Optimal Site Selection for Civil Servants' Medium-Rise Apartments in Kathmandu Valley: An AHP-GIS Multi-Criteria Proximity and Feasibility Ranking Approach

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Abstract

Kathmandu Valley, Nepal's administrative and political center, faces increasing demand for affordable and accessible housing for civil servants. High land prices near urban amenities create a trade-off between affordability and accessibility, often resulting in longer commuting distances. This study aims to identify optimal locations for medium-rise civil servant apartments by integrating accessibility and land affordability considerations. A stratified survey was conducted to determine housing preferences and acceptable land-price levels. The Analytical Hierarchy Process (AHP) was used to derive criterion weights, while spatial analyses in QGIS incorporated accessibility indicators, land affordability, vacant land availability, planning constraints, and environmental restrictions. Pareto Frontier analysis identified locations with the best accessibility-cost trade-offs, and TOPSIS was used to rank the alternatives. Sensitivity analysis and expert interviews were conducted to validate the results. The study provides a practical decision-support framework for selecting feasible apartment sites and supports sustainable housing planning for civil servants in Kathmandu Valley.

Keywords: Site Optimization; Multi-Criteria Decision Making; Civil Servant Apartments; GIS-Based Site Suitability; Investment Decision; Kathmandu Valley.

1 Introduction

1.1 Background

Housing is one of the most essential human needs, and a significant proportion of the population aspires to own comfortable homes in urban areas to access better facilities, a trend that is also evident in Nepal. In response to this growing demand, the Employees' Provident Fund (EPF) has provided housing loans to civil servants, allocating substantial financial resources to support residential construction.

In Nepal, Kathmandu Valley serves as the political and administrative center, making it a highly desirable place of residence for many. Consequently, construction activities have rapidly increased across the region, leading to the conversion of agricultural land into built-up areas. To address the rising demand for housing while preserving farmland, apartment living has emerged as a practical and sustainable alternative to traditional housing solutions. In this context, the Government of Nepal, through the Budget Speech of 2082/2083 (2025/2026), introduced a program to develop apartment units for government employees in all provinces. [1] Additionally, the private sector has actively invested in apartments within the Kathmandu Valley. [2][3][4]

1.2 Problem statement

Kathmandu Valley, as the political and administrative center of Nepal, hosts a large concentration of civil servants, resulting in rapidly increasing demand for urban housing. However, the provision of suitable housing remains a significant challenge owing to high land prices in prime locations and the uneven distribution of essential urban services. Civil servants are often required to make trade-offs between affordability and accessibility, leading many to reside in suboptimal conditions such as congested rental housing or locations far from their workplaces. This negatively affects their quality of life, commuting efficiency and job performance.

Although the Government of Nepal introduced initiatives to develop apartment units for civil servants in the Budget Speech of 2082/2083 (2025/2026), the effectiveness of such programs largely depends on the appropriate site selection. "Past experiences, such as the housing project for squatters at Ichangu Narayan, demonstrate that inadequate consideration of location factors-particularly accessibility, infrastructure availability, socio-economic compatibility, and affordability—can lead to project failure despite substantial financial investment."[5]

Therefore, a comprehensive analysis is required to identify the key amenities influencing residential location choice, determine their preferred proximity, and quantify their importance in residential location choice. This approach can support evidence-based decision-making in the planning and development of apartment projects for civil servants, thereby reducing the risk of unsuitable site selection and improving the overall success of housing initiatives for them.

1.3 Research Objectives

Given the aforementioned background and problem statement, the primary aim and objective of this research is to select optimal sites for civil servants' medium-rise apartments in the Kathmandu Valley using the AHP-GIS Multi-Criteria Proximity and Feasibility Ranking Approach.

The specific aims and objectives are as follows:

1. To identify the criteria influencing the location of civil servants' mid-rise apartments in Kathmandu Valley, their preferred proximity, and weightage.
2. To identify and rank feasible optimal locations for civil servants' mid-rise apartments in the Kathmandu Valley.

2 Literature Review

2.1 General Literature

Residential Apartments include any building or structure that provides residential units in a single building for three or more families living independently of each other. Medium rise apartments are apartment buildings of 6-8 storeys or between 18m-25m. [6]

Location theory is rooted in geography, engineering, mathematics and economics. [7] People tend to select the location of a habitat location that is comfortable and low in price. Such decisions are made differently by different individuals. However, for investment in apartment projects, an investor must be very careful about the selection of a location to ensure an adequate return.

The factors influencing the selection of housing sites in the Kathmandu Valley are the price of land, quality and proximity of infrastructure and amenities, and the topography of the land.[8] In a statistical study, it was found that housing location has a significant positive influence on purchase decisions. [9] Occupancy in apartments increases if they are near a campus, office area, mall, or business center. In addition, apartments in mixed-use areas are more attractive because they are close to different amenities. [10] According to location theory, the distance from the city center decreases the value of apartments. [11]

According to the Economic Equilibrium Theory, people determine the location of housing according to their income and the price of land. [12] The decision to purchase housing is significantly influenced by housing prices. [9]

The existing literature confirms that location is one of the key determinants of apartment choice. This location factor determines the land price, accessibility, and proximity to urban amenities. However, most of these studies focused on the significance of individual entities but did not evaluate their relative importance. Furthermore, no study has been conducted on apartments for civil servants in the Kathmandu Valley.

2.2 Analytical Hierarchy Process (AHP)

The Analytical Hierarchy Process is a multi-criteria decision-making tool primarily used to make decisions for identifying hierarchy. When we need to compare the hierarchy of different aspects, we identify the hierarchy of each possible pair from different respondents, and their consistency is checked, as in Eq. (1).

$$CR = \frac{CI}{RI}. \tag{1}$$

Where,

CR is Consistency Ratio

CI is Consistency Index, and

RI is Random Consistency Index

The CI was calculated using Eq. (2).

$$CI = \frac{\lambda_{max} - n}{n-1}. \tag{2}$$

CR should be below 0.1 or 10% to be reliable for a set of findings. [13]

2.3 Geographic Information System (GIS)

GIS integrates spatial (location-based) data with descriptive attribute information, linking "where things are" with "what they are like." This integration supports mapping and spatial analyses in various fields. It helps users identify patterns, relationships, and geographic contexts, thereby improving communication, operational efficiency, resource management, and decision making. [14] QGIS Desktop 3.44.5 was used for GIS analysis in this study and was downloaded for free from https://qgis.org/download/.

2.4 Risk Sensitive Land Use Plan (RSLUP) of Kathmandu Valley

The KVDA and UNDP prepared the RSLUP for the Kathmandu Valley in December 2016. The RSLUP was prepared by considering the following risks and maps.

