the building's performance with user expectations and best practices in residential design.

4. Results

4.1. Evaluating the Technical Performance Specifications

The following is a discussion of the residents' satisfaction ratio for each of the five technical performance specifications:

- Thermal comfort:

This category has five performance components: relative humidity, airflow across the apartment, summer and winter temperatures, individual control over heating and cooling, and overall impression of thermal comfort. A total of 15 households completed the user satisfaction survey, and the average response was that they were "satisfied" with the performance characteristics that were previously stated. Table 3 displays this category's average satisfaction rating of 2.82. The satisfaction rates of the residents for each thermal comfort category indication are shown in Figure 5.

Table 3. Assessment of the performance indicators of technical performance elements of residential services.

	Building Performance Components	Evaluation Terms					Standard Deviation	Rate of Satisfaction
		SS	S	D	SD	Mean		
	A. Technical performance elements							
	A1. Thermal comfort					**2.82**		
A1	Temperature in summer and winter	5	6	2	2	2.93	1.00	S
A2	Personal control of cooling and heating	4	5	6	0	2.86	0.81	S
A3	Relative humidity level	5	7	2	1	3.06	0.85	S
A4	Air movement throughout all spaces	4	3	6	2	2.6	1.02	S
A5	Apartment's general thermal comfort rating	3	6	4	2	2.66	0.94	S
	A2. Acoustical comfort					**2.93**		
A6	Noise ratio originating from the HVAC systems	5	7	2	1	3.06	0.81	S
A7	Noise level resulting from exposure to external roads and parking lots	6	5	4	0	3.13	0.93	S
A8	Noise level from neighbors	5	5	4	1	2.93	0.91	S
A9	Personal control of noise level	5	2	8		2.8	0.85	S
A10	Overall perception of acoustic privacy and comfort in the apartment	3	6	5	1	2.73	0.85	S
	A3. Visual comfort					**2.79**		
A11	Adequacy of natural lighting reaching the bedrooms	5	7	2	1	2.8	0.93	S
A12	Adequacy of natural lighting reaching the kitchen	1	1	9	4	1.93	0.82	D
A13	Adequacy of natural lighting reaching guest reception/family living spaces	6	5	3	1	2.6	0.44	S
A14	Adequacy of artificial lighting in all indoor spaces	4	8	2	1	3	0.54	S
A15	Personal control of artificial lighting	4	11		0	3.26	0.85	S
A16	Quality and type of artificial lighting	4	10	1	0	3.2	0.63	S
	A4. Indoor air quality (IAQ)					**3.04**		
A17	The freshness and quality of indoor air throughout all the spaces	5	7	2	1	3.06	0.87	S
A18	Control of mechanical and natural ventilation levels in the apartment	3	9	3	0	3	0.85	S
A19	Overall perception of indoor air quality at the apartment	4	8	3	0	3.06	1.03	S
	A5. Safety and security					**2.09**		
A20	Availability and distribution of fire sprinklers	1	1	5	8	1.66	0.72	D
A21	Ease of egress in cases of emergency	3	6	5	1	2.73	0.91	S
A22	Ease to reach the fire alarm system	2	2	5	6	2	1.00	D
A23	Adequacy of the main doors' security system	2	5	5	3	2.4	0.81	S
A24	Adequacy of outdoor lighting	2	10	2	1	2	0.85	S
A25	Adequacy of closed-circuit television (CCTV) systems for security monitoring	1	2	5	7	1.8	1.02	D

