



Unveiling Key Factors for Enhanced Residential Satisfaction and Space Efficiency in Duhok's Apartment Designs

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Abstract

With the city's fast growth and the growing needs for efficient housing solutions, this study deals with the challenges of high-rise living in the Duhok region of Iraq. The main problem is that there are no clear architectural standards in modern apartment designs. This should balance functionality, cultural importance, and resident satisfaction. This study involves the basic factors affecting apartment living. The factors are functionality, privacy, adaptability, and sustainability. The main research question is how these factors can be included in apartment designs to improve space efficiency and occupant satisfaction. This study uses a mixed-method involving surveys and in-depth interviews. The study finds important design elements that reflect the local context. The research aims to develop a new design method with what Duhok's residents need and value. It should also set new standards for the quality of urban living. The results suggest a design approach that puts residents first, encouraging architects to focus on adaptability and sustainability to improve living efficiency and satisfaction in Duhok's changing urban landscape.

Discipline: Architectural Engineering.

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1 Introduction

Kurdistan's cities, especially Duhok, have seen high growth due to socio-economic factors, increasing their urban population from 43% in 1977 to 75% in 2014 (Krso, 2018). This led to a surge in housing demand. The local government understood the necessity for 250,000 new homes by 2016 for this demand (Ministry of Planning, 2011). Also, they set plans like land allocations and investment incentives under Investment Law No. 4 of 2006 (Raswol, 2019). This work studies the

factors influencing optimal apartment space usage in Duhok, intending to improve design and resident satisfaction. It also gives architectural guidelines to improve housing quality and support urban development.

Ameen et al.(2021) showed the importance of lighting to improve residential satisfaction and energy efficiency in Iraq. This research sums findings from many studies to improve space efficiency and resident satisfaction, identifying gaps in strategy and understanding. It discussed many subjects, such as the social housing adaptability, energy efficiency, economic effects (Sherzad and Imamzada, 2021), historical aesthetics, and urban renewal (Gao et al., 2022). Also, Mridha (2023) emphasized the need for structured models. Further, Shehab (2018) explored cultural impacts on housing design. Privacy, comfort, and affordability were also explored (Kizami and Soheili, 2019). The innovation around design customization, using 'Grasshopper' technology, demonstrates dynamic changes to continue with updates to needs (Attiorbati & al-Kazzaz, 2021)

This study seeks to increase housing satisfaction in Duhok by identifying primary design features that might guide the architect to design people-oriented living spaces. It aims to lay down new housing standards and promote urban development through the extensive survey of residents and the enhancement of the living experience.

2 Literature Review

2.1 Residents Satisfaction

Resident satisfaction, affecting happiness, covers design and social aspects. It is tied to community, housing quality, and amenities (Smith, 2023). Also, it is influenced by housing theories, and crucial for evaluating life quality and housing changes (Abidin et al., 2019). Satisfaction varies with infrastructure and demographics, understood through a four-dimensional framework, with design guided by resident preferences (AL Chalabi, 2024).

2.2 Affecting Factors

Home design must address functional needs and environmental considerations like natural lighting and ventilation in apartments (Kalcheva, 2018). Economic conditions and material availability impact housing markets, while technology influences architecture. Health, mobility, and individual preferences affect comfort and sustainability (Kennedy, 2015), whereas cultural elements strengthen community ties (Kennedy, 2015). Community design enhances safety and well-being, and neighborhood ambiance impacts mental health in older adults(Smith, 2023). Housing policies aim at affordability and inclusivity (Zyed, 2014). Various elements combine to create functional, comfortable living spaces that meet diverse needs, focusing on safety, aesthetics, and economic factors (Mridha, 2023).

2.3 Case Study (Duhok City)

Duhok City, known as "two lumps" and serving as the administrative center of Duhok Governorate since 1969, is strategically located near Turkey and Syria. Surrounded by mountains, it is crucial for regional urban development (Directorate of Urban Planning, 2010; Ibrahim, 2017).