- Landslide susceptibility map
- Slope land unsuitable for development
- Flood-prone areas and water recharge areas
- Liquefaction susceptible area
- Existing land use map

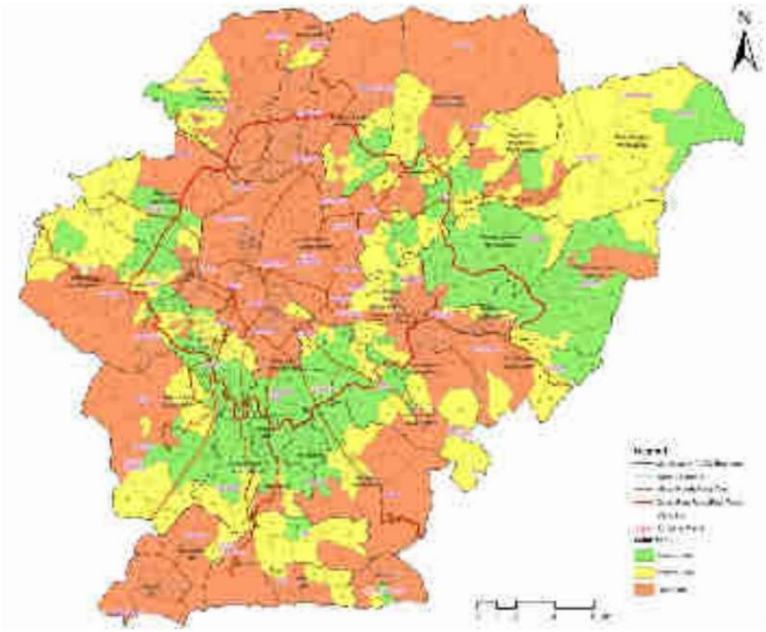

Fig. 1. Risk Sensitive Land Use Plan of Kathmandu Valley.

The final output was a color zone map based on the development constraints, as shown in Figure 1. It categorizes the local bodies within the Kathmandu Valley into three color zones: red, yellow, and green. It is recommended to allow the construction of up to seven storey apartment in the Red Zone, up to ten storey apartments in the Yellow Zone, and up to five storey apartment in the Green Zone. [15]

2.5 Multi-objective optimization

Multi-objective optimization solves problems with several objectives that often conflict. Because improving one objective can worsen another, there is usually no single best solution to the problem. Instead, it produces a set of optimal trade-off solutions that balance competing objectives in different ways. [16]

2.6 Pareto Frontier Analysis

A widely used approach for multi-objective optimization is Pareto Frontier Analysis, where a solution is considered optimal if no other feasible solution can improve one objective without worsening at least one other. These solutions are called non-dominated solutions. When all objectives are treated equally without predefined preferences, dominance is the primary comparison rule. The complete set of non-dominated solutions is known as the Pareto set, and its representation in the objective space is called the Pareto Frontier. [17]

2.7 TOPSIS

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is a widely used multi-criteria decision-making method valued for its simplicity and efficiency. It works by identifying the alternative that is closest to the ideal solution (best possible performance across all criteria) and farthest from the negative ideal solution (worst possible performance). The ideal solution represents maximum benefits and minimum costs, whereas the negative ideal solution represents the opposite.

This method ranks alternatives based on their geometric (Euclidean) distances from these two reference points. The best option is the one with the shortest distance to the ideal solution and the greatest distance from the negative ideal solution. This is because it allows trade-offs among criteria, where a weakness in one factor can be offset by another factor's strength. TOPSIS effectively models real-world decision-making and is widely applied to research and practical problems. [18]

2.8 Sensitivity Analysis

Sensitivity analysis is a method used to examine how changes in input variables affect the output of a model under defined assumptions. It involves testing different "what-if" scenarios to observe how variations in parameters influence results, such as cost, profit, or performance outcomes.

This technique helps identify the most influential variables, improves the understanding of the relationships between inputs and outputs, and supports better decision-making by highlighting the areas of uncertainty and risk. Although the analysis of many variables can be complex, modern computational tools make the process more practical and accurate, allowing for better-informed predictions in dynamic systems. [19]

3 Research Methodology

3.1 Research Framework

The research framework began with a survey of civil servants, and the collected data were integrated into GIS analysis. A risk-sensitive land-use plan and buffer analysis of the Kathmandu Valley were used to identify candidate sites. These candidate sites were optimized using Pareto Front analysis and subsequently ranked using TOPSIS analysis. Sensitivity analysis was conducted to assess the robustness of the results, and the final findings were validated through Key Informant Interviews (KII). A pictorial presentation of the Research Framework is shown in Figure 2.

3.2 Questionnaire Survey

A questionnaire survey was conducted among civil servants to determine which amenities influence apartment location, the acceptable distance of such amenities from the apartment for the price they are willing to pay, and the relative importance of each amenity, proximity, and land price. The key amenities affecting location preference were identified through a review of the relevant literature, and additional basic amenities were

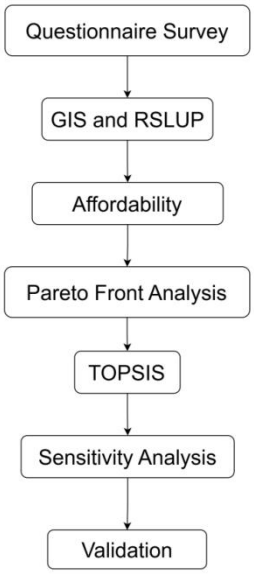

Fig. 2. Research Framework.

incorporated into the questionnaire. Eight amenities were included in the questionnaires. Respondents were also asked if they preferred additional amenities along with their preferred distance.

The questionnaire was designed using the Kobo Toolbox. It was pretested with two respondents and found suitable for further use. Subsequently, the survey was distributed to civil servants from various ministries through online platforms, and a portion of the respondents was surveyed through in-person data collection.

From the Questionnaire Survey, key amenities, their preferred distances, their weightage, and the weightage of proximity to amenities and land price were obtained. The Analytic Hierarchy Process (AHP) was employed to determine the relative importance of various amenities that influence the location of an apartment.