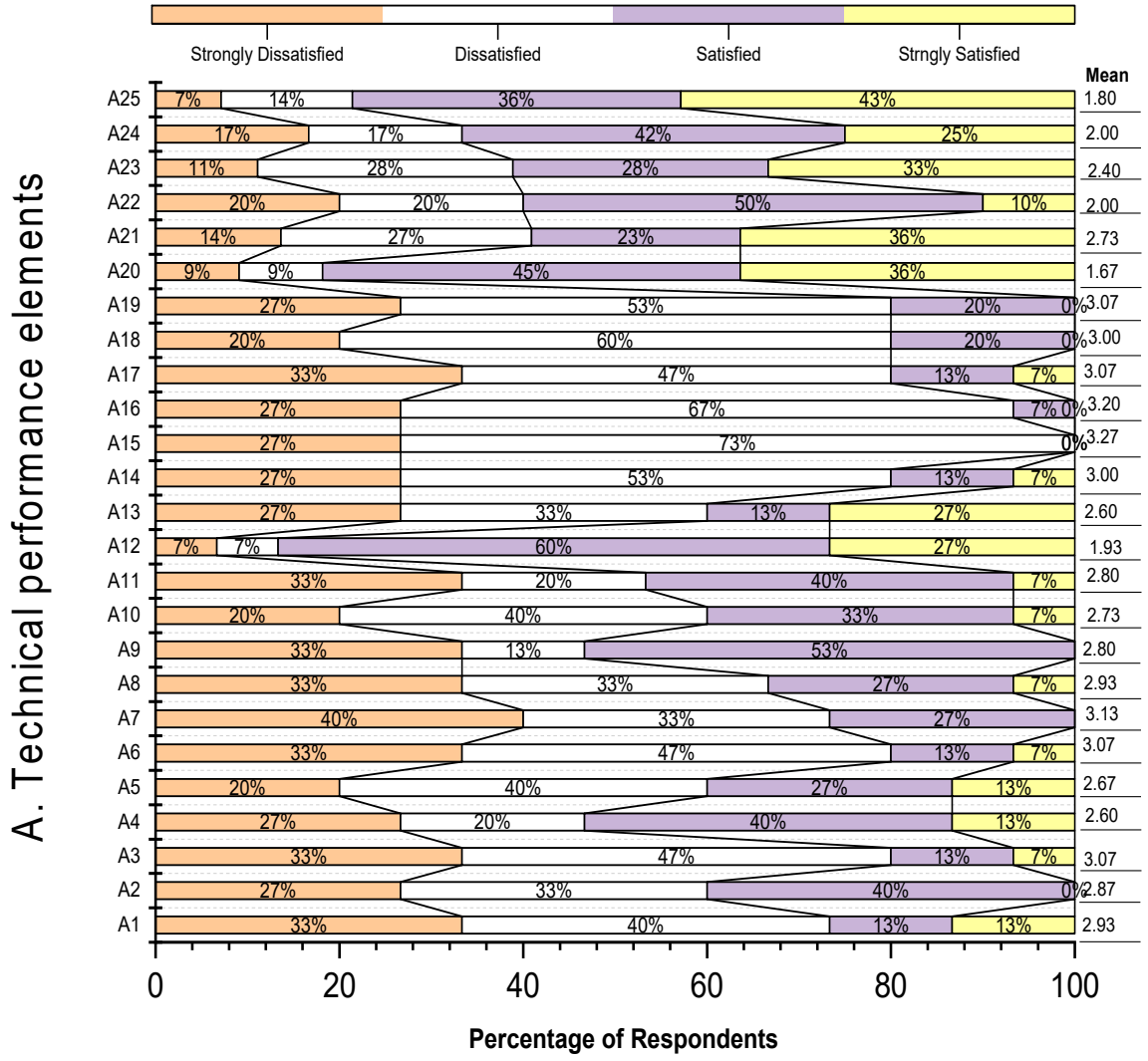

Figure 5. The technical performance elements in residential buildings (Category A).

- Acoustical comfort. This category included five performance elements: the noise level from heating, ventilation, and air conditioning (HVAC) systems, the noise level from exposure to external roads and parking lots, the noise level from neighbors, personal control of noise level, and general perception of acoustic privacy and comfort in the apartment. The mean response from the residents who completed the survey indicated that they were "Satisfied" with the five identified elements, with an average satisfaction rate of 2.93 for this performance category, as illustrated in Table 3 and Figure 5, which illustrate the residents' satisfaction rates for each indicator in the acoustical comfort category.
- Visual comfort. Six performance components in this category were identified and evaluated: the adequacy of natural lighting that reaches the bedrooms, the adequacy of natural lighting that reaches the kitchen, the adequacy of natural lighting that reaches the guest reception/family living areas, the adequacy of artificial lighting in all interior spaces, and personal control of artificial lighting and quality and type of artificial lighting. With an average satisfaction rating of 2.79 for this category, as shown in Table 3, the mean average response from residents who completed the user satisfaction survey indicated that they were "satisfied" with the other performance items listed, and "dissatisfied" with one of the listed ones. Figure 5 displays the percentage of satisfied residents with each visual comfort category indicator.

- Indoor air quality. Table 3 displays the three performance items included in this category. With an average satisfaction rating of 3.04, the residents who participated in the user satisfaction survey said, on average, that they were "satisfied" with the performance items included in this area. These elements included the freshness and quality of indoor air all around all the spaces, command of mechanical and natural ventilation ratio in the apartment, and overall perception of indoor air quality. Figure 5 illustrates the residents' satisfaction rates for each indicator in the indoor air quality category.
- Safety and security. This category contained six performance items. These include having fire sprinklers available and distributed, quickly escaping in an emergency, having simple access to the fire alarm system, having a sufficient security system for the main entrances, having enough exterior lighting, and having enough closed-circuit television (CCTV) systems for security monitoring. On average, residents who answered the poll said they were "satisfied" with the remaining items and "dissatisfied" with the three they had chosen. Table 3 displays the average satisfaction rating of 2.09 for this performance area. Rates of resident satisfaction for each indoor air quality indicator are shown in Figure 5.