Despite rapid urbanization and a moderate climate, Duhok faces significant urban challenges, including outdated housing policies from the 1980s that hinder modern construction and living standards (Directorate of Municipalities, 2018; Hassan & Kotval-K, 2019). There's a pressing need for policy updates to address current urban and housing issues (Raswol, 2019).

3 Methodology

The study on Duhok City's residential satisfaction followed a six-step methodology that began by identifying 12 key factors from existing research. Residents answered a Likert-scale survey, and expert interviews were conducted. Housing projects were assessed, survey results quantified, and interview insights visualized with Word Cloud. Data analysis from surveys, interviews, and projects highlighted key determinants of residential satisfaction.

3.1 First Step: From the Theoretical Framework

Developed a theoretical framework analyzing apartment satisfaction based on 12 key factors, focusing on their impact on residential satisfaction and future living improvements. These 12 factors are ①Functional Factors, ②Environmental Factors, ③Economic Factors, ④Technical Factors, ⑤Individual Factors, ⑥Behavioural Factors, ⑦Cultural Factors, ⑧Social Factors, ⑨Personal Factors, ⑩Physical Factors, ⑪Psychological Factors, and ⑫Policy Factors (Figure 1).

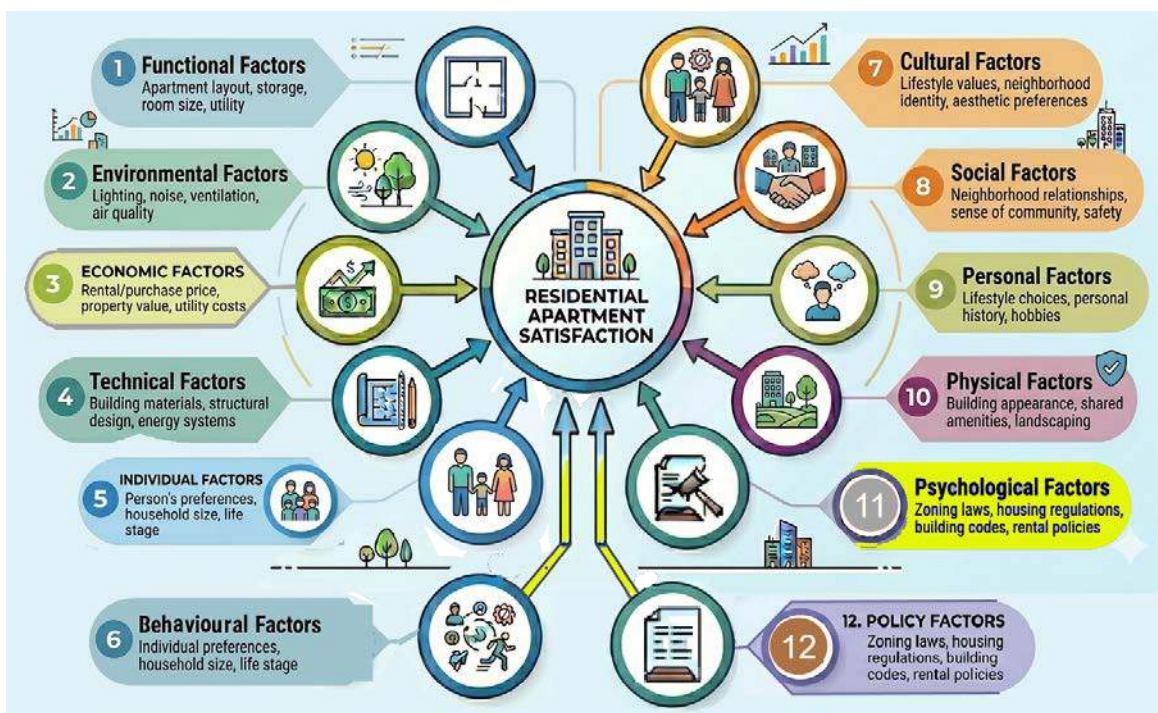


Figure 1: Theoretical Framework: Impact on Residential Apartment Satisfaction.