3.2.1 Population

The number of civil servants in the Kathmandu, Bhaktapur, and Lalitpur districts were 1639, 910, and 563, respectively, making a total of 3112. [20]

3.2.2 Sample Size

To determine the number of data points required from the finite population, Cochran's formula was used, as shown in Eq. (3).

$$n = \frac{Z^2 p\, q\, N}{e^2 (N-1) + Z^2 p\, q}. \tag{3}$$

Where,

Z = Value obtained from table (for confidence level = 90%)

p = Estimated percentage of the population that possesses the attribute = 0.5

q = 1 - p = 0.5

N = Total population, which is equal to 3112

e = Margin of Error = 10%

After assigning the respective values, we get,

$$n = \frac{\left((1.645)^2 (0.5)(0.5)(3112)\right)}{\left((0.1)^2 (3112-1) + (1.645)^2 (0.5)(0.5)\right)}$$

Thus, the minimum sample size was 67. Although the minimum sample size was 67, 84 respondents were surveyed. This was done considering that some answers could be incomplete or irrelevant to this study. In this case, collecting more data provides the flexibility to delete incomplete and irrelevant cases.

A 90% confidence level and 10% precision are appropriate for homogeneous populations. [21] The population of civil servants in the Kathmandu Valley shares standardized income levels, job characteristics, and administrative responsibilities, making it a relatively homogeneous group. Therefore, the selected parameters were justified.

3.2.3 Sampling Method

This study adopted a stratified sampling method. According to the Annual Report 2080/81 of the Department of National Personnel Records (Civil), the proportion of male to female employees is approximately 70:30, whereas the ratio of technical to administrative employees is approximately 60:40. Based on the minimum required sample size of 67, these proportions were preserved in the sample distribution of the minimum sample, as shown in Figure 3.

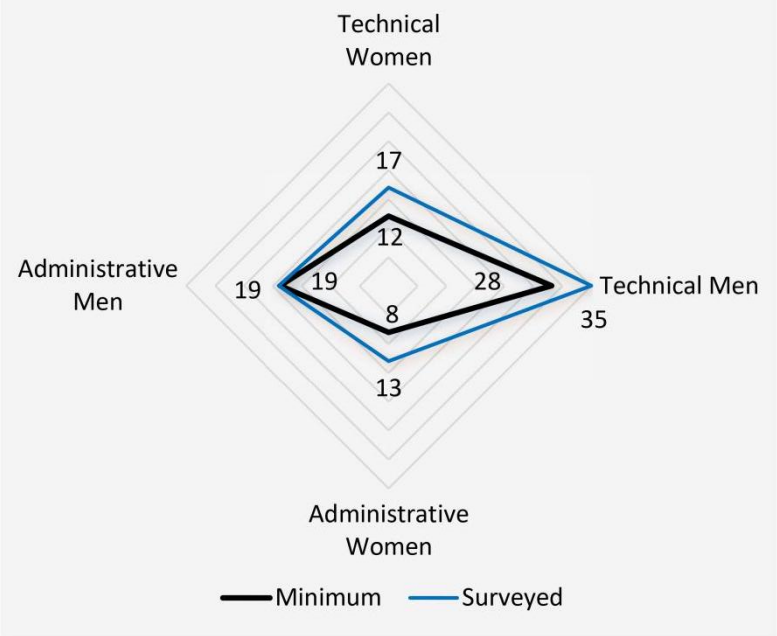

Fig. 3. Minimum Sample Size and Surveyed Sample Size.

3.3 Methods of Data Collection

The primary data for this study were collected through a questionnaire survey of the civil servants. The survey aimed to assess the demand for apartments in the Kathmandu Valley, identify influential amenities, determine acceptable distances to these amenities relative to willingness to pay, evaluate the relative weightage of amenities, and evaluate the importance of land price and proximity. Key amenities were identified through a literature review, and the respondents were asked to suggest additional amenities and preferred distances. The questionnaire was developed using the Kobo Toolbox and followed research ethics principles by ensuring anonymity and voluntary participation of respondents. After pretesting with two respondents, it was distributed across different ministries, and data were collected through face-to-face surveys. Key Informant Interviews (KII) were conducted for validation.

3.4 Data Analysis

The study analyzed questionnaire survey data using IBM SPSS Statistics and Microsoft Excel to identify civil servants' housing demand, preferred amenities, acceptable proximity distances, weightage, and the relative importance of land price and accessibility.

Iso-area and raster analyses were conducted using QGIS to identify potential apartment locations in the Kathmandu Valley. Additional spatial constraints and planning considerations, including risk-sensitive land use planning (RSLUP), location of brick kilns, location of parks, minimum land area requirements, CAAN height restrictions, and World Heritage Site buffer zones, were incorporated to further screen the feasible sites.

The shortlisted candidate sites were then evaluated using Pareto Frontier Analysis to identify optimal alternatives. The Technique for Order of Preference by Similarity to Ideal Solution was applied to rank the optimal sites, and a sensitivity analysis was conducted to test the robustness of the results. Finally, Key Informant Interviews (KII) were conducted to validate the findings and identify optimal locations for medium-rise civil servants' apartments in the Kathmandu Valley.

4 Results and Discussion

4.1 Results

4.1.1 Questionnaire Survey

The demand % for each amenity identified from the questionnaire survey is shown in Figure 4, from which we can see that the amenities listed in the questionnaire and additional amenities showed considerable demand. Hence, these amenities can be concluded as key factors influencing the location of civil servants' apartments in the Kathmandu Valley. Only the amenity "Park" showed notable demand as an additional amenity, as it was preferred by 22.62% of the respondents. Therefore, parks were included as key amenities. The preferred distance to parks was one km.

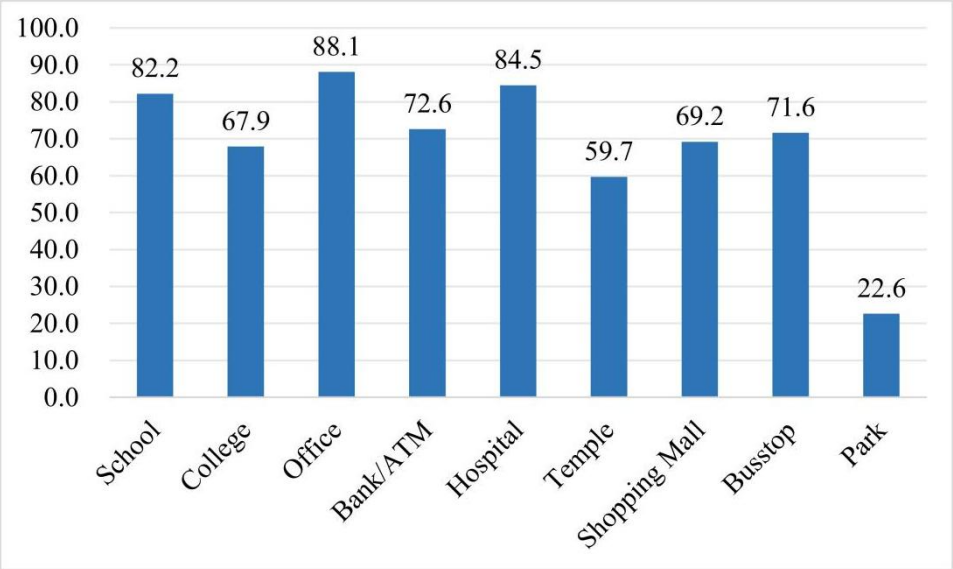

Fig. 4. Key Amenities and their demand in percentage.

