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# **Evaluation of the Housing Aggregation Model for Young People in Urban Areas**



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**Abstract:** A large number of young people are leaving their countries in search of a better life. The quality of life in the country they live in influences this. Therefore, it is essential to improve the quality of life for young people in Bosnia and Herzegovina (BiH) to prevent the outflow of youth. This research focuses on addressing the issue of housing for young people to improve their quality of life in the urban area of the Brčko District of BiH. A total of ten criteria and six alternatives for housing young people were considered. Consequently, this decision-making problem was solved using multi-criteria decision-making (MCDM) methods and a fuzzy approach. This approach was chosen because the evaluations of criteria and alternatives were in the form of linguistic values. The fuzzy simple weight calculation (SiWeC) method was used to determine the importance of the criteria, and its results showed that the most significant criterion for housing young people is financial capability. The consideration of alternatives for housing was conducted using the fuzzy compromise ranking of alternatives from distance to ideal solution (CRADIS) method, and the results of this method indicated that the alternative of collective housing for youth is the most suitable for addressing this problem. These results were also confirmed by conducting a sensitivity analysis. The contribution of this research lies in improving the quality of life for young people and retaining them in the country to influence the economic development of that country.

Keywords: Housing; Quality of life; Brčko District BiH; Fuzzy approach; Collective housing

# 1 Introduction

Recently, many countries around the world are facing a change in the demographic structure of their citizens. Birth rates are declining, leading to a decrease in the population. According to available statistical data, the population in Bosnia and Herzegovina (BiH) is decreasing every year, and the average age of the population is increasing [1]. These changes in the population structure have serious and far-reaching consequences for the economy and society. Young people are leaving the country in search of a better life, which has become a mass phenomenon. They hope for better conditions in other countries regarding education, employment, quality of life, and a more secure future. Young people are uncertain about the future that awaits them in BiH [2]. As a result, the workforce is decreasing every year, which can negatively affect economic trends.

One of the conditions for improving the quality of life for young people is affordable, safe, and quality housing for youth, especially in urban areas. Due to rising real estate and rental prices, young people are unable to secure adequate housing [3]. Therefore, it is necessary to systematically address this problem and provide conditions for young people to resolve their housing issues in urban areas, which represents a challenge for modern society. The problem of housing for youth in urban areas is further complicated by the fact that a housing policy at the local level is not developed. Furthermore, there are no funds dedicated to addressing this issue. Because this problem is not adequately resolved, more and more young people are contemplating leaving the country or are not starting a family, which further jeopardizes the long-term demographic stability of the community. This, in turn, has far-reaching consequences for economic trends in these communities.

When observing the issue of housing for young people in urban areas, which is also the focus of this research, several key factors emerge that complicate the resolution of this problem. These include economic, institutional, and demographic-social factors. Economic factors manifest in the continuously rising real estate prices; additionally, young people often have lower incomes since they are at the beginning of their careers. Furthermore, they frequently face unemployment or have unstable jobs, while the cost of living continues to increase. As a result, high living expenses further complicate housing solutions for young people in urban environments. Institutional factors primarily reflect the difficulties in obtaining housing loans, as young people struggle to meet requirements regarding salaries and employment. Furthermore, there is a lack of adequate programs funded by the government, as there is no strategic urban development planning that would allow for social housing, and laws do not provide sufficient protection for tenants, worsening the situation for young renters. All of this affects young people's decisions to postpone marriage and start families late, which impacts birth rates and reduces fertility. Additionally, the education system is becoming increasingly lengthy, making young people more dependent on parental support. An additional problem is that an increasing number of people want to live in urban areas, which drives up apartment prices. All these factors contribute to the challenges of housing young people.

The Brčko District of Bosnia and Herzegovina, as a specific administrative unit in BiH, holds significant powers regarding the resolution of this issue. Unlike other local communities in BiH, the Brčko District can enact its own laws and has a larger budget compared to other local communities. Therefore, it is essential to leverage these advantages to provide young people with opportunities to address their housing issues. On the other hand, it is also possible to attract youth from other communities to come to the Brčko District. To achieve this, flexible and accessible solutions must be sought to resolve this problem. Various alternatives that could be utilized need to be considered as well. Hence, the research question arises: What alternatives for housing young people in the town of Brčko should be considered to effectively and efficiently solve this problem and keep young people in BiH?

The aim of this research is to evaluate different alternatives for housing young people in the Brčko District of BiH using various aspects in order to address this issue in an efficient and sustainable manner. The results obtained from this research can serve as a basis for developing strategies and measures to enhance the quality of life for young people in the Brčko District through housing solutions in urban areas. Given that there are several alternatives that have been examined from different perspectives, this decision-making problem will be addressed using multi-criteria decision-making (MCDM) methods. To achieve this, specific research objectives need to be defined:

- Consider and determine the significance of various aspects that affect housing support for young people.
- Apply a fuzzy approach that allows for decision-making using linguistic values.
- Identify alternatives for housing support for young people.
- Perform an evaluation of alternatives and select the most suitable options for housing support for young people.