3.2 Second Step: Survey

Table 1 is the Survey Sheet on demographic and Personal Information Section of Surveyed residents on satisfaction. apartment details and 12 criteria related to improving living conditions and quality of life. (see Tables 1 and 2).

Table 1: Demographic and Personal Information Section of the Survey Sheet

General Information					
Part A:- Respondent information					
1	Residential project name	1-Avro city	2. French village 1	3-Kayar city	4-Others
2	No.of bedrooms in your apartment	1-(1) bedroom	2- (2) bedrooms	3- (3) bedrooms	4-(4) bedrooms
3	Head of the family's gender	1-Male	2-Female		
4	Head of family age	() Years old			
5	Length of residence	1-under 1 year	2-(1-5) years	3- over 5 years	
6	Tenure type	1-Owner	2-Renter		
7	Previous dwelling type	1-House	2-Apartment		
8	Family size	() Person			
9	Net income of the head of family	() \$			
10	Total income of the family	() \$			

Table 2: The Survey Sheet Design (Evaluation of Residential Satisfaction Levels - Post-Occupancy Evaluation)

Part B: -Residential satisfaction level (POE)					
Please rate each item below based on your level of satisfaction from (1 to 5), where:					
(1) Very Dissatisfied	(2) Dissatisfied	(3) Neutral (Neither satisfied nor dissatisfied)	(4) Satisfied	(5) Very Satisfied	
①Functional Factors					1 2 3 4 5
1. Flexibility/ To what extent are you satisfied with the possibility of modifying the design of your apartment according to your needs?					
2. Space layout/ What is your satisfaction rate with the area of the rooms in your current apartment?					
3. Privacy/To what extent are you satisfied with the privacy in your recent apartment?					
4. Circulation/To what extent are you satisfied with the movement system in your current apartment?					
5. Space configuration /To what extent do you support the idea of a kitchen open to the reception (hall or living)?					
②Environmental Factors					1 2 3 4 5
6. Natural lighting/How satisfied are you with your current apartment's solarization (natural light)?					
7. Acoustic/to what extent are you satisfied with the sound (noise) insulation from the outside in your apartment?					
8. Ventilation/ What is your level of satisfaction with the ventilation system in your current residence?					
9. Thermal comfort/ How do you assess the thermal comfort in your current apartment in terms of cooling in summer and heating in winter?					
③Economic Factors					1 2 3 4 5
10. Maintaining cost/Are you satisfied with the cost of maintaining and repairing internal features (e.g., plumbing and electrical systems)?					
④Technical Factors					1 2 3 4 5
11. Electricity service / To what extent are you satisfied with the electricity service system in your apartment?					
12. Water & Sewer Service/ How satisfied are you with your apartment's water and sewer service system?					
13. Artificial lighting / What is your satisfaction with the adequacy of the lighting system in your current apartment rooms?					
⑤Individual Factors					1 2 3 4 5
14. Personal taste/ To what extent are you satisfied that your taste matches the design of your current apartment (room divisions - relationships between spaces)?					
15. Personal expectation / Does the ambiance of the common areas and corridors in your building meet your expectations?					

16. Personal needs/What is your level of satisfaction with the current type of apartment?

⑥Behavioural Factors 1 2 3 4 5

17. security and a sense of reassurance /To what extent are you satisfied with your current apartment in terms of providing security and a sense of reassurance?

18. Social interaction / What is your assessment of the space relationship (the space connecting the apartments (corridors)) between your current apartment and the adjacent or opposite apartment regarding social communication with neighbours?

⑦Cultural Factors 1 2 3 4 5

19. cultural privacy /To what extent are you satisfied with dividing the bedrooms for men and women?

20. Separation areas /To what extent are you satisfied with the availability of private spaces for the individual and public spaces for the family in your current apartment?

21. Sense of identity/ What is your level of satisfaction with how the design of your current apartment fits your cultural identity?

⑧Social Factors 1 2 3 4 5

22. Social interaction/ How satisfied are you with your interaction and relationship with your neighbors?

23. Shared facilities / How satisfied are you with the shared spaces between the apartments inside and outside the building?

