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SYNERGY OF ARCHITECTURE & CIVIL ENGINEERING
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International Conference

Synergy of Architecture & Civil Engineering

Niš (SERBIA) - Science & Technology Park Niš - September 14-15, 2023

PREFACE

The primary goal of the SINARG 2023 conference is to present contemporary achievements in the scientific and practical aspects of architecture and civil engineering. The organizers of the conference aimed to facilitate the participation of both national and international professionals in theoretical and experimental research related to the processes of design, project management, construction, and building maintenance within the construction industry.

Simultaneously, this scientific conference serves as a platform for exchanging experiences and information regarding innovations and advancements in planning, design, new materials, and construction and reconstruction technologies within the fields of architecture and civil engineering.

Therefore, this conference should serve as a forum where experts from civil engineering, architecture, and other related fields have the opportunity to present the results of their research. In that context, conference topics have been carefully selected to provide focus on current issues in the field and encourage productive discussion bringing fresh and original insights and concepts to the forefront.

More than 180 paper proposals have been submitted to the conference. A single-blind review process was used to assess the full papers. The reviewers are esteemed scientists holding PhD degrees in the same field as the paper's topic. There are more than 70 reviewers from ten countries who have significantly contributed to the scientific quality of the conference, and their names are printed in the proceedings.

A total of 142 full papers have been accepted for publication. Some of the papers have been selected for publication in our journals, with nineteen papers in Facta Universitatis: Architecture and Civil Engineering and nine in the Journal of the Faculty of Civil Engineering and Architecture. The conference proceedings consist of 114 papers divided into two volumes.

The total number of authors and co-authors accepted for publishing at SINARG 2023 exceeds 320. Out of this number, more than 80 authors come from abroad, representing 19 countries (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Germany, Greece, Hungary, India, Indonesia, Netherlands, North Macedonia, Montenegro, Oman, Poland, Romania, Serbia, Slovakia, Turkey, United Kingdom).

The editors express their gratitude to all the authors for their participation and to the reviewers for their valuable comments, which have contributed to the improvement of the original manuscripts and have enhanced the overall quality of the conference..

Niš, September 2023 *Editors*

CONTENTS

FUNCTIONAL ORGANIZATION OF MEDIUM-SIZED APARTMENTS IN NEW CONSTRUCTION IN SERBIA

Hristina Krstic[1], Branislava Stoiljkovic[2], Natasa Petkovic[3], Vladana Petrovic[4]

Abstract

The paper deals with the analysis of the functional organization of medium-sized (about 55 m^2) newly built apartments in the Republic of Serbia. The research was conducted through a comparative analysis of 8 selected examples of apartments from the territory of the City of Nis, one of the largest cities in Serbia. Analyzed apartments are chosen based on the criteria of total net area, as well as the diversity of the organizational scheme. The aim of the research is to review the current situation in the field of residential architecture in Serbia and to find out whether newly built apartments meet all the needs of their users. The scientific methods applied in the work are analysis, synthesis, comparison, observation, modeling method and survey. The research came to the conclusions that in the design of medium-sized apartments it is aimed the maximum use of space, that the degree of flexibility of the apartments is low and that a large number of medium-sized apartments offered on the market often do not meet all the criteria prescribed by the current regulations. Based on the conclusions, at the end of the paper were given some proposals for regulation amendment and suggestions on the necessity of greater involvement of competent authorities in the control of market apartments.

Key words: *medium sized apartments, functional organization, newly built apartments in Serbia*

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1. INTRODUCTION

The topic of the paper are *medium-sized apartments* (a term introduced for research purposes that refers to apartments with an area between 45 m^2 and 65 m^2, that is, with an average area of around 55 m^2), the most popular in housing construction and apartment sales in the current situation of the City of Nis and the Republic of Serbia. The research deals with the analysis of the functional organization of such apartments, the degree of their flexibility, as well as the possibility of adaptability to the current needs of the users. The aim of the research is to review the current situation in the field of residential architecture in Serbia, as well as to find out whether newly built apartments meet all the needs of their users. The research was carried out on the territory of the City of Nis, which, as one of the largest cities in Serbia, was selected as a representative sample, whose circumstances can be mirrored to a greater extent on the circumstances of the entire country.