The number of preferences for different proximity levels for each amenity is presented in Figure 5, which indicates positive skewness. Owing to this, the median is a more appropriate measure of central tendency than the mean. Hence, the median was calculated to determine the preferred distance for each amenity type. The resulting preferred distances are shown in Figure 6.

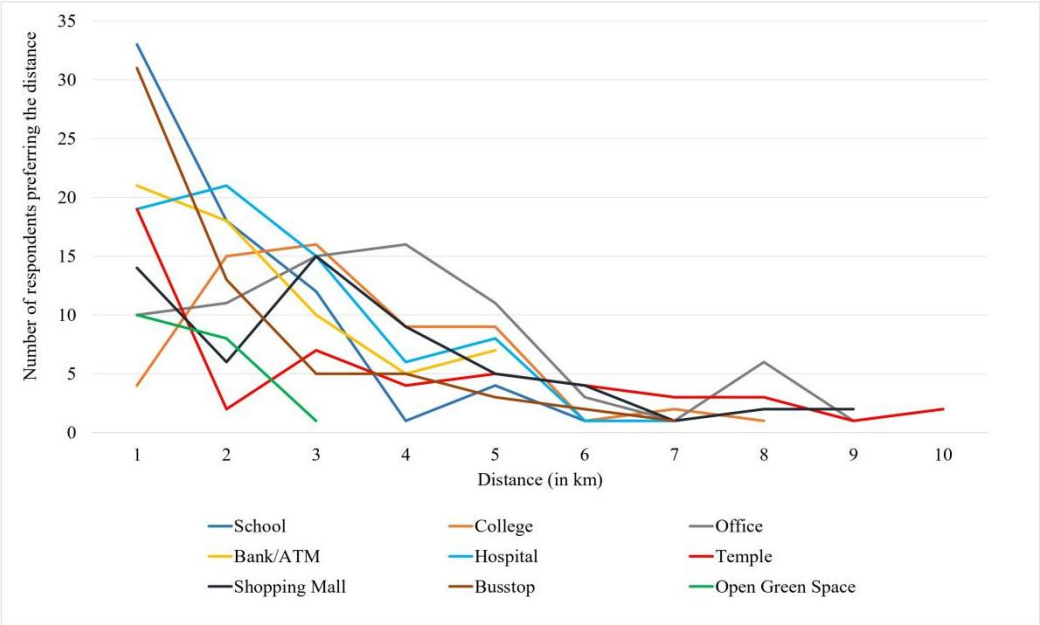

Fig. 5. Number of respondents preferring different distances from Key Amenities.

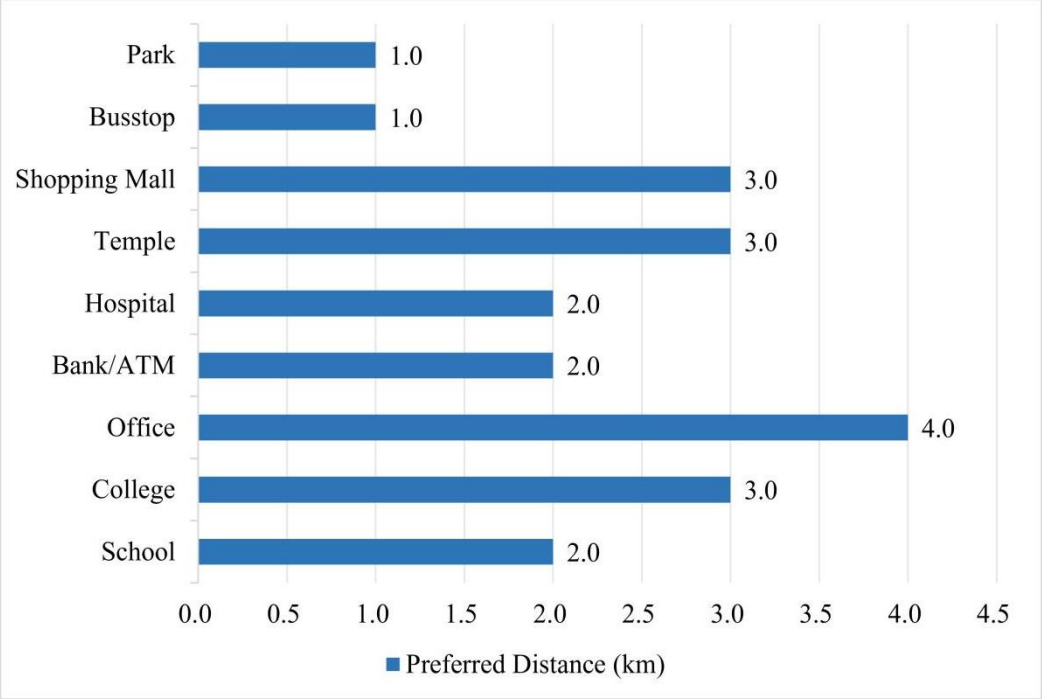

Fig. 6. Preferred distance from Key Amenities (in km).

Valid responses to the pairwise comparisons were obtained from 22 respondents in the Questionnaire Survey. AHP analysis was performed, and the overall consistency ratio of the calculation was 0.001992, which was well below the threshold of 0.1. Hence, the pairwise comparisons made can be said to have a reasonable level of consistency. The results of the AHP analysis are presented in Table 1 and Figure 7. The amenities in Table 1 are listed in descending order of weight. As an additional amenity identified after completing the questionnaire survey, the weight of "Park" could not be determined.

Table 1. Weights of Key Amenities as per Analytical Hierarchy Process.