⑨Personal Factors 1 2 3 4 5

24. Gender/Does gender affect your perception of personal factors in internal spaces?

25. Lifestyle preferences / What is your assessment of the design of your current apartment in terms of providing spaces that meet your hobbies and needs?

26. Age group / How would you rate the apartment's current design, matching your age group?

⑩Physical Factors 1 2 3 4 5

27. Aesthetic satisfaction / How satisfied are you with the interior design, the aesthetic design of the spaces, and their relationships with each other??

28. Sufficient physical space / How satisfied are you with the interior design of the current apartment in terms of satisfying functional needs?

⑪Psychological Factors 1 2 3 4 5

29. emotional well-being / How satisfied are you with the impact of the internal environment on your emotional and psychological health regarding the feeling of belonging to the place?

30. Perception of safety and security /What is your perception of safety and security within the internal spaces of your apartment?

⑫Policy Factors 1 2 3 4 5

31. rent policies / Are you satisfied with the payment policy and the rental price?

32. The policy of installments / Are you satisfied with the payment policy for your apartment installments?

33. Usage procedures/ How satisfied are you with the procedures to determine apartment usage levels? For example, converting it into commercial apartments

3.3 Third Step: Expert Interviews

Architecture experts were interviewed from Nawroz University on apartment design's impact on residential satisfaction in Duhok, using purposive and snowball sampling. Discussions, anonymized (coded as IN M 01, etc.), focused on the influence of international and local design firms on living experiences. Ethical standards were upheld, and findings were visualized in word clouds for clarity.

3.4 Fourth Step: Sample Selection

The fourth step involved selecting Avro City, Kayar City, and French Village 1 in Duhok, notable for their foreign firm designs. Selection criteria focused on architectural features and resident experiences. A field survey gathered resident feedback, aiming to assess satisfaction and identify success factors of these complexes.

3.4.1 Avro City

Situated in Duhok, Kurdistan, near the Tenahi district, Avro City covers 81.7 hectares and showcases urban residential development. Developed by Gorbag and Guinsal Companies since 2007, it merges modern design with local heritage, accommodating over 23,300 residents in 4,532 apartments and 93 villas. The city features buildings with 8 to 14 stories, mainly offering three-bedroom apartments, excluding 4+2 configurations, focusing on comfort, security, and community (see Figure 2) (Avrocity Administration, 2024).

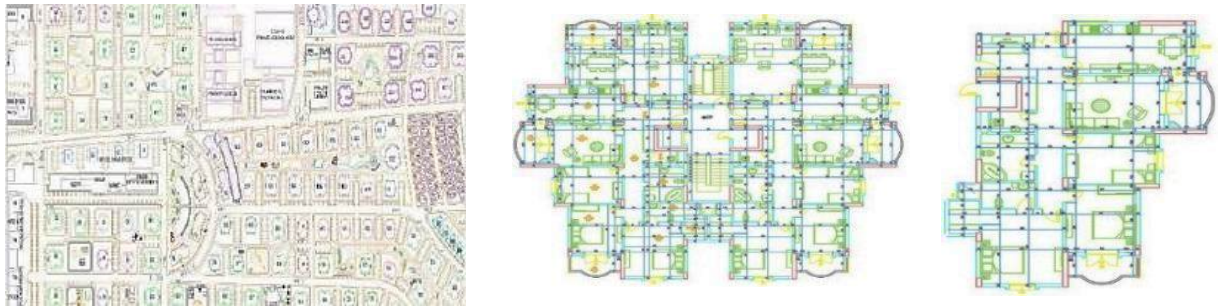


Figure 2: Avro City Site Plan, Apartment Floor Plan, and Three-Bedroom Floor Plan
(Source: Avro City Project Office Administration, 2024)

3.4.2 French Village 1

Located in Duhok near Zawa Mountain, French Village 1 features seven 23-story towers and 69 villas over 65,000 square meters. Completed in 2021, it offers luxury living with diverse amenities and green views, including leisure facilities. Developed by Ava Gara Company to Iraqi standards, it houses 500 apartments in configurations like 2+1, 2+2, and 3+2, with prices starting at \$74,500. It sets a benchmark for upscale living in the region (see Figure 3) (French Village 1 Administration, 2024).