Based on the number of currently active construction sites (Figure 1), the offer of newly built apartments and apartments under construction that can be found by searching real estate sales websites and investor websites, as well as the empirical experience of problems related to housing construction in Serbia, it can be concluded that the demand for apartments on the territory of the city of Nis in recent years has been in expansion. The reason for this can be found in the constant migration of the population from the countryside to the city, the development of Nis as a leading center of the IT industry in the region, the opening of several factories, the role of Nis as the university city, increased investment in real estate due to the global economic crisis after the COVID pandemic and increased inflation.

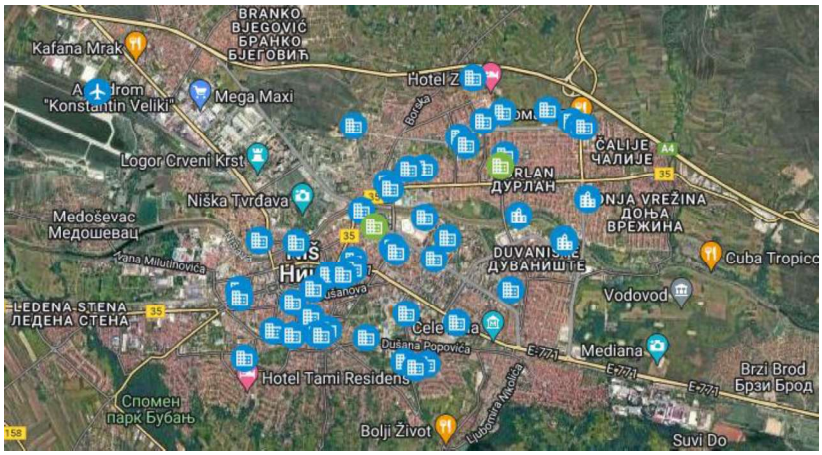

Figure 1. The map of active construction sites in the City of Nis, source: https://www.gradnja.rs/mapa/, *(accessed: 20.6.2023.)*

According to the data of the *Statistical Office of the Republic of Serbia (RZS)* [1], the average area of sold newly built apartments in 2022 on the territory of the Republic of Serbia was 57 m^2. Based on the data published on the *RZS* website, the average area of newly built apartments sold in 2022 on the territory of the Belgrade municipalities of Vozdovac, Zvezdara, Palilula and Rakovica was, respectively: 56 m^2, 52 m^2, 55 m^2 and 54 m^2. The situation is similar in other major cities of the country: in Novi Sad - 55 m^2, Kragujevac - 54 m^2, in the municipalities of Pantelej and Medijana in Nis - 55 m^2. In Nis, the users of the largest number of newly built *medium-sized apartments* are young married couples with or without children, or

couples who are in the initial phase of starting a family (for example, in a survey conducted for research purposes in one of the parts of the residential buildings in Vojvodjanska Street in Nis, constructed in 2018, out of 8 apartments, as many as there are, only one apartment is occupied by elderly users, while the users of the other apartments are primarily couples with small or school-aged children).

1.1. Apartment as one of the basic prerequisites for a normal life

According to G. Knezevic [2], the issue of meeting the needs and the right to housing worthy of a human being is the most significant after the issue of hunger. B. Nestorovic [3] points out that in a series of complex social problems, human housing occupies one of the most important places. Dealing with the issue of housing in post-war socialist Yugoslavia, he talks about how the life of the family, both in terms of health and social aspects, depends primarily on housing conditions, adding that these conditions indirectly extend to the spiritual development of the family and the whole society. Taking into account that housing takes up 70-75% of a person's life, and is expressed in various manifestations that are conditioned by the physiological, sociological and psychological needs of a person, he underlines that, from a sociological point of view, it cannot be considered that the problem of housing is solved only by the existence of sufficient number of apartments, i.e. rooms for living, but also by the fact that those apartments really have conditions for living, because: "it is not the same whether a family lives, eats and sleeps in one same space, or in several spaces, which have their own specific purposes". According to him, in modern society, an apartment cannot be understood only as a "roof over the head", but as the possibility of housing under modern social conditions, which, on the one hand, are in accordance with the technical progress of our time, and on the other hand, with the rights of a free man. Also, as he says, housing is the result of the general social culture and economic progress of the people, and it has a direct impact on the development of man, family and the entire social community.