4.2. Evaluating the Functional Performance Requirements

The following discussion is to residents' satisfaction rates for the five functional performance requirements:

- Design adequacy. Fifteen performance items were evaluated in this category, namely, the adequacy of the guest reception area, the privacy of the living space, the size of the living space, the availability of windows to provide views of the outside, the arrangement of spaces within the apartment, the typical size of bedrooms, the availability of storage space, the suitability of the rooms to the family structure, the number of bathrooms and toilets, the area of the toilet, the area of the kitchen, the availability of laundry rooms, the height of the ceilings, the aesthetics of the entrance and lobby, and the overall quality of the functional design of the apartment. The mean response from residents who completed the user satisfaction survey indicated that they were "dissatisfied" with four of the performance items listed and "satisfied" with the others, as shown in Table 4, with an average satisfaction rating of 2.39 for this category. Figure 6 shows the resident satisfaction rates for each indicator in the design adequacy category.
- Finishing. As shown in Table 4, there are five performance items in this area. A total of 15 inhabitants completed the user satisfaction survey, and the average response was 2.94, meaning that the residents were "satisfied" with the performance items in this category. These elements included the quality and durability of the apartment's paint, the quality of the floor tiles, the maintainability of the walls and ceilings, protection from moisture, and protection from insects and termites. Figure 6 shows resident satisfaction rates for each indicator in the finishing category.
- Furnishings, fittings, and equipment. This category had sixteen performance items. These are the quality and maintainability of kitchen cabinets, the quality and maintainability of toilet cabinets, the quality and durability of toilet fixtures, the quality and durability of bedroom furniture, the adequacy of bedroom furniture, the quality and durability of living room furniture, the adequacy of living room furniture, the quality of doors and windows, the adequacy of the guest room furniture, the quality and durability of the guest room furniture, the availability and quality of drinking water, the capacity of the water heater and its response to use, the adequacy and suitability of 110-volt electrical socket locations, the adequacy and suitability of 220-volt electrical

socket locations, the quality and capacity of the available refrigerator, and the quality and capacity of the stove, oven, and kitchen exhaust vent. The mean response of residents who completed the survey indicated that they were "satisfied" with the items evaluated, with an average satisfaction rating of 2.74 for this performance category, as shown in Table 4. Figure 6 shows the residents' satisfaction ratings for each indicator in the furnishing category and supplies and equipment.

- Building location. Table 4 displays the five performance items included in this category. With an average satisfaction rating of 3.05, the 15 residents who participated in the user satisfaction survey said, on average, that they were "satisfied" with the performance items included in this area. These elements include proximity to shops such as supermarkets and shopping centers, proximity to restaurants, proximity to ATMs, banks centers, proximity to restaurants, proximity to ATMs, banks, postal services, proximity to schools and workplaces, and proximity to mosques.
- Building support services. In this category, seven performance elements were assessed: the effectiveness and efficiency of the trash collection and the cleanliness of the collection points, the responsiveness and efficacy of the maintenance services, the accessibility of the main entrances (taking wheelchairs and strollers into consideration), the adequacy of the car parking spaces, the availability of car parking shades, and the quality of the plantation, vegetation, and landscaping. As shown in Table 4, the average response rate for this category was 2.26. The mean response from the residents who completed the user satisfaction survey revealed that they were "Dissatisfied" with three of the stated performance criteria and "Satisfied" with the others. The satisfaction rates of the residents for each indicator in the building support services category are shown in Figure 6.

