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DEVELOPMENT OF FUZZY MODELS FOR THE STUDY OF SUBJECTIVE ASSESSMENT OF COMFORT IN THE SCILAB ENVIRONMENT

Abstract. *The current state of construction and design of an apartment building in terms of comfort does not cover all the necessary aspects for the residence of future residents. Quantitative criteria are usually used, an excessive number of which, unfortunately, cannot improve the substance of the case between all the actors involved. This paper discusses the method of fuzzy description of uncertainty to assess the comfort of an apartment building using software products to find results over fuzzy values. A comparative analysis of quantitative and qualitative indicators of comfort, which are determined in conditions of uncertainty, which makes it difficult to make the optimal decision. Therefore, when evaluating all the influencing factors that affect the comfort of housing, it is proposed to apply fuzzy logic and choose a function that at certain input parameters corresponds to the representation of formalized terms in the study of membership functions. The theory of fuzzy logic makes it possible to reflect various methods of constructing fuzzy sets for the needs of the subject research described below. Fuzzy set theory is used to describe the comfort of an apartment building by calculating fuzzy numbers. Subjective logic is also a non-additive theory of uncertainty, namely its theory of possibilities, as well as a universal tool for modeling, on the basis of which the subject research is built. In addition, fuzzy sets have strong logical foundations in multitasking logic. The application of this fuzzy set to this topic has influenced the multi-criteria assessment of the quality of comfort of a high-rise building, and also helped to bring optimization methods to the needs of users. Therefore, a fuzzy set can take on any meaning of a linguistic variable, which includes certain terms to describe the comfort of a residential apartment.*

Keywords: Hierarchy of influencing factors; comfort; fuzzy sets; linguistic variables; terms

Introduction

Nowadays, IT technologies are developing at a fairly rapid pace, which makes it possible to combine different branches of computer science. They allow us to make continuous decisions as a result of learning. In this regard, this article is very relevant because it contributes to the effective mastery of new technologies in the form of computer systems [1].

"Fuzzy Models in IT Technologies" explores intelligent methods for solving various problems that have arisen before us, based on fuzzy models that are used in information technology.

The SCILAB system is an integrated computer modeling software environment that covers various areas of mathematics.

The relevance of the research topic is due to the fact that information technology as a science should work to anticipate the results of their research.

Computer technology is quite common in its mathematical calculations with fuzzy concepts and approximate quantities, and not only with certain objects and computational values. Therefore, the statement can be used to describe scientific problems in the field of information technology in the following general form: "If, then" [1].

Therefore, to predict this subject area, namely the assessment of the comfort of a residential apartment, the authors set the task to use the formalization of human expressions using the theory of fuzzy logic and the theory of fuzzy sets.

Based on the concepts represented by fuzzy sets, the process of modeling and forecasting the problem of

assessing comfortable living in a high-rise building is implemented.

But it is very difficult to implement this process without computer technology. To do this, first of all it is necessary to build a structure of factors in assessing the value of a residential apartment, which is determined by its comfort.

The goal of the work

Consideration of the main tasks that arise in the analysis of comfort factors that can be used to evaluate a particular selected apartment for sale or purchase.

Presenting main material

Consider a detailed hierarchy of the living environment and identify the main parameters that can characterize the properties of its components.

Thus, the cost of the apartment from the influence of factors on the final price. Their general view is presented in Figure 1.

The comfort of housing is a set of favorable conditions of the external and internal environment for the resident [1].

The convenience of an apartment building is determined by the formation of the main urban parameters, namely:

– Housing security (maintenance of indoor systems);

– Planning the structure of apartments;

– Urban development of residential buildings;

– Density of housing environment;

– Providing the population with infrastructure services [2].

To assess the comfort you need to determine the indicators of housing comfort, ie to identify the main features that characterize everyday life in the apartment for the occupant. In this case, it is necessary to take into account the subjective side of the convenience of an apartment building, which makes the assessment of comfort a rather difficult task [10].