Based on the established goals and specifics of this research, the contribution of this paper is reflected in the following. First, there will be a systematization and evaluation of alternative models for solving the housing issue of youth in the Brčko District, considering the specificities of this local community, in order to adequately address this problem. Second, the research provides guidelines for recommendations on developing strategies and policies that should be implemented in practice to improve the quality of life for young people. Third, the application of a fuzzy approach allows for a more flexible analysis that incorporates uncertainty in decision-making regarding the qualitative aspects that need to be included in this research. The use of this approach enables the nuanced evaluation through the application of linguistic values. Fourth, the contribution of this research is also broader, as solving this problem will improve the demographic structure of the population, which will impact the society and economy of this local community. Fifth, the guidelines of this research will serve for application in other communities and influence the improvement of conditions for youth in Bosnia and Herzegovina.

#### 2 Literature Review

Research on solving housing issues for youth is largely shaped by economic, cultural, and institutional factors. In contemporary urban environments, young people face the challenge of leaving their parental home to gain independence, but they encounter numerous obstacles such as high housing prices, unstable incomes, and limited access to credit [4]. Although it is believed that young people have a greater tolerance for compact and communal forms of housing, their decisions are deeply connected to personal experiences, aspirations, and perceptions of urban life. Woodhall-Melnik et al. [5] addressed the topic of housing for youth, particularly in relation to youth homelessness. Through seven studies, measures addressing this issue are explored. Gaetz et al. [6] tackled the same problem in Canada, conducting preliminary research to gather sufficient information for a detailed study that would offer solutions for housing young homeless individuals. Littman et al. [7] focused on the issue of youth homelessness, noting that one in ten young people is homeless, which led them to investigate the effects of Marsha and Marian's Neighbors program for youth housing. While the focus of most studies has been on young people experiencing homelessness, important lessons from these studies can also be applied to youth who wish to leave their parental home but have limited options for independent living.

Rietdijk [8] examined social housing policies using Taipei as an example. He considered the possibility of using social housing for young people. In a study conducted in Auckland by Opit et al. [4], it was indicated that the acclimatization of younger generations to denser forms of housing meets their needs. These authors emphasize the importance of quality of life and functionality of the apartment as key elements for the acceptance of alternative housing models. Similar conclusions are drawn in the research by Jin et al. [9], which analyzes the housing trajectories of young people in Shenzhen (China), showing how the interaction between individual agency, capital, and structural constraints shapes different housing options. Young people choose to live at home with their parents, private rentals, progressive rentals, and other variants, with their decisions reflecting long-term migration plans. Research from Taiwan conducted by Chang [10] highlights the role of the parental home as a "platform" for housing autonomy. While staying at home often comes from economic reasons, it also allows young people to plan their future and prepare for independent living. This approach provides a clear picture of how family support can serve as a temporary variant.

Coulter et al. [11] conducted research in multiple countries, and their results showed that housing inequalities among young people are becoming increasingly pronounced, particularly regarding home ownership. These studies provide theoretical frameworks for understanding how socioeconomic status and geographical location affect young people's possibilities to leave the parental home. Furthermore, it is shown that unstable economic conditions and changes in the labor market increasingly influence the housing choices of young people. In Ireland, it was found that young people often cannot leave the parental home or transition from renting to home ownership due to non-standard and insecure employment [12]. Instead of classical solutions to the housing issue, they choose alternative solutions such as long-term co-living or returning to their parents, which do not address the housing problems of young people. Similar conclusions are drawn in a study conducted by Matel [13] in Poland during and after the COVID-19 pandemic, where changes in the living conditions of young people after leaving the parental home were analyzed.

In the context of global changes, there are certain situations that create additional barriers to housing for young people, such as mental health, social exclusion, or discrimination. An example of research on lesbian and gay youth in Greece and Italy shows that these groups have limited housing options, often relying on intergenerational support or alternative housing models [14]. The mentioned research also indicates the importance of flexible and permanent housing solutions, especially during periods of significant social change, such as pandemics or economic crises. Young people are often forced to change their life plans, and the system must be capable of providing them support without long-term uncertainty [12, 13]. Housing decisions of young people are not made in isolation, but are deeply connected to their socioeconomic context, access to employment, and the support they receive from institutions and the community. Collaboration between housing agencies, social services, and the employment sector can significantly contribute to resolving this issue, especially for those coming from families with limited resources [15].