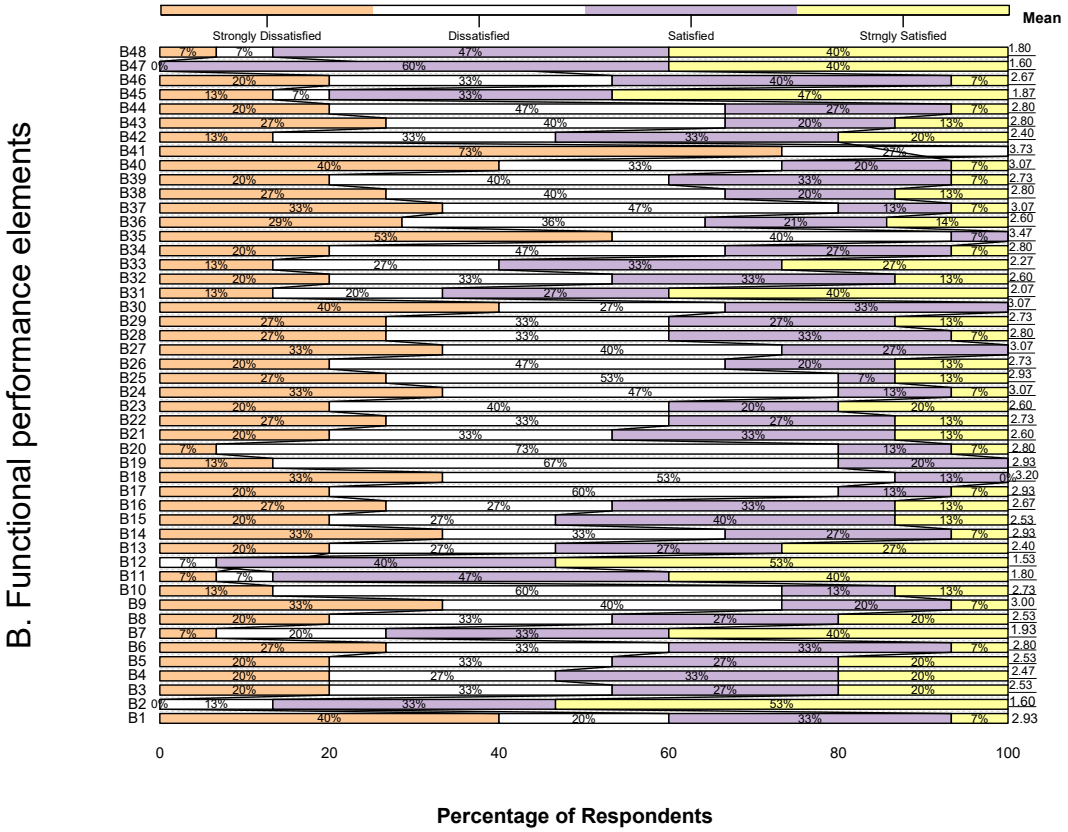

Figure 6. The functional performance elements in residential buildings (Category B).

Table 4. Assessment of the performance indicators of the functional performance elements of residential services.

	Building Performance Components	Evaluation Terms					Standard Deviation	Rate of Satisfaction
		SS	S	D	SD	Mean		
	B. Functional performance elements							
	B1. Design adequacy					**2.39**		
		SS	**S**	**D**	**SD**			
B1	Adequacy of the guest reception area	3	3	5	4	2.93	0.96	S
B2	Privacy of the living space	0	2	5	8	1.6	3.50	D
B3	Area of the living space	3	5	4	3	2.53	0.96	S
B4	Availability of windows for providing views for outside	3	4	5	3	2.46	0.96	S
B5	Arrangement of spaces within the apartment	3	5	4	3	2.53	0.96	S
B6	Area of typical bedrooms	4	5	5	1	2.8	1.89	S
B7	Availability of storage space	1	3	5	6	1.93	2.22	D
B8	Adequacy of rooms for the household structure	3	5	4	3	2.53	0.96	S
B9	Number of bathrooms and toilets	5	6	3	1	3	2.22	S
B10	Area of toilet	2	9	2	2	2.73	3.50	S
B11	Area of kitchen	1	1	7	6	1.8	3.20	D
B12	Availability of laundry rooms	0	1	6	8	1.53	3.86	D
B13	Ceilings height	3	4	4	4	2.4	0.50	S
B14	Aesthetic of entrance and lobby	5	5	4	1	2.93	1.89	S
B15	Overall quality of the functional design of the apartment	3	4	6	2	2.53	1.71	S
	B2. Finishing					**2.94**		
B16	Quality and durability of the paint of the apartment	4	4	5	2	2.66	3.59	S
B17	Quality of floor tiles	3	9	2	1	2.93	3.50	S
B18	Maintainability of walls and ceilings in the apartment	5	8	2	0	3.2	4.35	S
B19	Protection against dampness	2	10	3	0	2.93	4.86	S
B20	Protection against insects and termites	1	11	2	1	2.8	1.50	S
	B3. Furnishings, fittings, and equipment					**2.74**		
B21	Quality and maintainability of kitchen cabinets	3	5	5	2	2.6	1.50	S
B22	Quality and maintainability of toilet cabinets	4	5	4	2	2.73	2.75	S
B23	Quality and durability of toilet fixtures	3	6	3	3	2.6	3.10	S
B24	Quality and durability of bedroom furniture	5	7	2	1	3.06	2.22	S
B25	Sufficiency of bedrooms furniture	4	8	1	2	2.93	2.63	S
B26	Quality and durability of living room furniture	3	7	3	2	2.73	1.89	S
B27	Sufficiency of living room furniture	5	6	4		3.06	1.26	S
B28	Quality of doors and window	4	5	5	1	2.8	2.63	S
B29	Sufficiency of guest room furniture	4	5	4	2	2.73	1.71	S
B30	Quality and durability of guest room furniture	6	4	5		3.06	1.50	S
B31	Availability and quality of drinking water	2	3	4	6	2.06	1.26	S
B32	Water heater capacity and responsiveness to use	3	5	5	2	2.6	2.50	S
B33	Adequacy and suitability of locations of 110 V power sockets	2	4	5	4	2.26	3.86	S
B34	Adequacy and suitability of locations of 220 V power sockets	3	7	4	1	2.8	1.29	S
B35	Quality and capacity of provided refrigerator	8	6	1		3.46	2.75	S
B36	Quality and capacity of stove, oven, and kitchen exhaust vent	4	5	3	2	2.6	1.71	S
	B4. Building location					**3.05**		
B37	Proximity to supermarkets and shopping centers	5	7	2	1	3.06	2.22	S
B38	Proximity to restaurants	4	6	3	2	2.8	5.19	S
B39	Proximity to ATMs and banks	3	6	5	1	2.73	1.50	S