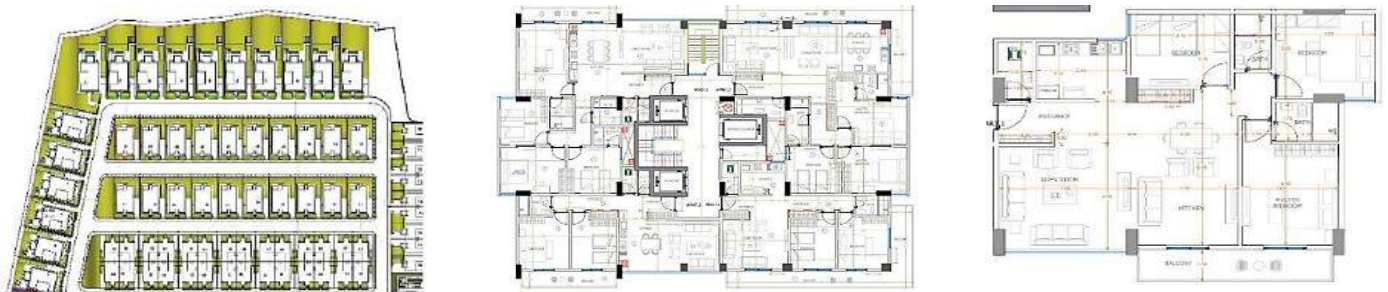


Figure 3: French Village 1 Site Plan, Apartment Floor Plan, and Three-Bedroom Floor Plan
(Source: French Village 1 Project Office Administration, 2024)

3.4.3 Kayar City

Located in Duhok and designed by Alaa Architect, Kayar City features 64 buildings, including villas and apartments, complemented by green spaces and educational facilities over 12,619 square

Table 3: Survey Outcome Percentages Evaluating Satisfaction Across Different Factors and Variables within Duhok City

No	Influencing Factors	Variables	Likert 5 Responses				
			(1) Very Dissatisfied	(2) Dissatisfied	(3) Neutral	(4) Satisfied	(5) Very Satisfied
1	Functional Factor	Flexibility	6.8%	19.3%	22.7%	36.4%	8%
		Space layout	13.6%	17%	15.9%	42%	4.5%
		Privacy	11.4%	17%	18.2%	39.8%	6.8%
		Circulation	6.8%	8%	12.5%	56.8%	9.1%
		Space configuration	26.1%	19.3%	12.5%	28.4%	6.8%
2	Environmental Factor	Natural lighting	5.7%	13.6%	13.6%	44.3%	15.9%
		Acoustic	11.4%	17%	36.4%	20.5%	8%
		Ventilation	1.1%	11.4%	8%	60.2%	12.5%
		Thermal comfort	2.3%	6.8%	12.5%	51.1%	20.5%
3	Economic Factor	Maintaining cost	2.5%	6.9%	13.3%	50.1%	21.5%
4	Technical Factor	Electricity service	1.1%	8%	8%	51.1%	25%
		Water & Sewer Service	1.1%	4.5%	6.8%	58%	22.7%
		Artificial lighting	3.4%	17%	21.6%	46.6%	4.5%
5	Individual Factor	Personal taste	5.7%	14.8%	35.2%	35.2%	2.3%
		Personal needs	4.5%	10.2%	18.2%	50%	10.2%
6	Behavioral Factor	security and a sense of reassurance	2.3%	2.3%	8%	52.3%	28.4%
		social interaction	5.7%	13.6%	33%	37.5%	3.4%
7	Cultural Factor	cultural privacy	4.5%	20.5%	22.7%	40.9%	4.5%
		Separation areas	3.4%	19.3%	21.6%	43.2%	5.7%
		Sense of identity	4.3%	8%	26.1%	46.6%	8%
8	Social Factor	Social interaction	4.5%	11.4%	38.6%	30.7%	8%
		shared facilities	11.4%	11.4%	23.9%	36.4%	10.2%
9	Personal Factor	lifestyle preferences	3.4%	17%	31.8%	37.5%	3.4%
		Age group	1.1%	9.1%	17%	59.1%	6.8%
10	Physical Factor	Aesthetic satisfaction	5.7%	11.4%	29.5%	40.9%	5.7%
		Sufficient physical space	1.1%	5.7%	30.7%	48.9%	6.8%
11	Physiological Factor	Emotional well-being	4.5%	6.8%	33%	44.3%	4.5%
		Perception of safety and security	4.3%	7%	32%	45.7%	5.2%
12	Policy Factor	Rent policies	11.4%	25%	27.3%	27.3%	2.3%
		Policy of installments	9.1%	11.4%	27.3%	40.9%	4.5%