Dealing with the analysis of the apartment as a whole, M. Baylon [4] highlights some elements that have an impact on the quality of the apartment: 1) the communication between basic groups of rooms (group of the living room, group of rooms for sleeping and hygiene, group of rooms for the household, which also includes the kitchen) has to take place as smoothly as possible, without large distances and without many intersections; 2) the connection between individual rooms in one group has to be as short and simple as possible, without unnecessary corners (in communication), and without passing through other rooms; 3) the usability of certain rooms for a specific purpose has to be quantitatively and qualitatively good (maximum) considering the size of the room.

2. RESEARCH

The research is based on the analysis of functional organization of selected examples of newly built apartments in Nis, whose area varies between 50 m^2 and 60 m^2. For the purposes of the research were selected 8 apartments, which fit into the given square footage, and whose organization schemes vary among themselves (Figure 2). The floor plan drawings of the apartments were found on the websites of the investors, where they were displayed in the catalog of apartments for sale, or

were made based on the recordings. The apartments were chosen based on the diversity of the organizational scheme and the diversity of the structure.

Apartment number 1, with an approximate net area of 53 m^2, is designed as a two-room apartment (typology of apartments according to the current Rulebook in the Republic of Serbia based on the apartment's structure [5] [5]). The living room, dining room and kitchen are combined into one unit (open space concept of living area) from which the open area is accessed. The bedroom is designed as a double room and has the possibility of creating a mini work corner on the side of the window. Access to the bedroom, bathroom and living area is possible through the entrance part of the apartment, which reduces the area of communications in the apartment to a minimum. All square footage prescribed by the Rulebook have been met.

Apartment number 2, with an approximate net area of 53 m^2, is also designed as a two-room apartment. The living room, dining room and kitchen are also combined into one unit. Although in this example the living area, bedroom and bathroom are accessed through a common entrance hall, the night area of the apartment is formed in a better way compared to the previous example, because it is separated from the living area. The path from the entrance to the apartment to the living room is straight and direct, so that, with the elongated geometry of the corridor, it was possible to differentiate the basic zones in the apartment. The open area is connected to the living room. The dimensions of the kitchen and bedroom are debatable, as they are slightly below the minimum prescribed by the Rulebook. For the given structure, the minimum prescribed width of the living room is 340 cm, and we can take this condition as satisfied in the given apartment, only if we take into account the area belonging to the dining area, as communication around the table.

Apartment number 3, with an approximate net area of 50 m^2, is designed as a two-and-a-half-room apartment, although according to the Rulebook, the minimum area of an apartment of that structure should be 56 m^2. The living room, dining room and kitchen are also here united into one common space, but their total area does not meet the minimum required by the Regulations. What can be ascertain as unfavorable in the functional organization is the peripheral position of the entrance to the apartment, which affects the lack of zoning of the apartment into day and night parts. The path to the living area is long, and in order to get there one has to go pass by every room. The entrance to the bathroom is positioned right in front of the front door, which spoils the first impression after stepping into the interior of the apartment. Also in this case, the open area is connected to the living area. The width of the kitchen is almost 30 cm below the prescribed minimum, which is half of the modular measure.

[5] According to the current Rulebook, an apartment, based on its structure, can be:
1) studio apartment (entrance, multipurpose room with space for food preparation (kitchenette) and bathroom);
2) one-room apartment (entrance, food preparation area (kitchen), multipurpose room with dining area and bathroom);
3) one-and-a-half-room apartment (entrance, food preparation area (kitchen), living room, dining area, room for one person and bathroom);
4) two-room apartment (entrance, food preparation area (kitchen), living room, dining area, bedroom and bathroom);
5) two-and-a-half-room apartment and larger (entrance, food preparation area (kitchen), living room, dining area, bedrooms, bathroom and toilet).