Table 4. *Cont.*

	Building Performance Components	Evaluation Terms					Standard Deviation	Rate of Satisfaction
		SS	S	D	SD	Mean		
B40	Proximity to schools and workplaces	6	5	3	1	3.06	1.71	S
B41	Proximity to the mosque	11	4			3.73	2.50	S
	B5. Building support services					**2.26**		
B42	Efficiency of garbage collection and cleanliness of their collection points	2	5	5	3	2.4	2.22	S
B43	Responsiveness and efficiency of maintenance services	4	6	3	2	2.8	3.20	S
B44	Accessibility of the main entries (consideration of wheelchairs and trollies)	3	7	4	1	2.8	0.96	S
B45	Accessibility of car parking (consideration of wheelchairs and trollies)	2	1	5	7	1.86	3.50	D
B46	Adequacy of the car parking spaces	3	5	6	1	2.66	0.96	S
B47	Provision of car parking shades			9	6	1.6	0.96	D
B48	Quality of plantation, vegetation, and landscaping	1	1	7	6	1.8	0.96	D

4.3. Evaluation of the Requirements for Behavioral Performance

The residents' satisfaction ratio for the two behavioral performance requirements is discussed as follows:

- Apartment building attributes. There were seven performance elements in this category: the sense of privacy (auditory, visual, etc.) in the apartment, the sense of community involvement among residents, the ease of mobility inside the building, and the sense of social inclusion (allowing individuals from different origins, cultures, or age groups to live there). The general opinion is that the building's architecture fosters social interactions among its occupants, and the general opinion is that the building's design encourages healthy habits. On average, residents who answered the user satisfaction survey said they were "satisfied" with the performance factors in Table 5 and Figure 7, giving this category an average satisfaction rating of 2.87.
- Managerial and logistical support. Within this area, there were five performance items. These include the ease with which information is shared and communicated between building management and residents, the feeling of individuality and ownership that comes from personalizing one's living space through décor, paint color, or small repairs, the availability of entertainment options within the building, and the provision of services. For those who are disabled or elderly, as well as supporting long-term projects, rehabilitation programs are available. Additionally, information about recycling and energy saving is available. The mean response of residents who completed the survey indicated that they were "satisfied" with the selected items, with an average satisfaction rating of 2.58 for this performance category, as shown in Table 5. Figure 7 shows the residents' satisfaction rates for each indicator in the administrative and logistical support category.

Table 5. Assessment of the performance indicators of the behavioral performance elements of residential services.

	Building Performance Components	Evaluation Terms				Mean	Standard Deviation	Rate of Satisfaction
		SS	S	D	SD			
	C. Behavioral performance elements							
	C1. Apartment building attributes					**2.87**		
		SS	**S**	**D**	**SD**			
C1	Feeling of privacy in the apartment (sound, visual, etc.)	1	3	7	4	2.06	2.50	S
C2	Sense of community engagement among the residents	3	9	3	0	3	3.77	S
C3	Feel for comfortable and inviting common spaces	5	7	3	0	3.13	2.99	S
C4	Ease of navigation within the building	5	7	3	0	3.13	2.99	S
C5	Feel for social inclusivity (accommodating residents from diverse backgrounds, cultures, or age groups)	3	9	3	0	3	3.77	S
C6	Overall perception of building design for fostering social connections among residents	5	8	1	1	3.13	3.40	S
C7	Overall perception of building design for promoting healthy behaviors among occupants	4	7	3	1	2.93	2.50	S
	C2. Managerial and logistical support					**2.58**		
C8	Communication and information sharing between building management and inhabitants are made easy	3	6	5	1	2.73	1.71	S
C9	Personalization of living spaces by paint colors, decorations, or little adjustments demonstrates a sense of ownership and personality	3	4	6	2	2.53	2.63	S
C10	Recreational programs are offered inside the structure	4	5	6		2.86	1.71	S
C11	Services for the elderly and crippled are available	4	6	3	2	2.8	2.75	S
C12	Promotion of sustainable initiatives (availability of recycling programs and energy-saving information)	2	1	7	5	2	2.50	S