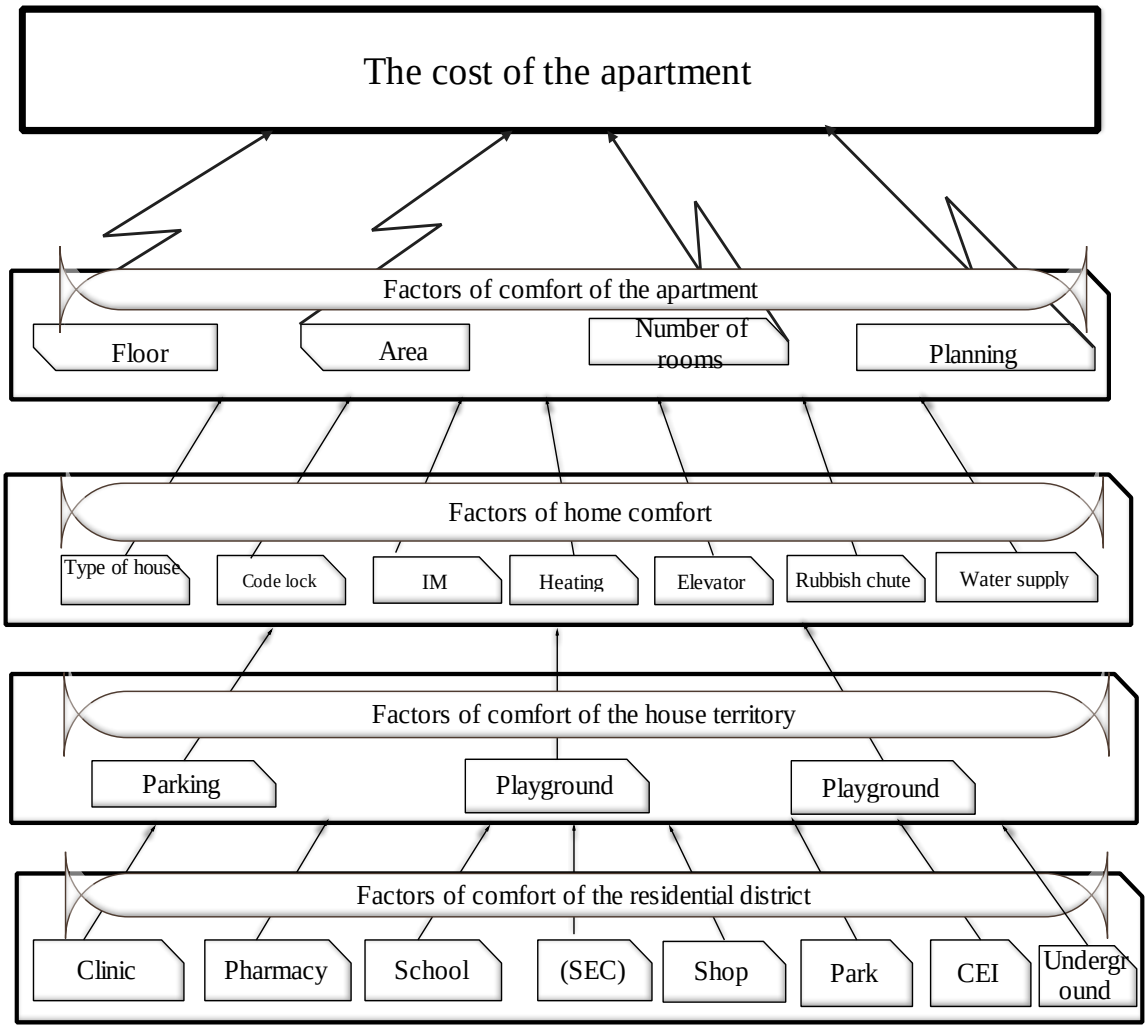


Figure 1 – Determining the value of the apartment according to the hierarchy of factors

For an apartment building, the objective features are enriched by the following parameters [3]:

– Spacious living space (kitchen, toilet, bathroom, number of rooms and other rooms);
– Floor of living;
– Availability of home amenities;
– Good location of the adjacent territory.