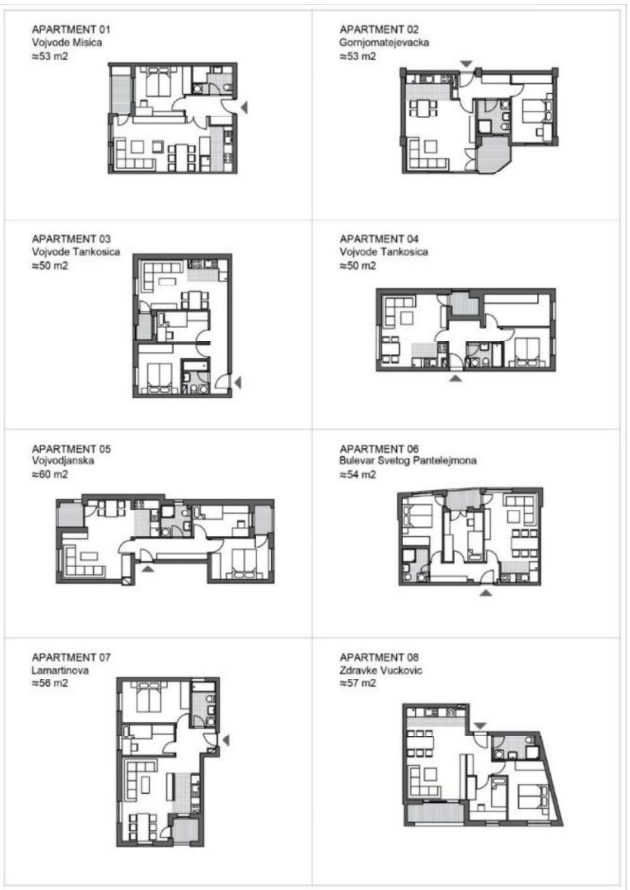

Figure 2. Floor plans of the analyzed apartments, source: drawings are authors' interpretation

Apartment number 4, with an approximate net area of 50 m^2, is also designed as a two-and-a-half-room apartment, with the total net area below the one required for such a structure. The central position of the entrance creates the conditions for an adequate division of the space into day and night zones. The living room, dining room and kitchen, arranged within the same space, do not meet the minimum required area. The width of the living room and kitchen are below the minimum dimensions. The room designed as a parent's room does not meet the required minimum area, as well as the prescribed dimensions. It is impossible to fit a wardrobe in it. Although the adjacent room in the drawing of the floor plan is shown as a cloakroom, it is evident that in practice it will be used as a children's room, for which it is suitable both in terms of square footage and dimensions. The open area is positioned between the day and night zones, and is only accessible through the living room.

Apartment number 5, 60 m^2 in basis, is designed as a two-and-a-half-room apartment. Its advantage is three-sided orientation, which enables cross ventilation and the fact that it has two balconies, which is rare for this type of structure and apartment's net area. The entrance part is placed centrally, and in relation to it, the apartment is divided into two zones. An elongated hallway divides the apartment space into day and night spaces, at the same time serving as a storage space or an additional wardrobe. The problem arises because the entrance part is not separated, but occupies a part of the mentioned corridor, which is imposed as the main line of communication through the apartment. One must pass through it on the way to a

certain room, which causes the crossbreeding of clean and dirty paths. In Serbian culture, the habit of tenants taking off their shoes after entering the apartment is widely presented, primarily for hygiene reasons. After entering apartment, the users take off their shoes and put on the home shoes. In this way, the entrance area is considered a dirty area of the apartment, because it is accessed in shoes that were previously used outside.

Apartment number 6, with an approximate net area of 54 m^2, is designed as a two-and-a-half-room apartment, although according to the Rulebook, the minimum required area for an apartment of that structure is slightly larger - 56 m^2. The day area is clearly separated from the night area and unites the living room, dining and kitchen in a common area. It is accessed directly from the entrance. The night zone, although not separated by a door, is clearly divided from the living room in the spatial organization of the apartment. It consists of two bedrooms and a bathroom. Due to the absence of an additional toilet, the bathroom is also used from the living area, which overlaps the domains of the day and night areas. A balcony is inserted between the day and night zones and can be accessed from all the main rooms. Although the good position of the entrance part impacted adequate zoning in the apartment, the fact that it is not clearly secluded (it is an integral part of the corridor from which is the access to individual contents) affects, as in the previous example, the intersection of frequency communication lines and the mixing of dirty and clean paths. In this example, we can see a deviation from the prescribed minimum areas in the part of the living room, kitchen and dining room, as well as in the parents' bedroom, which also lacks adequate width. The children's room is intended for one person, although due to its width, with a slight increase in length, it can grow into a room where there would be a space for two children.