S.N.	Amenities	Weight
1	School	0.191565
2	Busstop	0.162294
3	Bank/ATM	0.153201
4	Hospital	0.130690
5	Temple	0.108020
6	College	0.091193
7	Shopping Mall	0.085532
8	Office	0.077505

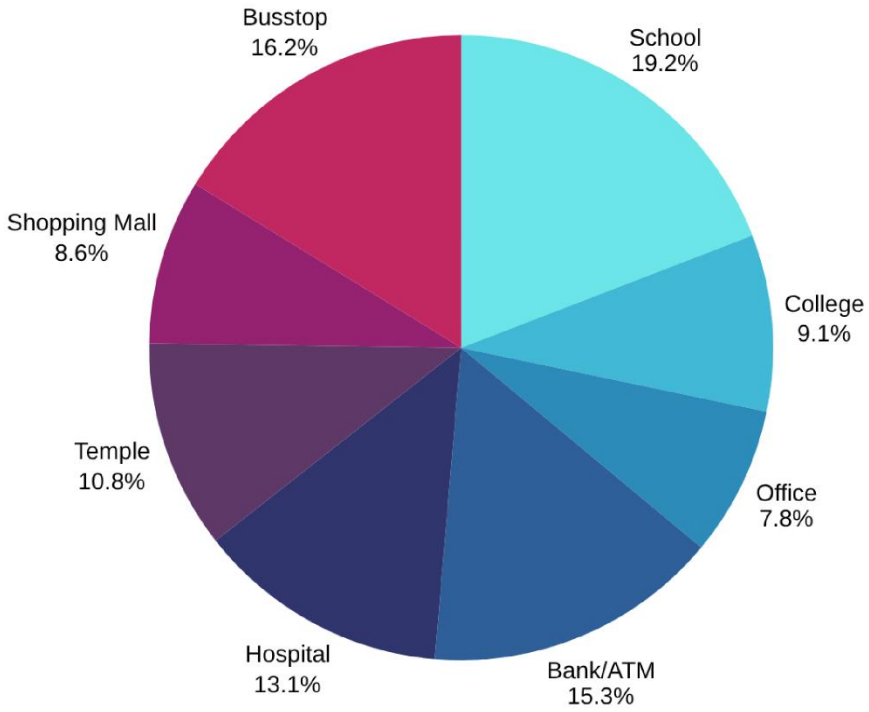

Fig. 7. Relative weightage of Key Amenities as per Analytical Hierarchy Process.

Respondents were asked, "Which is more important for selecting the optimum location of an apartment: Land Price or Proximity to Amenities?" A total of 39 responses were obtained for this question, among which 40% preferred land price and 60% preferred proximity to amenities. Hence, it can be concluded that the weight of land price is 0.4, while that for proximity to amenities, is 0.6.

4.1.2 Geographic Information System (GIS)

QGIS Desktop 3.44.5 was used for the GIS analysis. The OSM data for different amenities and the road network of the Kathmandu Valley were obtained mainly from geofabrik.de. The obtained data were separated into different layers for each of the amenities. The obtained data were then cleaned. The road layer was converted into a single part, and the validity of the road layer was confirmed. All amenities were snapped to the nearest road network.

Iso-area analysis was performed with the size of the iso-area equal to the preferred distance obtained for each amenity from the Questionnaire Survey. The contour interval was set to one-fifth of the preferred distance to the respective amenities. The road layer was considered a network layer. This was followed by raster analysis, with the weightage from Table 1. Thus, a combined interpolation was performed. The combined interpolation obtained from the Iso-Area Analysis is displayed in the "quantile" mode with three classes, as in Figure 8. This provided us with three categories of suitable sites with

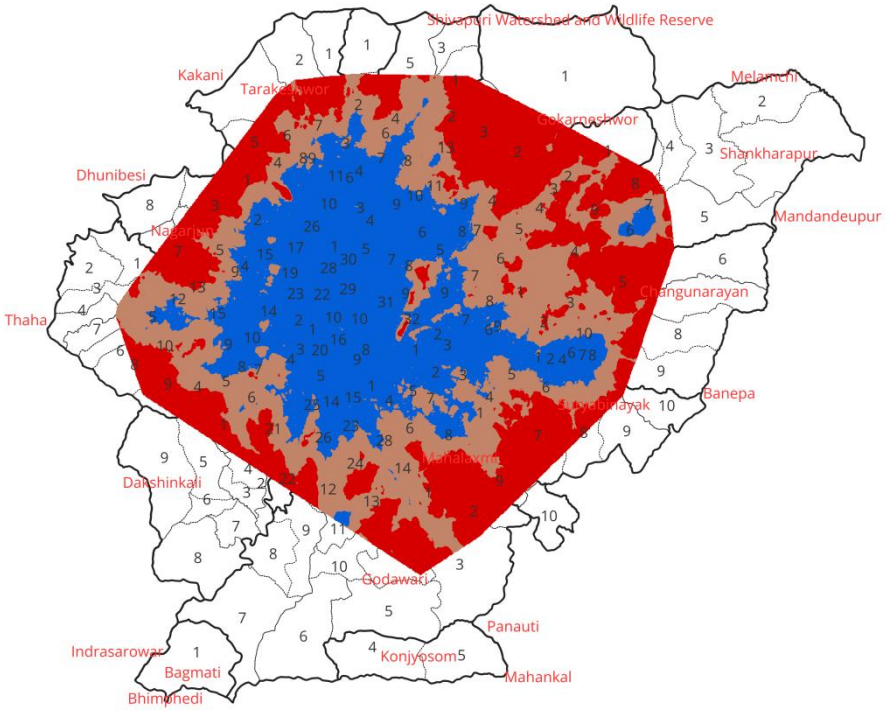

Fig. 8. Output of Raster Analysis shown in "Quantile" mode with 3 categories.

- Values < 757: "Highly Suitable Areas."
- Values < 1361: "Moderately Suitable Areas."
- Remaining values: "Less Suitable Areas."

The obtained raster was then reclassified to isolate the ``Highly Suitable Areas" The obtained raster of ``Highly Suitable Areas" was then polygonized.

Only the yellow zones of the RSLUP allowed the construction of medium-rise apartments of up to eight stories high. Hence, the yellow zones were extracted from the overall color zone map for further analyses. Thus, the obtained yellow zone was polygonized. Then, the layers of the “Highly Suitable Areas" and the yellow zones were clipped to identify areas fulfilling both types of suitability. The initially identified suitable areas are shown in Figure 9.