The comfort of the urban living environment can be represented in the form of a hierarchy (Figure 1), where its elements are interpreted as follows:

– The root of the hierarchy – the comfort of the living environment;
– Terminal vertices – factors of influence (X1, X2… .. Xn).

These factors can be described as follows: first of all, the price is affected by the location of the house in the neighborhood. The following factors are considered [9]:

– Walking distance to the metro;
– Walking distance to the clinic;
– Walking distance to the pharmacy;
– Walking distance to school;
– Walking distance to the mall;
– Walking distance to the store;
– Walking distance to the park;
– Walking distance to the school;

To work with these factors in the future, the authors suggested that they be considered through pedestrian accessibility. Schematically, all this is shown in Figure 2.

The proposed fuzzy hierarchical model due to the distribution of factors influencing the groups makes it possible not only to determine the level of comfort of the living environment at certain points in time, but also to analyze other important groups of factors [8]:

1. integrated assessment of living conditions in the neighborhood;
2. characteristics of the advantages of the adjacent territory for an apartment building;
3. diversity of the type of apartment building and providing it with both internal and external factors of comfort;
4. characteristics of apartments.

As can be seen from Figure 2, pedestrian accessibility was presented by the authors for further measurements using linguistic variables X:

Pedestrian accessibility = {near, far, far}.

For example, it is necessary to build a fuzzy set, which meaningfully describes the comfort of the neighborhood for future residents of the apartment building. In the terminology of classical sets, the situation is trivial [4-p.37], but in fact the district does not always have parks, shopping malls, etc [4].

Let's try to represent a fuzzy set graphically. To do this, on the horizontal axis, we note the individual values of the elements of the universe of the set X, and on the vertical axis – the values that correspond to the membership function μÁ (x).

As for the definition of the corresponding fuzzy set Á, let's try to assess the degree of subjective attitude to various factors of comfort [4-p.37]: for parks and malls, according to research, their presence is not very worried about future buyers, and the presence in the neighborhood communications, clinics, pharmacies, shops, schools, schools, public transport, subway is associated with residents with a full comfortable stay in an apartment building. [5].

Table 1 presents the linguistic variables that cover the assessment of the comfort of living in a residential building by the hierarchical component, according to Figure 1 and their fuzzy sets and their membership functions, which are constructed in parametric form, in the form of a triangular membership function.

For example, in the future we will choose one fuzzy set, with which we will show and describe the comfort of life in the house.

To determine the level of living in the house, its convenience for future residents is analyzed. Figure 2 above shows all the factors influencing comfortable living. Accordingly, Figure 3 presents a fuzzy set of descriptions of the technical condition of the apartment building.

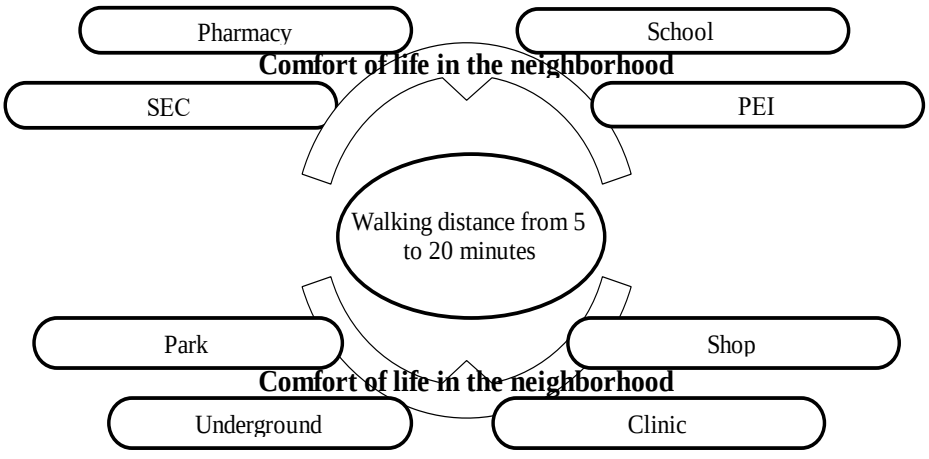
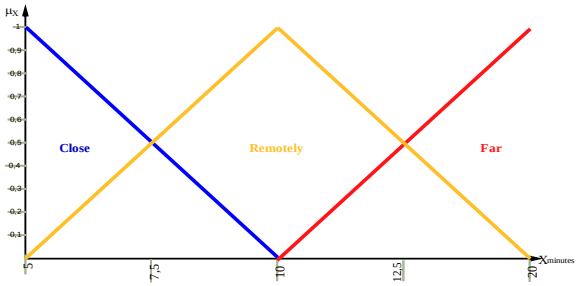