4.1 Functional Factors

In Duhok City, 50.2% of male heads aged 30-60 prefer three-bedroom apartments, with 62.5% owning and 48.9% residing for 1-5 years in Avro City (35.5%), French Village 1 (23.6%), and Kayar City (20%). Around 60% are satisfied with flexibility, and 46.5% with layout, but 35.2% are dissatisfied with social dynamics. "Residents adapt foreign-designed apartments for functionality to meet cultural needs," notes IN M 03 (February 6, 2024). IN M 01 and IN M 02 (February 1 and 3, 2024), discuss bedroom size and the need for separate spaces. Figures 5 and 6 and Table 3 highlight the need for culturally aligned designs.



Figure 6: Percentage distribution of satisfaction levels for each factor measured on a Likert 5-point scale.

4.2 Environmental Factors

In Duhok City, including Avro City, French Village 1, and Kayar City, 85.2% of respondents, mostly male, prefer three-bedroom apartments, with 62.5% owning homes and 48.9% residing for 1-5 years. Natural lighting and acoustics received positive ratings at 59.2% and 56.9%, respectively, while ventilation (72.7%) and thermal comfort (71.6%) need improvement. "Orient buildings for better light and air and adjust window sizes to reduce heat," suggests IN M 03 (interview, February 6, 2024). Noise and insulation issues are noted by IN M 01 (interview, February 1, 2024). Figures 5 and 6 and Table 3 illustrate the environmental factors' impact on living quality.

4.3 Economic Factors

In Duhok City, including Avro City and French Village 1, 85.2% of male heads prefer three-bedroom apartments, with 62.5% owning them. About 50% are satisfied with maintenance costs, though dissatisfaction is at 2.5% and discontent is at 6.9%. "High costs do not always match service quality," states IN M 03 (February 6, 2024). Projects often focus more on economics than function, unsuitable for low-income residents (IN M 01, February 1; IN M 02, February 3, 2024). The economic impact on satisfaction is shown in Figures 5 and 6 and Table 3.

4.4 Technical Factors

In Avro City, French Village 1, and Kayar City, 85.2% of male heads aged 20-60, primarily 30-40, prefer three-bedroom apartments, with 62.5% owning and 48.9% residing for 1-5 years. Satisfaction with water and sewer services is high at 80.7%, electricity at 76.1%, but artificial lighting is only at 51.1%. "Technical service quality varies by project but is generally good," notes IN M 03 (February 6, 2024). Details are in Figures 5 and 6, and Table 3.

4.5 Individual Factors

In Avro City, French Village 1, and Kayar City, 85.2% of male respondents aged 20-60 live in three-bedroom apartments. Ownership is at 62.5%, with 48.9% residing for 1-5 years. Satisfaction rates are 37.5% for aesthetics and 60.2% for functionality, indicating a mismatch between design preferences and practical needs. "Aligning designs with local tastes and enhancing security could improve their appeal," suggests IN M 03 (February 6, 2024), while IN M 02 notes general avoidance of apartments due to unmet needs (February 3, 2024). Details in Figures 5 and 6, and Table 3.