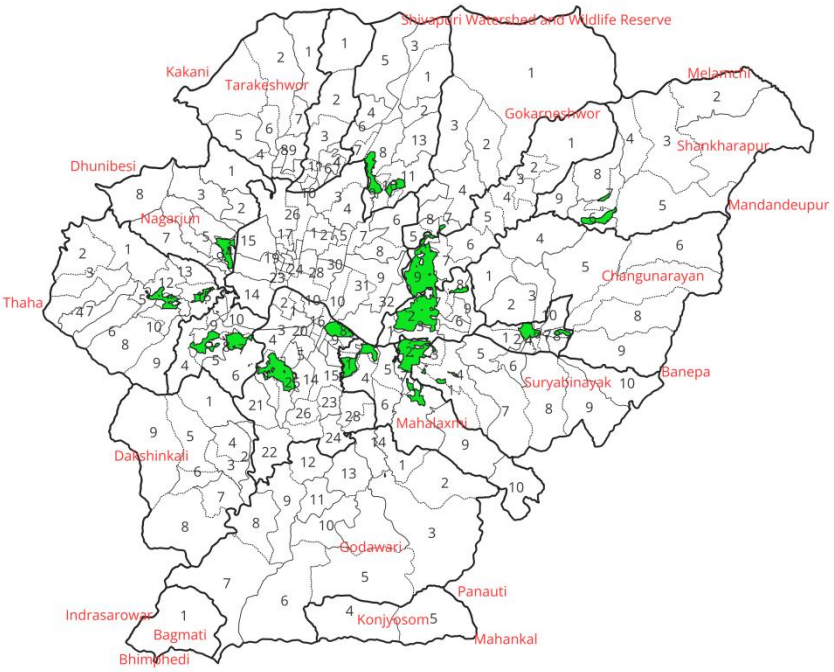

Fig. 9. Initial Suitable Areas.

The minimum distance of populated areas from brick kilns in Nepal is 500 m-1 km. Hence, a one km buffer zone was calculated for the brick kilns. The initial suitable areas not lying within a one km buffer of brick kilns were then identified. [22]

Respondents preferred a distance of one km from parks. Hence, the iso-area analysis for parks was performed with a distance of one km. The polygon layer obtained from the iso-area analysis of parks was clipped with the recently obtained highly suitable areas.

The opacity of the recent layer of highly suitable areas was decreased. A Google Map layer was added and placed below the layer of recently obtained highly suitable areas. The vacant lands in highly suitable areas were located and drawn as polygons to obtain candidate sites.

The minimum land area for an apartment in hilly areas should be 1000 sq.m. [23] The candidate sites obtained above were screened according to the minimum area requirement. All the candidate sites fulfilled this criterion.

The centroids of all candidate sites were calculated in QGIS and evaluated against the height-restriction criteria of the Civil Aviation Authority of Nepal for the Tribhuvan International Airport. [24] The sites were first checked against the 2% slope restriction within 3000 m from both sides of the runway of Tribhuwan International Airport. They were then assessed within the next 3600 m, using a 2.5% slope criterion. Similarly, the site nearest to the sideway of the runway was checked for the 14.3% transition surface requirement. Further analysis was conducted using the “Sample Raster Values” tool in QGIS to determine the elevations of the candidate sites and runway points. A 4000 m radius circle centered on the runway midpoint was created, and sites within this area were analyzed to verify that the medium-rise apartments did not exceed the allowable plane of 45 m above the runway midpoint. All the candidate sites passed this criterion, too.

The candidate sites were checked to determine whether any of them lay within the World Heritage Buffer Zones as apartments are not allowed to be constructed here. [25] One site was found to lie in this area and was removed from further analysis. The centroids of the final candidate sites are shown as red dots in Figure 10.

The OD Matrix was used to determine the road distance from each candidate site to the nearest amenity of each type. The total distance from each candidate site to all amenities was calculated.

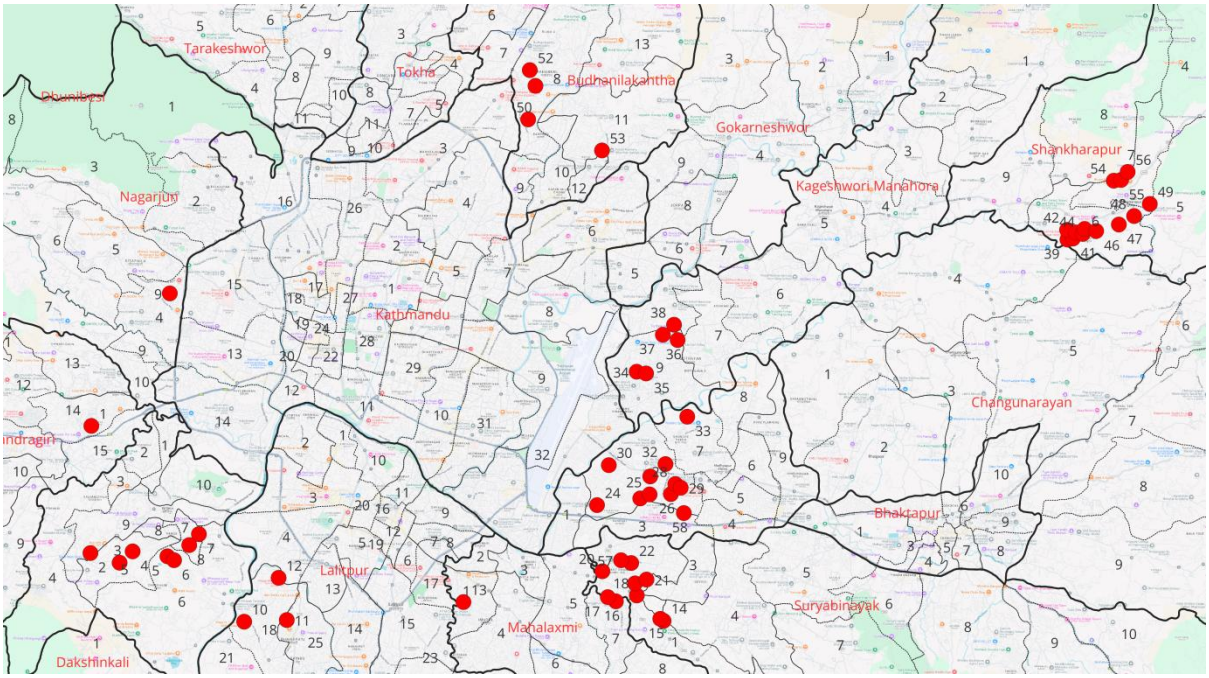

Fig. 10. Location of Final Candidate Sites.

4.1.3 Pareto Frontier

A Pareto Frontier Analysis was conducted to identify the sites with the minimum land price and minimum distance from all amenities. For the analysis, government land rate for all the candidate sites was taken for the fiscal year 082/83. [26] Market rate was not used for the valuation as it is highly volatile. Whereas, the government land rate is stable and authentic. In addition, many valuers take the market land rate to be equal to a certain multiple of the government rate. In such a scenario, even using the market rate yields a scatter plot similar to that obtained using only the government rate.

The total distance of all amenities from each site and the government land rate were plotted as a scatter diagram, as shown in Figure 11. Four sites were found to be on the Pareto Frontier. From the Pareto Frontier analysis, the optimal sites identified were as follows:

- Site 2: Kirtipur-9, Near APF School
- Site 8: Kirtipur-7, Panga
- Site 12: Lalitpur-18, near Nepal Mediciti Hospital
- Site 58: Madhyapur Thimi-2, Gatthaghar

The location of the optimal sites in the map of Kathmandu Valley is shown in Figure 12.