Figure 2 – Assessment of the comfort of life in the neighborhood from the standpoint of pedestrian accessibility

Table 1 – ***Fragment of fuzzy sets and their membership functions for linguisticvariables***

Linguistic variable	Universal plural	The appearance of a fuzzy set
Microdistrict		
Pedestrian accessibility	5 – 20	

Accordingly, it consists of three membership functions, which has the shape of a triangle. To describe the linguistic variable, three membership functions are used, triangular in shape. Accordingly, they have the following terms:

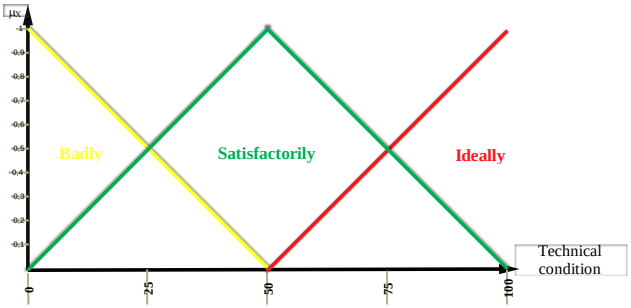


Figure 3 – View of the fuzzy set of descriptions of the technical condition of the house

Table 2 – ***Description of the linguistic variable technical condition***

№	Term of a linguistic variable	X		
		Interval	$\mu_{(x)}=1$	$\mu_{(x)}=0$
1.	Poor	0 – 50	0	50
2.	Satisfactory	0 – 100	50	0,100
3.	Ideal	50 – 100	100	50

Conclusion

According to the considered approaches to the comfort of an apartment building with the use of fuzzy sets, a range of methods has been developed that improve the quality of forecasting the assessment of comfort for future residents to choose a comfortable and cozy home. The main idea is based on the characteristics of input and output variables to construct fuzzy logic [6].

The peculiarity of the use of fuzzy methods in this case is the ability to apply a variety of opinions of people who intend to make or make decisions in the form of fuzzy information.

Fuzzy methods allow us to implement automated process control in this area, which is characterized by large scale, variability, versatility, namely the main forecasting of the accumulated data [7].

Fuzzy set theory as a methodology allows us to increase the accuracy of calculations and effective control. We can use it to use incomplete information about objects and create rules based on the knowledge and experience of experts. One of the areas of such activities is the creation of fuzzy models to manage the process of forming the cost of purchasing an apartment in an apartment building.

References

1. Kruglov, V. V., Dli, M. I., Golunov, R. Yu. (2001). Fuzzy logic and artificial neural networks. Moscow: PHYSMAT, 224.

2. Skofenko, A. V. (2017). On the construction of membership functions of fuzzy sets corresponding to quantitative expert estimates. *Naukovedenie i informatika*. Kyiv: Science.

3. Cheboraka, O. V. (2008). Time series forecasting based on aggregation of interval type-2 fuzzy logic systemsScientific Information for Society – from Today to the Future: Abstracts of the 21st International CODATA Conference. Kyiv: NTUU «KPI», P. 78.

4. Chernyshev, D. O., Kyivska, K. I., Tsyutsyura, S. V., Tsyutsyura, M. I., Gots, V. V. (2019). Introduction of technology of modeling of information objects at stages of a life cycle. *Management of development of complex systems*, 40, 140–146.

5. Tsiutsiura, Mykola, Yerukaiev, Andrii, Hots, Vladyslav & Kostyshyna, Nataliia. (2019). Implementation of a genetic algorithm using product rules. *Management of Development of Complex Systems*, 39, 64–68. dx.doi.org\10.6084/m9.figshare.11340653.