4.6 Behavioral Factors

In Avro City, French Village 1, and Kayar City, 85.2% of male heads aged 30-60 occupy three-bedroom apartments, with 62.5% owning and 48.9% residing for 1-5 years. Security satisfaction is high at 80.7%, but social interaction satisfaction is only 40.9%, highlighting a need for better community engagement in housing designs. This area is ripe for research to boost safety and social connectivity. See Figures 5 and 6, and Table 3 for details.

4.7 Cultural Factors

In Avro City, French Village 1, and Kayar City, 85.2% of male heads aged 30-60 in three-bedroom apartments show modest cultural satisfaction: 40.9% for privacy, 43.2% for separation areas, and 46.6% for cultural identity. "Interiors often fail to reflect local culture, prompting residents to modify spaces for better privacy and cultural fit," observes IN M 03 (February 6, 2024). Research into these cultural dynamics is advised. See Figures 5 and 6, and Table 3 for more information.

4.8 Social Factors

In Avro City, French Village 1, and Kayar City, 85.2% of male residents aged 30-60 in three-bedroom apartments report 69.3% satisfaction with social interaction, but only 46.6% with shared facilities. "The lack of sufficient communal spaces affects community relations," notes IN M 01 (February 1, 2024). Further research into social dynamics is recommended. Details are shown in Figures 5 and 6, and Table 3.

4.9 Personal Factors

In Avro City, French Village 1, and Kayar City, 85.2% of male heads aged 30-60 in three-bedroom apartments show high satisfaction with personal lifestyle preferences at 72.7%, although it varies by age at 55.9%. Previous living was divided between houses (53.4%) and apartments (46.6%). This indicates a need for further demographic research. See Figures 5 and 6, and Table 3.

4.10 Physical Factors

In Avro City, French Village 1, and Kayar City, 85.2% of male residents aged 30-60 occupy three-bedroom apartments, with 62.5% owning their homes. Satisfaction is high for aesthetics (76.6%) and space sufficiency (79.7%), suggesting good physical housing quality. See Figures 5 and 6, and Table 3 for details.

4.11 Psychological Factors

In the same cities, 85.2% of male residents report high satisfaction with aesthetics and space (76.6%, 79.7%) but lower rates for emotional well-being (44.3%) and safety (45.7%), indicating a need for further research in these areas. Details are in Figures 5 and 6, and Table 3.

4.12 Policy Factors

85.2% of male heads aged 30-60 in Avro City, French Village 1, and Kayar City live in three-bedroom apartments, with 54.6% satisfied with rent policies. "There is room for policy improvement to meet local needs better and promote insulation use," suggests IN M 01 (February 1, 2024). Further information is in Figures 5 and 6, and Table 3.

5 Conclusion

This study greatly improves our understanding of what affects how satisfied people are with their homes and how efficiently space is used in apartments in Duhok, this aligns with the goals of the research. The first aim was to find the functional, cultural, and environmental factors that impact living spaces. By using theoretical analysis, surveys, interviews, and critiques of designs, we found important elements such as functionality, flexibility, privacy, natural light, and sustainability that are important for enhancing the quality of life in Duhok's high-rise buildings.

The second goal pushed for design enhancements that focus on what residents need. The results show the necessity for designs that are more flexible, adaptable, and sustainable, going beyond the current standards. Having natural light and ensuring privacy, we deal with both the practical and emotional sides of residential satisfaction.

For the third goal, we suggested a design framework that considers empathy, innovation, and adaptability. This framework serves as a guide for architects and planners to create living environments that are functional and culturally relevant. With adaptability and sustainability, we encourage a more inclusive method to urban development.

This research provides a plan for improving residential satisfaction and architectural quality in Duhok. By putting apartment designs with the needs of residents, we give more efficient, empathetic, and sustainable urban areas, steering future architectural practices towards a landscape that is focused on people and innovation.

6 Availability of Data and Materials

All information is included in this article.

7 Acknowledgments

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