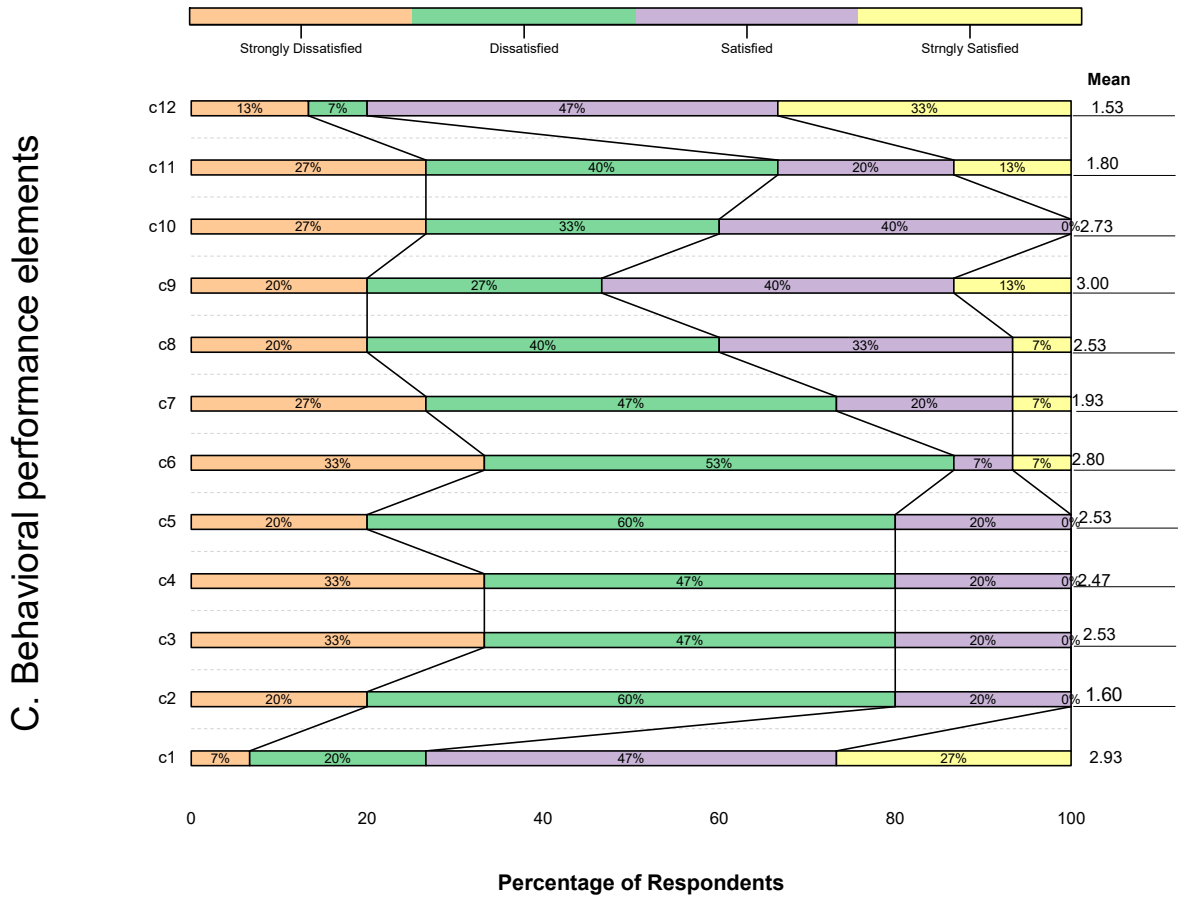

Figure 7. Behavioral performance elements in residential buildings (Category C).

5. Discussions

This study provides a comprehensive evaluation of resident satisfaction in a gated apartment building located in Onaizah, Qassim, Saudi Arabia. By employing a mixed-methods approach, the research captures both qualitative insights and quantitative metrics, contributing significantly to the field of post-occupancy evaluation (POE). The findings reveal varying levels of satisfaction across different performance categories, highlighting the strengths and weaknesses of the building's design and operational features.

In terms of technical performance, residents reported a satisfactory average rating of 2.82 for thermal comfort, as shown in Figure 8. This finding is particularly relevant given the extreme temperatures characteristic of the region's hot desert climate. The results align with the existing literature, such as Refs. [38,39,41], which emphasize the importance of managing indoor climates to enhance occupant comfort. Similarly, the acoustic comfort rating of 2.93 indicates that noise from HVAC systems and external sources is generally well-controlled, supporting the notion that acoustic privacy is vital for overall resident satisfaction [40]. Research by Ref. [39] also highlights the significance of thermal and acoustic comfort in enhancing the quality of life in residential buildings.