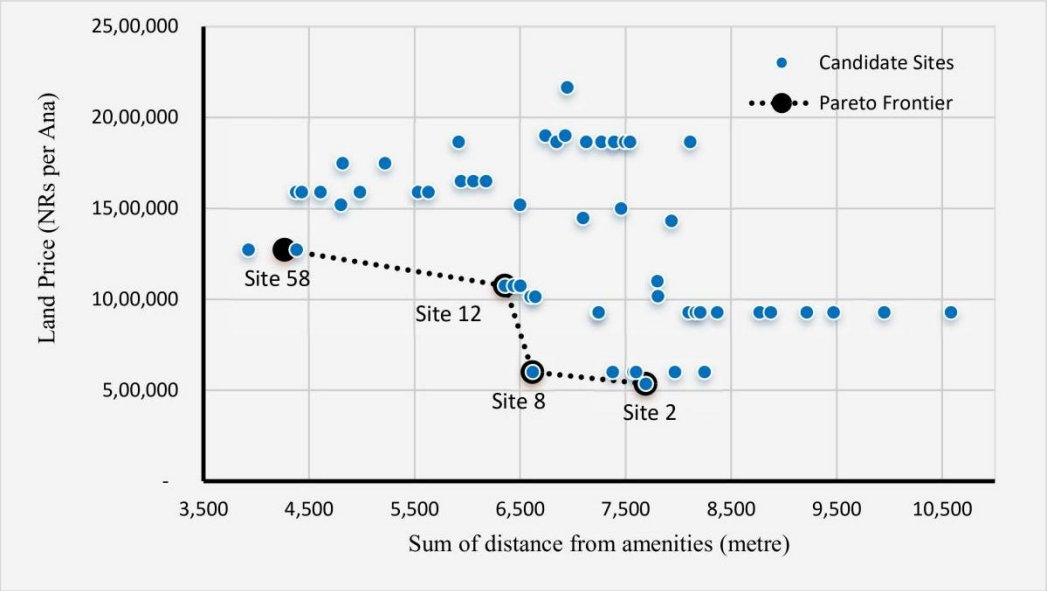

Fig. 11. Pareto Frontier Analysis.

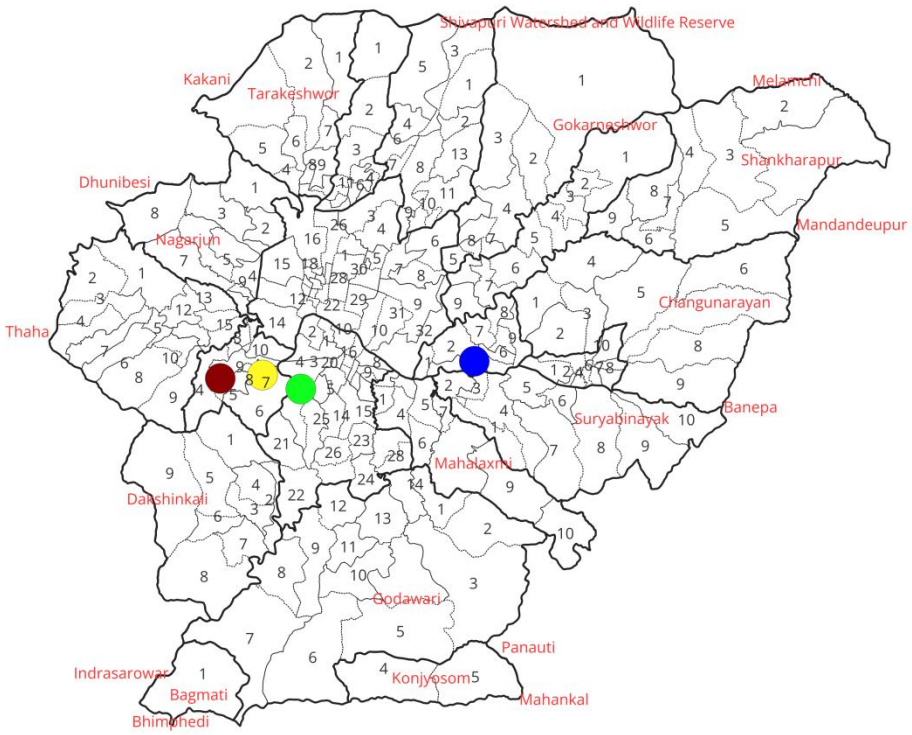

Fig. 12. Optimal Locations for Civil Servants' Apartment in Kathmandu Valley.

4.1.4 TOPSIS

TOPSIS analysis was subsequently performed to rank the sites identified on Pareto Frontier. The analysis used the distance to the nearest amenities, government land price, and weights derived from the Analytic Hierarchy Process as input parameters. The ranking of the sites obtained from the TOPSIS analysis is as follows:

- Rank 1: Site 2, Kirtipur-9, Near APF School
- Rank 2: Site 8, Kirtipur-7, Panga

- Rank 3: Site 12, Lalitpur-18, near Nepal Mediciti Hospital
- Rank 4: Site 58, Madhyapur Thimi-2, Gatthaghar

4.1.5 Sensitivity Analysis

The weights of different amenities were changed by ± 10 %, ± 20 %, ± 30 %, ± 40 %, ± 50 %, ± 60 %, ± 70 %, ± 80 %, ± 90 %, ± 100 %. A similar approach was used for the weights of proximity and land price. When the weight of one factor was changed, the weights of the remaining factors were adjusted by equal changes. Nineteen scenarios with different weights were identified in this study. TOPSIS analysis was performed for each scenario, and the ranks of the sites were recorded. With the change in weights, the rankings of the sites also changed. The change in the rank of sites 2 and 8 started only with a 50 % change in the weight of Bank, and that of sites 12 and 58 started only with a 40 % change in the weight of Land Price. Hence, it is confirmed that the ranks of the sites do not change easily. Hence, the output was found to be sufficiently reliable.

The sensitivity analysis demonstrated the robustness of the site rankings against changes in stakeholder preferences over time. Although the analysis does not explicitly incorporate the addition of new amenities as separate criteria, the observed sensitivity behavior provides an indirect indication of how the results may respond to evolving urban conditions in the future. Because the result is less sensitive to changes in the weights of amenities, this suggests that the inclusion of additional amenities does not significantly influence the suitability of the final sites.