In research analyzing housing support in Scotland, it was found that personal and parental socioeconomic circumstances play a key role in shaping housing issues [16]. Young people without strong familial capital increasingly depend on renting or staying with parents, clearly reflecting the growing inequality among certain groups of youth. This highlights the necessity for policies that will reduce disparities and provide a wide range of young people with affordable housing options. Research from Australia and the United Kingdom shows how employment can be a crucial point for achieving housing support [17]. Programs that connect young people with permanent jobs, particularly in the construction sector, not only improve their incomes but also enhance their self-confidence, social connections, and ability to become independent. These experiences emphasize the importance of so-called "intermediary" organizations that build bridges between young people and the industry, enabling a structured passage through the processes of employment and housing. Young people often seek flexible housing models that accommodate changes in their lives, whether temporary housing, shared forms, or support programs during the transition to independence. In this regard, models such as Foyer, Housing First, and Transitional housing offer valuable examples of how to address this issue systematically [15].

Such experiences can be used as a basis for the development of local support programs for young people in the Brčko District of Bosnia and Herzegovina, with adjustments to specific demographic, economic, and cultural conditions. It is necessary to develop housing support models that will consider the complexity of young people's lives and offer real options for the transition from family to independent living, with the support of institutions, the local community, and the private sector.

## 3 Methodology

The research for this work was conducted with the assistance of the Government of Brčko District of BiH. The Government of Brčko District of BiH aims to improve the living conditions for youth in the Brčko District of BiH through the development of a Youth Strategy. One segment of this strategy is addressing the housing issues faced by young people in Brčko. Therefore, to assess potential solutions, a working group of employees from the Government of Brčko District of BiH, who are engaged in resolving this issue, was selected. Thirteen employees were chosen for this working group, including civil engineers, social workers, and economists who are knowledgeable about this

problem. All employees have more than ten years of experience in these fields. Several working meetings were held with this working group, and at one of them, potential solutions were discussed. In that meeting, potential criteria were proposed using a brainstorming method. The criteria were then grouped, and some were merged into one. The criteria were then reviewed, and a total of ten criteria were selected, with explanations provided for the purpose of each criterion. These criteria are as follows:

• Financial options (C1) refer to the availability of financial resources for young people through loans, borrowing, funds, and various other opportunities.

• Location of real estate (C2) represents the place where the property is located; it is desirable for that location to have all the necessary amenities for young people.

• Housing flexibility (C3) represents the ability for the housing alternative to adapt to the new needs of young people.

• Ecological sustainability (C4) refers to the possibility of using ecological solutions in these housing alternatives.

• Social inclusion (C5) denotes the availability of a certain housing alternative to individuals with special needs they may have.

• Comfort and aesthetics (C6) refer to the quality of the living space and its adaptability to the new needs of young people, as well as the visual appeal of that alternative.

• Housing security (C7) refers to the ability to use that housing alternative for an extended period without the need to change alternatives.

• Traffic connectivity (C8) denotes the connection of a certain location with transportation means in the form of public transport or the use of bicycles.

• Investment potential (C9) indicates the likelihood of how much a certain alternative will be worth over a longer period.

• Speed of realization (C10) refers to the time it takes for a certain housing alternative to resolve the housing issue for young people.

After the criteria were determined, it was necessary to identify which alternatives for housing young people could be used in the Brčko District of Bosnia and Herzegovina, specifically in the urban part of this district. As with the criteria, brainstorming was employed to first generate all possible alternatives, from which those suitable for this local community were selected. In this way, six alternatives were chosen:

• Renting apartments (HO1) involves renting apartments for the purpose of housing young people without long-term obligations, whether the apartments are privately or publicly owned.

• Suburban houses (HO2) represents an alternative where a house is built on a specific plot in the suburbs of an urban settlement for young people to live in.

• Purchasing an apartment (HO3) represents the option for young people to buy an apartment in the urban parts of the city through credit or savings.

• Modular houses (HO4) this alternative is similar to suburban houses, but the houses are made from modular parts.

• Adapting commercial spaces (HO5) involves converting vacant offices, warehouses, or other unused industrial facilities into residential properties.

• Collective buildings for youth (HO6) this alternative involves the construction of residential buildings exclusively for young people with certain shared spaces.

Determining the criteria and alternatives is necessary to select the most suitable option for housing young people in the Brčko District of Bosnia and Herzegovina. The research was conducted based on the following research steps (Figure 1).



Figure 1. Research steps

The first step of the research is the preparation of the study. In the preparation of the research, criteria and alternatives are selected. Based on the criteria and alternatives, a questionnaire is formulated to determine the importance of the criteria and to evaluate the alternatives. In assessing the importance of the criteria and alternatives, scales with nine levels will be used, where the minimum and maximum values of the scales are defined in the form

of linguistic values. A specific feature of this research is that different scales tailored to the criteria will be used for evaluating alternatives based on the selected criteria (Table 1). The assessment of the importance of the criteria will be done on a scale of values from absolutely unimportant to absolutely important criteria.