6. Tsiutsiura, Mikola & Yerukaiev, Andrii. (2018). Application of the genetic algorithm for the formation of the membership function of fuzzy sets. *Management of Development of Complex Systems*, 36, 71–75.

7. Kyivska, Kateryna, Tsiutsiura, Svitlana & Kuleba, Mykola. (2020). Analysis of application of artificial intelligence in BIM-technology. *Management of Development of Complex Systems*, 43, 97–103, dx.doi.org\10.32347/2412-9933.2020.43.97-103.

8. Shtovba, S. (2007). Designing fuzzy systems by means MATLAB. Moscow, Russia: Horiachaia lynyia – Telekom.

9. Tsiutsiura, Svitlana, Bebeshko, Bohdan & Khorolska, Karyna. (2020). VR-technology as a modern architecture tool. *Management of Development of Complex Systems*, 42, 69–74, dx.doi.org\10.32347/2412-9933.2020.42.69-74.

10. Nikolajchuk, O. A., Pavlov, A. I. & Yurin, A. Y. (2010). Component approach: production expertise system module. Software Products and Systems, 3, 41–44.

11. Banfi, F. and Oreni, D. (2020). Virtual Reality (VR), Augmented Reality (AR), and Historic Building Information Modeling (HBIM) for Built Heritage Enhancement. *Impact of Industry 4.0 on Architecture and Cultural Heritage*, 111–136. Available: 10.4018/978-1-7998-1234-0.ch005 [Accessed 29 May 2020].

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РОЗРОБЛЕННЯ НЕЧІТКИХ МОДЕЛЕЙ ДОСЛІДЖЕННЯ СУБ'ЄКТИВНОЇ ОЦІНКИ КОМФОРТНОСТІ В СЕРЕДОВИЩІ SCILAB

Анотація. *Сучасний стан будівництва та проєктування багатоквартирних будинків не охоплює всі потрібні фактори комфортності життя у квартирах, якими керуються майбутні мешканці при купівлі. Зазвичай застосовуються кількісні критерії, надмірна кількість яких, на жаль, не може суттєво покращити ситуацію, що склалася на сьогодні між усіма зацікавленими сторонами: будівельниками, компаніями з продажу готових квартир, їх власниками та покупцями. У статті розглянуто технологію нечіткого опису невизначеності, що виникає у процесі оцінювання комфортності багатоквартирного будинку із застосуванням спеціальних програмних продуктів з метою опрацювання результатів, отриманих від нечітких множин. Виконаний порівняльний аналіз кількісних і якісних показників комфортабельності, які визначаються в умовах невизначеності, дав змогу дійти висновку, що складний процес прийняття оптимального рішення при використанні математичних методів, що побудовані на чіткій логіці, не дає необхідних результатів. Тому при оцінюванні всіх факторів, що впливають на комфортність житла, пропонується застосовувати нечітку логіку і вибрати функції, які за певних вхідних параметрів відповідають представленим формалізованим термам у їх дослідженні. Теорія нечіткої логіки надає змогу відображати різні методи побудови нечітких множин для потреб оцінювання комфортності житлових квартир за допомогою обчислення нечітких чисел. Суб'єктивна логіка є також неадитивною теорією невизначеності, універсальним інструментом для моделювання, на основі якого і будується предметне дослідження оцінки зручності проживання в квартирах. Крім того, нечіткі множини мають зручний математичний апарат, що надає змогу описати багатозадачність в будь-якій інформаційній системі. Застосування нечітких множин при дослідженні розглянутої предметної області покращили багатокритеальну оцінку якості комфортності багатоквартирних міських будинків, а також допомогли привести методи оптимізації для потреб користувачів, тобто власників та покупців квартир. Отже, нечіткі множини здатні набувати будь-які значення лінгвістичної змінної, що включає в себе визначені терми для опису комфортності житлових квартир*.

Ключові слова: ієрархія впливу факторів; комфортність; нечіткі множини; лінгвістичні змінні; терми

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