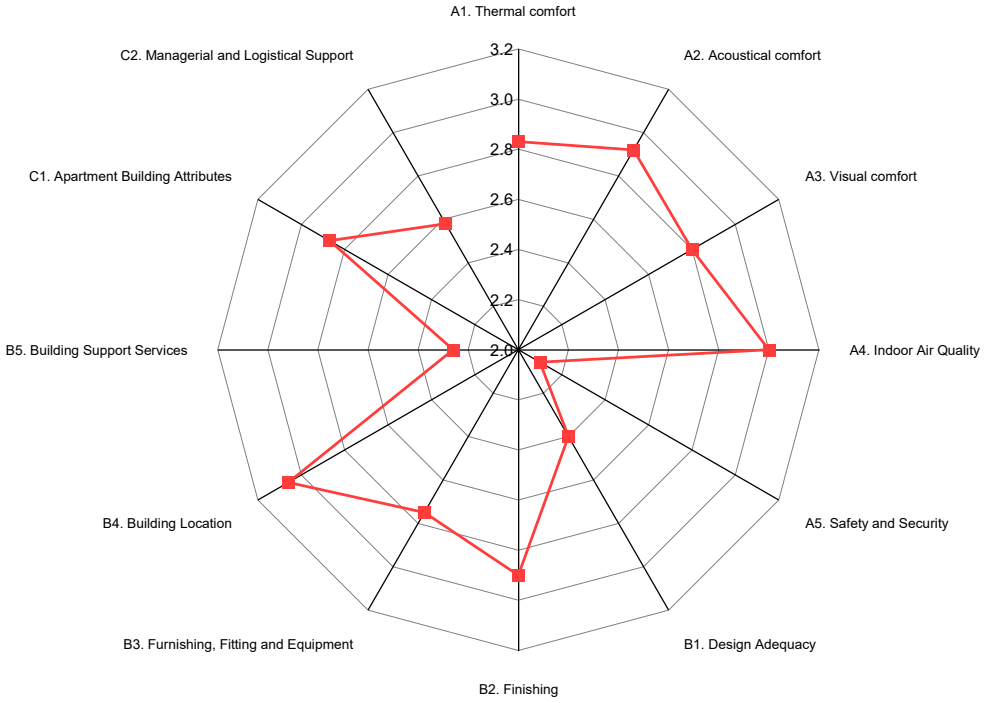

Figure 8. The average mean of technical, functional, and behavioral performance elements.

Conversely, safety and security emerged as areas of concern, with an average rating of only 2.09, as shown in Figure 8. This low score underscores the necessity for improved safety measures and security systems, reflecting findings from other studies that highlight the critical role of safety in residential satisfaction [41]. Residents expressed dissatisfaction with several safety features, indicating a pressing need for more robust security protocols to foster a sense of safety and well-being [42]. Another study discussed how perceptions of safety can significantly influence residential satisfaction, particularly in urban settings [41].

Regarding functional performance, the design adequacy received an average rating of 2.39, indicating dissatisfaction with certain spatial arrangements and privacy features. This result is consistent with research emphasizing the importance of thoughtful design in promoting resident satisfaction [43]. Issues such as inadequate storage space and poorly arranged living areas detracted from the overall functionality of the apartments, suggesting that future developments should prioritize these aspects to enhance livability [41]. Further,

this is supported by noting that well-designed spaces can lead to higher levels of resident satisfaction. The findings related to finishing and furnishings demonstrated higher satisfaction levels, with ratings of 2.94 and 2.74, respectively. Residents appreciated the quality of the finishes and furnishings, indicating that these elements meet their expectations. This aligns with previous studies that suggest high-quality materials contribute positively to resident satisfaction and perceived value [44]. Ref. [45] also found that the quality of interior finishes significantly impacts residents' overall satisfaction with multifamily housing.

In the context of behavioral performance, the apartment attributes category received an average rating of 2.87, reflecting a positive perception of community and privacy. This finding is supported by the literature, which highlights the significance of social interactions and community involvement in enhancing living experiences [46]. However, the managerial and logistical support category had a lower average rating of 2.58, indicating that residents feel there are gaps in communication and support services. This finding emphasizes the importance of effective management practices in residential settings, as highlighted by previous research advocating for improved communication between management and residents [47]. Ref. [41] also emphasizes that effective management can enhance community engagement and satisfaction.