Criterion	Minimum Value	Maximum Value
Financial options (C1)	Very low	Very high
Property location (C2)	Isolated	Ideally located
Housing flexibility (C3)	Unchangeable	Completely flexible
Environmental sustainability (C4)	Unsustainable	Fully sustainable
Social inclusion (C5)	Discriminatory	Completely inclusive
Comfort and aesthetics (C6)	Uncomfortable	Luxurious
Housing security (C7)	Unsecure housing	Secure housing
Traffic connectivity (C8)	Unconnected	Absolutely connected
Investment potential (C9)	Decreases significantly	Increases significantly
Speed of realization (C10)	Very slow	Very fast

Table 1	•	Key	parameters	of	our	mode	el
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After the questionnaire has been formulated and certain value scales determined, the next step in the research is to conduct the study. First, the questionnaires are distributed to the working group at the next meeting, where the completed questionnaires are collected and processed. Once the completed surveys are collected and processed, the next step involves preparing the data for analysis, which includes determining the importance of the criteria and ranking the alternatives, representing the subsequent step of this methodology.

The third step involves using the collected data to obtain the research results. To determine the importance of the criteria, the fuzzy SiWeC method will be employed, while the fuzzy CRADIS method will be used to obtain the ranking of the alternatives. Sensitivity analysis will be conducted to determine how much the ranking of the alternatives depends on specific criteria. The weights obtained from the fuzzy SiWeC method will be used, and those weights for individual criteria will be reduced to ascertain whether this reduction in the importance of one criterion influences the final ranking of the alternatives. After explaining the steps of the research, this part of the paper will also describe the steps involved in the methods used.

The fuzzy SiWeC method is utilized for the subjective determination of the weights of the criteria. In this method, decision-makers (DM) determine the importance of a specific criterion without considering comparisons with other criteria. Additionally, this method also determines the importance of the assessments given by the DM, and based on that, their evaluations are taken into account, which distinguishes this method from similar methods. The steps of this method are [18]:

Step 1. Determining the importance of criteria.

Step 2. Transformation of linguistic values.

Step 3. Formation of fuzzy decision matrix.

Step 4. Normalization of the decision matrix.

$$\tilde{n}_{ij} = \frac{x_{ij}^l}{\max x_{ij}^u}, \frac{x_{ij}^m}{\max x_{ij}^u}, \frac{x_{ij}^u}{\max x_{ij}^u}$$
(1)

where,  $max x_{ii}^{u}$  is the maximum value of the fuzzy number for all DM scores.

Step 5. Calculation of the standard deviation value for DM  $(st.dev_i)$ .

Step 6. Weighting of normalized scores with standard deviation values.

$$\tilde{v}_{ij} = \tilde{n}_{ij} \times st.dev_j \tag{2}$$

Step 7. Calculating the sum of the weight values of individual criteria.

$$\tilde{s}_{ij} = \sum_{j=1}^{n} \tilde{v}_j \tag{3}$$

Step 8. Calculating the values of the criteria weights.

$$\widetilde{w}_{ij} = \frac{s_{ij}^l}{\sum_{j=1}^n s_{ij}^u}, \frac{s_{ij}^m}{\sum_{j=1}^n s_{ij}^m}, \frac{s_{ij}^u}{\sum_{j=1}^n s_{ij}^l}$$
(4)

The CRADIS method is used for ranking alternatives based on the evaluations of DM. They determine how well each alternative meets the established research criteria. The ranking is performed based on calculating the deviations from the ideal and anti-ideal solutions, as well as on the utility function [19]. The steps for applying the fuzzy CRADIS method are as follows [20]:

Step 1. Formation of the initial decision-making matrix.

Step 2. Normalization of the decision-making matrix.

$$n_{ij} = \frac{x_{ij}^l}{\max x_j^u}, \frac{x_{ij}^m}{\max x_j^u}, \frac{x_{ij}^u}{\max x_j^u}$$
(5)

Step 3. Weighted decision matrices.

$$\tilde{v}_{ij} = \left(v_{ij}^l, v_{ij}^m, v_{ij}^u\right) = \tilde{n}_j \times \tilde{w}_j \tag{6}$$

Step 4. Determining ideal and anti-ideal values.

$$t_i = \max \tilde{v}_{ij}, \text{ where } \tilde{v}_{ij} = \left(v_{ij}^l, v_{ij}^m, v_{ij}^u\right)$$
(7)

$$t_{ai} = \min \tilde{v}_{ij}, \text{ where } \tilde{v}_{ij} = \left(v_{ij}^l, v_{ij}^m, v_{ij}^u\right)$$
(8)

Step 5. Calculating deviations from ideal and anti-ideal values.

$$d^+ = t_i - \tilde{v}_{ij} \tag{9}$$

$$d^- = \tilde{v}_{ij} - t_{ai} \tag{10}$$

Step 6. Formation of ideal and anti-ideal optimal alternatives. Step 7. Calculation of the sum of deviations.

$$s_i^+ = \sum_{j=1}^n d^+$$
(11)

$$s_i^- = \sum_{j=1}^n d^-$$
(12)

Step 8. Defuzzification.

$$s_{idef}^{\pm} = \frac{d_i^l + 4d_i^m + d_i^u}{6}$$
(13)

Step 9. Calculating the utility function.

$$K_i^+ = \frac{s_0^+}{s_i^+} \tag{14}$$

$$K_{i}^{-} = \frac{s_{i}^{-}}{s_{0}^{-}}$$
(15)

where,  $s_0^+$  is the optimal ideal alternative, while  $s_0^-$  the optimal anti-ideal alternative.