4.1.6 Key Informant Interview (KII)

Different policy-level officials from the DUDBC were interviewed for the KII. From the KII, all the identified sites were found to be appropriate for constructing civil-servant apartments. Among these sites, Site 12, near Mediciti Hospital was preferred by three out of five experts because the location was being developed as a high-class residential area, had convenient access from the site to the city area, and was in proximity to the ring road. Site 4 at Gatthaghar was preferred by one out of five experts because it was approximately equidistant from the government offices of all three districts of the Valley.

4.2 Discussion

Among the listed amenities, the office was preferred at a relatively greater distance than the others. During the survey, many respondents stated that commuting to the office provided an opportunity to travel outside their home environment, which they would not have otherwise experienced. College, temple, and shopping mall were also preferred farther. They might have been preferred relatively distant as their use was less common. Park and bus stops were preferred because they were approached on foot.

Respondents might have weighted schools more because commuting to schools required extra care regarding children safety. Bus stops might have been weighted more because most civil servants might frequently need public transportation. The higher weight assigned to proximity to amenities than to land price reflects the respondents' strong preference for convenience and accessibility. In urban contexts, such as the Kathmandu Valley, where traffic congestion and infrastructural constraints can significantly influence daily mobility, proximity to essential services becomes increasingly important in residential location decision-making. The relatively lower but still substantial weight of land prices suggests that affordability remains an important constraint on the housing demand. However, these disadvantages do not outweigh the benefits associated with proximity to essential amenities. This trade-off highlights that civil servants are willing to balance cost considerations with accessibility to improve their overall quality of life.

Four optimal locations for civil servant apartments were identified. Among these, Site 2 has the lowest land cost but involves greater travel distances. In contrast, Site 58 offers the highest level of accessibility but at a considerably higher land price. Sites 8 and 12 represent compromise solutions that balance the cost and accessibility. Decision-makers can choose based on an acceptable trade-off between accessibility and affordability, according to their investment criteria. The sites obtained from the quantitative analysis were further assessed using qualitative insights from Key Informant Interviews (KII). The preferences derived from the KII differed from those of the quantitative results. As expert opinions often reflect socioeconomic, political, and practical considerations, greater weight was given to the KII findings. Accordingly, Site 12 (near Nepal Mediciti Hospital) was considered the most suitable location, followed by Site 58 (Gatthaghar).

5 Conclusions and Recommendations

5.1 Conclusions

The findings show that proximity to essential amenities such as transport, schools, banks, healthcare, and religious sites has a greater influence on residential location choice than land prices. This highlights the importance of accessibility and convenience in the Kathmandu Valley. Site 12 (near Nepal Mediciti Hospital) was identified as the most suitable location, followed by Site 58 (at Gatthaghar) through quantitative and qualitative analysis.

5.2 Recommendations

For the construction of apartments for civil servants within the Kathmandu Valley, it is recommended that development be carried out at the locations identified in this study, as they provide data-driven assurance of the project's financial viability. Additionally, a more detailed site-specific assessment, such as a SWOT analysis, is recommended before construction to ensure informed decision-making.

To evaluate alternative sites within the valley, this study proposes a Weighted Proximity Score (WPS) framework. The proximity score for each amenity can be calculated as presented in Eq. (4) and (5).

$$Weighted\ Proximity\ Score\ (WPS) = \sum(w_i \times Proximity\ Score_i). \tag{4}$$

$$Proximity\ Score_i = \frac{D_{\{preferred\}}}{D_{\{actual\}}}. \tag{5}$$

Where,

$D_{preferred,i}$ is the preferred distance to amenity "i" identified in this study

$D_{actual,i}$ is the actual distance from the proposed site to such amenity, and

w_i represents the AHP-derived weight of amenity "i."

Higher WPS values indicate more desirable locations. Accordingly, the proposed sites can be systematically compared to identify the most suitable alternatives. These findings have important implications for investors and housing developers, as they provide a structured decision-support tool for selecting optimal locations for apartment development and facilitating sound investment choices.

5.3 Recommendations for further study

Some recommendations for further study are as follows:

1. To address the limitations of this study, future research should verify the accuracy of the data from OpenStreetMap.

2. After identifying the optimal sites, residents near these locations need to be consulted to assess their acceptance of apartment development.

3. Additionally, a GIS-based model, such as one developed using Model Builder or similar tools in QGIS, can be created to automate the sequence of analytical steps applied in this study, thereby improving efficiency, consistency, and scalability in site suitability analysis.

4. Furthermore, similar studies can be extended to other regions of Nepal that are experiencing high population growth. This supports data-driven investment decisions and enhances the reliability of expected returns on investment.

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Author Contributions

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All authors have read and approved the final manuscript.

Data Availability Statement

The data used in this study were generated and compiled specifically for the purpose of this research and are available from the corresponding author upon reasonable request. Due to the inclusion of project-specific datasets and supplementary GIS layers used for spatial analysis, some data may not be publicly accessible to protect institutional or administrative restrictions.

Where applicable, publicly available secondary data sources have been appropriately cited within the manuscript. The authors confirm that all relevant data supporting the findings of this study are included within the article or can be obtained from the corresponding author upon reasonable request.

Ethics Statement

The authors confirm that this study was conducted in accordance with ethical standards and relevant institutional guidelines. As the research does not involve human or animal experimentation, formal ethical approval was not required.

However, all secondary data used in this study were obtained from authorized public sources and relevant government agencies, and were used strictly for academic and research purposes. No personal or sensitive human data were collected, and no individuals were directly involved in surveys, interviews, or experiments. The authors further confirm that the research process adhered to principles of academic integrity, transparency, and honesty in data handling, analysis, and reporting.

Conflict of Interest Statement

Ar. Prabin Shrestha and all co-authors declare that there are no conflicts of interest regarding the publication of this manuscript. The authors confirm that the research was conducted in the absence of any commercial, financial, or personal relationships that could be construed as a potential conflict of interest. The study design, data collection, analysis, interpretation, and manuscript preparation were carried out independently without influence from any funding agency, organization, or individual that could bias the results or conclusions. All authors have reviewed and approved the final manuscript and agree to its submission for publication.

Plain Language Summary

This study explores suitable locations for building medium-rise apartment for civil servants in Kathmandu Valley, Nepal. Many government employees currently face long commuting times and high living costs due to limited affordable housing near major workplaces. To address this issue, the study evaluates different areas within the valley to identify the most appropriate sites for residential development.

The assessment considers important factors such as accessibility, and land suitability. By comparing and ranking different locations using a structured decision-making approach, the study identifies areas that provide a good balance between affordability and convenience.

The results show that certain peri-urban and well-connected locations around Kathmandu Valley are more suitable for developing government housing projects. These findings can support policymakers and urban planners in making informed decisions for future housing development, ultimately helping to reduce commuting burdens and improve living conditions for civil servants.

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