In addition to the quantitative findings, qualitative insights from the guided tour, interviews, and focus group discussions were analyzed to provide a richer understanding of the case study building performance. A guided tour by the authors of the paper revealed serious deficiencies in building components, such as non-adherence to plumbing and safety standards, which were later validated by residents' comments. Interviews with long-term residents, particularly those with architectural experience, highlighted specific areas for improvement, such as better control of thermal comfort and improved sound insulation measures. Focus group discussions further reinforced these observations, providing actionable suggestions to address these issues, such as introducing more efficient HVAC systems and upgrading lighting solutions. These qualitative findings provide contextual depth to satisfaction scores and highlight raters' priorities, bridging the gap between user perceptions and technical performance.

Overall, this study contributes valuable insights into the satisfaction levels of residents in Onaizah, revealing both strengths and weaknesses in the building's performance. By comparing these results with the existing literature, the research underscores the importance of addressing safety, design, and support services to enhance resident satisfaction. The findings not only expand the understanding of POE in the Saudi context, but also provide actionable recommendations for improving residential design and management practices. Future studies should continue to explore these dimensions, particularly in culturally diverse settings, to further enrich the discourse on post-occupancy evaluations and their implications for residential satisfaction.

6. Limitations of This Study

While this study provides valuable insights into the performance and satisfaction levels of residents in the analyzed low-rise, gated apartment building, certain considerations must be noted. The findings are specific to the building typology and geographic context of Onaizah, characterized by its hot desert climate, cultural heritage, and gated community design. In addition, this study did not include specific performance factors such as "ability to control natural light" and "elimination of glare", which are recognized as important factors of indoor environmental quality (IEQ) in the POE literature. Future research could address these aspects to provide a more comprehensive assessment of passenger satisfaction.

Moreover, this study's findings are based on a single case study of a gated apartment building. Future research should consider a wider range of building typologies (e.g., high-

rise apartments, villas) and geographical locations within Saudi Arabia to enhance the generalizability of the results. Comparative analysis across multiple case studies would further strengthen the conclusions.

While the 67 respondents represent 75% of the occupied units, the relatively small sample size may limit the findings' generalizability to the entire building population. Future studies should aim for a larger sample size to minimize potential sampling bias and enhance the reliability of the results.

7. Conclusions

Recognizing occupants as a primary source of information about building performance, this study utilized a comprehensive user satisfaction questionnaire to evaluate the functional, technological, and behavioral aspects of a gated community building in Onaizah, Qassim, Saudi Arabia. This study solicited input from the building tenants regarding their level of satisfaction across 85 distinct performance factors, including 25 elements of technical performance, 48 elements of work performance, and 12 elements of behavioral performance.

The results reveal that residents were generally satisfied with the majority of the building's attributes, with mean satisfaction scores falling within the "Satisfied" and "Very Satisfied" ranges. This suggests that the building is successfully meeting the needs and expectations of its occupants across a wide variety of operational, design, and experiential criteria. This study identified three subcategories that received "Unsatisfied" ratings from respondents: safety and security, suitability of design, and construction support services. The average satisfaction scores for these dimensions were 2.09, 2.39, and 2.26 out of 4, respectively, indicating room for improvement. Delving deeper, occupants expressed concerns about issues like building access control, lighting adequacy, storage space, and the responsiveness of maintenance staff. These findings underscore the value of soliciting direct user feedback to pinpoint specific pain points that may not be evident through other evaluation methods.

While the post-occupancy evaluation (POE) results are specific to the low-rise, gated apartment building studied in the Alshifa neighborhood of Onaizah, the design of the user satisfaction questionnaire is adaptable with appropriate customization for local contexts. This standardized assessment tool has the potential to identify performance issues and their underlying causes systematically. The detailed, occupant-centric data collected can be valuable for informing targeted improvements to building operations, design, and resident services. Future research could expand the geographic and building typology scope of POE studies to develop a more comprehensive understanding of resident satisfaction trends and drivers across the broader residential real estate landscape. Incorporating additional qualitative and quantitative methods, such as in-depth interviews, observational analyses, and building performance monitoring, could also yield richer insights into the complex interplay of factors influencing occupant experiences and building functionality. Ultimately, this study contributes to the growing knowledge of user-centric evaluations of the built environment.

This study highlights the importance of integrating POE findings into future developments to improve resident satisfaction. First, including enhanced security measures is critical. This includes the use of better lighting and advanced monitoring systems to address security concerns effectively. Additionally, involving residents in the design process can lead to more efficient design and storage solutions, ensuring that residential areas meet their needs. Regular post-occupancy inspections should be established to identify and resolve emergent problems to maintain a high standard of living. Effective communication between staff and residents is essential for transparency and engagement, which can

increase overall satisfaction. Additionally, creating community spaces and activities can foster social interaction and strengthen community ties.

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