Step 10. Ranking of alternatives.

$$Q_i = \frac{K_i^+ + K_i^+}{2}$$
(16)

The best alternative is the one with the highest value obtained using the CRADIS method.

#### 4 Results

To determine which of the considered alternatives the best for housing provision is, it is first necessary to establish the importance of the criteria. The determination of the importance of the criteria is carried out using the fuzzy SiWeC method. To do this, the importance of the criteria is first assessed with a numeric score defined by linguistic values. The highest score indicates that the criterion is very important, while the lowest score signifies that the criterion is completely unimportant, with other scores representing linguistic intermediate values. The scores will be marked with values from 1 to 9, which represent the linguistic values of the importance rating for the criteria (Table 2).

	C1	C2	C3	C4	C5	C6	<b>C7</b>	<b>C8</b>	<b>C9</b>	C10
Expert 1	9	8	7	6	7	7	8	8	5	7
Expert 2	9	8	7	6	7	6	8	8	5	7
Expert 3	9	7	6	5	8	7	8	9	4	6
Expert 4	8	9	8	7	6	5	7	7	6	8
Expert 5	9	8	7	6	7	8	8	9	5	7
Expert 6	9	8	6	5	7	8	8	9	5	7
Expert 7	9	7	7	6	7	8	7	9	4	7
Expert 8	9	8	7	5	6	7	8	8	5	6
Expert 9	9	8	6	5	7	6	8	7	5	6
Expert 10	9	8	7	5	6	6	8	7	6	6
Expert 11	8	9	8	6	6	7	8	9	7	6
Expert 12	9	7	8	7	9	7	9	7	6	7
Expert 13	9	8	7	5	6	7	8	7	6	6

Table 2. Importance rating of the criteria

For these linguistic values expressed as numbers to be used in further analysis, they need to be converted into fuzzy numbers (Table 3). This is done by applying a membership function that defines the membership of a certain linguistic value to a fuzzy number. Using this membership function, the values of fuzzy numbers for individual grades are determined, so the grade 9 is transformed into the fuzzy number (8, 9, 9), the grade 8 into the fuzzy number (7, 8, 9), and thus all grades are transformed into defined fuzzy numbers.

Table 3. Membership function for fuzzy numbers

Linguistic Value Label	Fuzzy Number
1	(1, 1, 2)
2	(1, 2, 3)
3	(2, 3, 4)
4	(3, 4, 5)
5	(4, 5, 6)
6	(5, 6, 7)
7	(6, 7, 8)
8	(7, 8, 9)
9	(8, 9, 9)

By applying the defined membership function (Table 3), a fuzzy decision matrix is formed, which represents the relationship for calculating the fuzzy SiWeC method. First, the largest value of the fuzzy number is found for all values, which are 9. This value is then used to normalize the fuzzy decision matrix. In this step of the fuzzy SiWeC method, all values of the fuzzy number are divided by this value. For the criterion C1 and expert 1, this is done in the following way:

$$\tilde{n}_{11} = \frac{8}{9} = 0.89, \frac{9}{9} = 1.00, \frac{9}{9} = 1.00$$

In this way, a normalized decision matrix (Table 4) is formed, and the standard deviation is calculated individually for each expert based on their ratings. If the value of the standard deviation is higher, the ratings from that expert are more diverse, indicating greater importance compared to other experts with less diversity in their ratings. Then, the normalized values are multiplied by the corresponding standard deviation value. For example, for criterion C1 for expert 1, it is calculated as follows:

$$\tilde{v}_{11} = 0.89 \times 0.15 = 0.13, \ 1.00 \times 0.15 = 0.15, \ 1.00 \times 0.15 = 0.15$$

	C1	C2	C3	•••	C10	SD
Expert 1	(0.89, 1.00, 1.00)	(0.78, 0.89, 1.00)	(0.67, 0.78, 0.89)		(0.67, 0.78, 0.89)	0.15
Expert 2	(0.89, 1.00, 1.00)	(0.78, 0.89, 1.00)	(0.67, 0.78, 0.89)		(0.67, 0.78, 0.89)	0.15
Expert 3	(0.89, 1.00, 1.00)	(0.67, 0.78, 0.89)	(0.56, 0.67, 0.78)		(0.56, 0.67, 0.78)	0.19
Expert 4	(0.78, 0.89, 1.00)	(0.89, 1.00, 1.00)	(0.78, 0.89, 1.00)		(0.78, 0.89, 1.00)	0.15
Expert 5	(0.89, 1.00, 1.00)	(0.78, 0.89, 1.00)	(0.67, 0.78, 0.89)		(0.67, 0.78, 0.89)	0.15
Expert 6	(0.89, 1.00, 1.00)	(0.78, 0.89, 1.00)	(0.56, 0.67, 0.78)		(0.67, 0.78, 0.89)	0.17
Expert 7	(0.89, 1.00, 1.00)	(0.67, 0.78, 0.89)	(0.67, 0.78, 0.89)		(0.67, 0.78, 0.89)	0.17
Expert 8	(0.89, 1.00, 1.00)	(0.78, 0.89, 1.00)	(0.67, 0.78, 0.89)		(0.56, 0.67, 0.78)	0.17
Expert 9	(0.89, 1.00, 1.00)	(0.78, 0.89, 1.00)	(0.56, 0.67, 0.78)		(0.56, 0.67, 0.78)	0.16
Expert 10	(0.89, 1.00, 1.00)	(0.78, 0.89, 1.00)	(0.67, 0.78, 0.89)		(0.56, 0.67, 0.78)	0.15
Expert 11	(0.78, 0.89, 1.00)	(0.89, 1.00, 1.00)	(0.78, 0.89, 1.00)		(0.56, 0.67, 0.78)	0.14
Expert 12	(0.89, 1.00, 1.00)	(0.67, 0.78, 0.89)	(0.78, 0.89, 1.00)		(0.67, 0.78, 0.89)	0.13
Expert 13	(0.89, 1.00, 1.00)	(0.78, 0.89, 1.00)	(0.67, 0.78, 0.89)		(0.56, 0.67, 0.78)	0.15

Table 4. Normalized decision matrix for determining the weight of criteria

After that, the aggregate value for each criterion is calculated, and finally, the weight value of the criteria is calculated by dividing the individual criterion value by the total value for all criteria. Using criterion C1 as an example, this is done as follows:

$$\widetilde{w}_{ij} = \frac{1.78}{17.98} = 0.01, \ \frac{2.01}{16.06} = 0.12, \ \frac{2.04}{13.80} = 0.15$$

The results of the fuzzy SiWeC method show that the most important criterion is C1 – financial capabilities, followed by criterion C2 – property location, and criterion C7 – housing safety, while the least important criterion is C9 – investment potential (Table 5). Based on this, it can be concluded that, according to expert opinions, the most important aspects are that housing issues can be financed in various ways and that they are located in optimal locations while also being safe for young people to use for many years.

 Table 5. Values of criterion weights

-	C1	C2	С3	C4	C5
$\tilde{s}_{ij}$	(1.78, 2.01, 2.04)	(1.57, 1.79, 1.99)	(1.35, 1.58, 1.80)	(1.05, 1.28, 1.51)	(1.32, 1.55, 1.76)
$\widetilde{w}_{ij}$	(0.10, 0.12, 0.15)	(0.09, 0.11, 0.14)	(0.07, 0.10, 0.13)	(0.06, 0.08, 0.11)	(0.07, 0.10, 0.12)
	C6	C7	C8	С9	C10
$\tilde{s}_{ij}$	(1.33, 1.56, 1.78)	(1.57, 1.79, 2.00)	(1.60, 1.82, 1.96)	(0.96, 1.19, 1.42)	(1.27, 1.50, 1.72)
$\widetilde{w}_{ij}$	(0.07, 0.10, 0.13)	(0.08, 0.11, 0.14)	(0.10, 0.11, 0.14)	(0.05, 0.07, 0.10)	(0.07, 0.09, 0.12)

11	01	<b>CA</b>	<b>C</b> 2	04	05	0(	07	CO	CO	C10
EI	CI	C2	C3	C4	C5	C6	C/	<b>C8</b>	<b>C9</b>	C10
A1	7	8	9	4	6	7	5	8	3	9
A2	5	5	6	7	5	8	8	4	7	4
A3	4	8	5	5	6	7	9	8	9	3
A4	6	6	9	8	7	7	7	5	6	7
A5	8	7	7	6	6	6	6	7	7	6
A6	9	7	8	7	9	8	8	8	5	5
E13	C1	C2	C3	C4	C5	C6	<b>C7</b>	<b>C8</b>	C9	C10
A1	8	8	9	5	7	6	6	9	3	9
A2	5	5	6	6	6	7	8	5	6	4
A3	4	9	4	5	6	9	9	9	9	3
A4	6	6	7	8	7	7	7	6	7	6
A5	7	7	8	7	8	6	6	7	6	7
A6	7	8	6	7	9	7	7	8	8	6

Table 6. Evaluation of housing support models for young people

After the importance of the criteria weights is determined, the ranking of the selected models for housing support for young people in the Brčko District of Bosnia and Herzegovina is carried out. The first step in obtaining this ranking is the evaluation of alternatives by experts according to the selected criteria (Table 6). A specific aspect of this step is that for each criterion, a linguistic value is specially formed to simplify the task for experts, so they do not have to think about what is, for example, very poor and what is very good. This ensures that the evaluations are such that there is no need to consider the type of criterion, whether its value should be lower or higher. By forming linguistic values in this way, it allows the evaluation values for all criteria to be as high as possible for that alternative to be considered better. As with the criteria, the evaluations will also be presented with numerical values to ensure uniformity in the representation of evaluations.

The next step is the transformation of linguistic values into fuzzy numbers using a defined membership function (Table 3). This is followed by normalization and weighting of the normalized values with the criteria weights. Due to the fact that the fuzzy CRADIS method, applied in many studies, will not detail the steps of this method. After weighting, the ideal and anti-ideal values are calculated, and the deviation of the weighted data from these values is determined. Then, the total deviations for all criteria, including the optimal alternatives, are calculated. After that, the defuzzified values and utility functions are calculated, and finally, the value of the fuzzy CRADIS method is obtained. The results of the fuzzy CRADIS method (Table 7) show that the highest rating was received by alternative A6 – collective housing for youth, followed by alternative A1 – rental apartments. The lowest rated alternative was A2 – a house in the suburbs. These results indicate that collective housing for youth should be the first choice for addressing the housing issues of young people in the Brčko District of Bosnia and Herzegovina. To achieve this, it is necessary to provide support to young people and facilitate the acquisition of location and construction permits to realize this alternative as soon as possible. Additionally, it is possible to develop typical projects to further ease the implementation of this form of housing provision for youth.

Table 7. Results of the fuzzy CRADIS method

	$s_i^+$	$s^+_{i\ def}$	$K_i^+$	$s_i^-$	$s_i^-{}_{def}$	$K_i^-$	$Q_i$	Rank
A1	(0.35, 0.70, 0.97)	0.690	0.771	(0.37, 0.50, 0.63)	0.502	0.761	0.766	2
A2	(0.49, 0.84, 1.07)	0.819	0.649	(0.27, 0.37, 0.49)	0.373	0.565	0.607	6
A3	(0.43, 0.76, 1.02)	0.752	0.707	(0.32, 0.44, 0.55)	0.440	0.666	0.687	5
A4	(0.35, 0.72, 0.99)	0.707	0.752	(0.35, 0.48, 0.63)	0.485	0.735	0.744	3
A5	(0.35, 0.73, 0.99)	0.709	0.750	(0.35, 0.48, 0.63)	0.483	0.731	0.740	4
A6	(0.28, 0.64, 0.92)	0.628	0.846	(0.42, 0.56, 0.71)	0.564	0.854	0.850	1
A0	(0.18, 0.54, 0.85)	0.532		(0.49, 0.66, 0.81)	0.660			

At the end of this paper selection, a sensitivity analysis will be conducted. The development of decision science has led to sensitivity analysis becoming a standard in MCDM models [20–23]. The sensitivity analysis in MCDM models confirms the quality of the obtained solutions or adjusts the obtained solutions [24, 25]. The most common method of sensitivity analysis is through changes in the weight coefficients of the criteria [26, 27]. The sensitivity analysis will be conducted by utilizing the initial weights of the criteria, where individual weight values for a specific criterion will be reduced by 30, 60, and 90%, while the remaining values of the criteria will be proportionally increased to maintain a similar total weight of the criteria. In this way, a total of 30 scenarios have been formed.



Figure 2. Sensitivity analysis results

The results of this analysis (Figure 2) show that in three housing alternatives there was no change in ranking: for the highest-ranked A6 – collective housing for young people and for the two lowest-ranked alternatives A3 – purchasing an apartment and A2 – house in the suburbs. Alternative A1 – renting an apartment was ranked lower than alternative A4 – modular houses in three scenarios because for two criteria, alternative A1 was better than alternative A4, specifically for criteria C2 and C8. When the significance of these two criteria was reduced, alternative A4 was better than alternative A1. Changes in rankings of other alternatives can be explained in a similar manner. Furthermore, this analysis showed that there is the smallest difference between alternatives A4 and A5, so there was the greatest change in rankings between these alternatives depending on the criteria. Sometimes A4 was better, and sometimes A5. Since alternative A6, collective housing for young people, was not ranked lower in any criterion, it was shown that this alternative is resistant to sensitivity analysis, which allows us to say that it is the best alternative for housing for young people.

# 5 Discussion

To improve the quality of life for young people, it is necessary to implement various strategies. Many factors influence the quality of life for youth. One of these factors is the housing situation of young people. Young people remain with their parents because they cannot afford any of the housing alternatives [9]. Therefore, it is essential to systematically address this issue [1]. The Brčko District of Bosnia and Herzegovina, as a separate administrative unit within BiH, has good preconditions to resolve this problem for young people. For this reason, in cooperation with the Government of the Brčko District of BiH, this research was conducted to evaluate possible solutions for housing for young people.

For the purposes of this research, a working group of employees from the Brčko District Government was formed to contribute to solving this problem within the implementation of the Youth Strategy. This strategy aims to create certain preconditions to retain young people in the city of Brčko. This is due to the fact that many young people are leaving the country in search of a better life. A total of 13 government employees were engaged to assist in the realization of this research. Since the alternatives for housing for young people were examined from several aspects, this decision-making problem was addressed using MCDM methods.

To select housing solutions for young people in an urban environment, ten criteria were chosen to evaluate the alternatives. The importance of the criteria was determined using the fuzzy SiWeC method. This method utilizes the determination of criterion weights based on individual evaluations of the criteria, taking into account how each expert assesses these criteria [28]. This method thereby favors certain experts who provided a more varied assessment of the criteria. This approach is intended because if the evaluations for all criteria are similar, then the evaluation process lacks meaning [29]. Without this, the criteria could be assigned equal importance and have the same influence on the final decision.

By applying expert evaluations and the steps of the SiWeC method, it has been determined that the most significant criterion for the selection of housing for young people is financial capability. This is because young individuals typically do not have high salaries at the beginning of their careers or may not have employment at all, so parents play a significant role in addressing this issue [16]. If young people come from wealthier families, they are more likely to resolve this matter easily. On the other hand, those who cannot rely on such support must utilize various financial options such as loans or subsidies. In addition to this criterion, the location criterion also plays a significant role. It is very important where the housing alternative is located, as young individuals often do not have their own means of transportation and must rely on public transport. Therefore, it is essential for the location to be connected to all the amenities necessary for young people. Following these two criteria is the housing security criterion. The importance of this criterion lies in the fact that the housing alternative should provide young people with the security that they can use that alternative for a longer period. In this way, young individuals do not have to worry about what to do if, for instance, the owner of the rented apartment changes, whether they will have to leave the apartment or pay a higher rent. Thus, security is a very important factor influencing the final decision regarding the choice of alternatives.

After the evaluation of the criteria used to assess the selected alternatives, it is necessary to choose which of them best meets the goals set in the Youth Strategy for the Brčko District of BiH. For this purpose, possible alternatives that can be utilized by young people for housing in the urban area of the city of Brčko were first selected. A total of six possible alternatives were chosen, and they were evaluated by the working group. The application of the CRADIS steps and the obtained scores showed that the best alternative is collective housing for young people. The reason this alternative was chosen lies in the fact that these buildings are constructed in the city center, thus having a better location than houses in the suburbs, and in addition, this alternative can be financed from various sources, including subsidies from the Brčko District Government. Furthermore, this alternative offers better security compared to renting apartments, which was the second-ranked alternative in this research.

However, the implementation of this alternative in practice can occur in several ways. Firstly, the local community can finance the construction of these buildings aimed at providing housing for young people. The second way is

for young people to pool their resources to construct a building. This second model of collective housing for young people depends on the financial resources available to the youth, which is why it is less frequently used in practice. Based on this, the Brčko District Government must decide to allocate part of the budget for the construction of buildings for the housing of young people. In this way, the financier would be the Government, which could also provide certain subsidies to young people for purchasing apartments in these buildings. This way, young people would have their housing needs resolved, and the quality of life for young people would improve.

#### 6 Conclusions

The problem of housing for young people is a significant factor in increasing the quality of living standards for youth. Therefore, the aim of this research was to evaluate various alternatives for housing young people in order to effectively and sustainably address this issue. To achieve this research goal, it was first necessary to determine the criteria that would be used to assess the selected alternatives for housing young people in the Brčko District of Bosnia and Herzegovina. These criteria and alternatives were evaluated using linguistic values, and a fuzzy approach was utilized to transform these evaluations into crisp values and identify the most significant criteria and alternatives. This research employed the fuzzy SiWeC and CRADIS methods. The results of the fuzzy SiWeC method indicated that the most significant criterion is financial capability, while the results of the fuzzy CRADIS method showed that the most significant alternative for housing young people is collective housing for young people. Thanks to these research results, guidelines are provided to the Government of Brčko District of Bosnia and Herzegovina on how to address this issue and ensure a better quality of life for youth.

This research has shown that the application of a hybrid methodology based on the fuzzy SiWeC and CRADIS methods provides a very flexible tool for solving this problem. Additionally, this hybrid methodology can also be used in future research where evaluations of criteria and alternatives are conducted using linguistic values. However, despite this, the research has certain limitations that should be addressed in future studies, such as considering additional criteria that were not included in this research and incorporating additional alternatives that could help solve the issue of housing for young people.

# **Author Contributions**

Conceptualization, A.P. and J.B.; methodology, A.P.; software, A.P.; validation, A.B., and D.B.; formal analysis, A.P; investigation, A.P.; resources, A.P.; data curation, D.B.; writing—original draft preparation, A.P.; writing—review and editing, D.B.; visualization, J.B.; supervision, J.B.; project administration, J.B.; funding acquisition, D.B. All authors have read and agreed to the published version of the manuscript.

## **Data Availability**

Not applicable.

#### **Conflicts of Interest**

The authors declare no conflict of interest.

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