Apartment number 7, with an approximate net area of 56 m^2, is designed as a two-and-a-half-room apartment. The living room and dining room are combined into one space, connected to the kitchen. The wall between the kitchen and the living room, besides allowing the living room to complement the contents, creates an interesting circular connection of these rooms with the entrance area. The entrance is slightly pushed out in relation to the longitudinal axis of the apartment, which makes it possible to separate the dirty from the clean area to some extent. Although the day zone, due to its position in the apartment, is clearly separated, the night zone is not formed as a separate one, but the bedrooms are accessed directly from the entrance. Also here, the bathroom is the only sanitary room. Deviations in the area occur in the living room and dining room, and in the width of the room in the parents' bedroom.

Apartment number 8, with an approximate net area of 57 m^2, is designed as a two-and-a-half-room apartment. The living room, dining room and kitchen, linearly strung together, are united within the same space, which is followed by an open area, the length of which follows the width of the mentioned contents. Also here, there is no clear zoning in the part of the bedrooms, so there is no distinctly formed night zone, although it is separated from the day contents. The entrance hall is part of the corridor that leads to the bedrooms. It is not physically emphasized, so it is a place that is often passed when moving through the apartment. The position of the bathroom, right across the dining room, creates a bad visual connection, where the dining table and the bathroom door are in direct visual contact, which should be avoided. Although the kitchen and dining room are in the same space and their areas

for communication are united and overlap, it is still clear that the width of the communication area in the kitchen is far below adequate. We can see the debatable dimensions of the space in the living room and the parents' bedroom.

Table 1. Tabular overview of analyzed parameters in apartments

	AP. 01	AP. 02	AP. 03	AP. 04	AP. 05	AP. 06	AP. 07	AP. 08
approximate net area (m^2)	53 m^2	53 m^2	50 m^2	50 m^2	60 m^2	54 m^2	56 m^2	57 m^2
apartment's structure	two-room	two-room	two-and-a-half-room	two-and-a-half-room	two-and-a-half-room	two-and-a-half-room	two-and-a-half-room	two-and-a-half-room
minimum required area of the certain apartment's structure according to the regulations (m^2)	48	48	56	56	56	56	56	56
number of bedrooms	1	1	2	2*	2	2	2	2
number of bathrooms	1	1	1	1	1	1	1	1
number of toilets	0	0	0	0	0	0	0	0
number of balconies	1	1	1	1	2	1	1	1
living room + dining room approximate net area / minimum required area according to the regulations (m^2)	22.89 / 16+4	21.77 / 16+4	16.49 / 16+4	17.20 / 16+4	21.10 / 16+4	17.93 / 16+4	18.18 / 16+4	19.50 / 16+4
kitchen approximate net area / minimum required area according to the regulations (m^2)	5.10 / 4	4.85 / 4	3.67 / 4	3.25 / 4	4.16 / 4	3.75 / 4	4.57 / 4	4.65 / 4
bathroom approximate net area / minimum required area according to the regulations (m^2)	4.90 / 3	4.79 / 3	3.56 / 3	3.45 / 3	4.28 / 3	4.15 / 3	4.74 / 3	4.86 / 3
parents' bedroom approximate net area / minimum required area for two persons bedroom according to the regulations (m^2)	11.65 / 11	12.16 / 11	11.16 / 11	8.12 / 11	10.40 / 11	10.65 / 11	12.58 / 11	12.13 / 11
children's bedroom approximate net area / minimum required area for one person bedroom according to the regulations (m^2)	/	/	7.16 / 7	9* / 7	8.16 / 7	9.05 / 7	7.31 / 7	7.48 / 7
entrance + corridor approximate net area (m^2)	5.23	5.47	6.77	6.20	6.85	6.35	6.71	4.59
balcony approximate net area (m^2)	4.03	4.46	1.70	2.56	2.83 + 2.32	2.97	2.61	4.47
parents' bedroom width / minimum required width according to the regulations (cm)	330 / 280	275 / 280	284 / 280	268 / 280	273 / 280	270 / 280	273 / 280	270 / 280
children's bedroom width / minimum required according to the regulations (cm)	/	/	210 / 210	210 / 210	217 / 210	260 / 210	210 / 210	260 / 210
living room width / minimum required according to the regulations (cm)	365 / 340	280 / 340	340 / 340	270 / 340	310 / 340	360 / 340	339 / 340	275 / 340
kitchen width / minimum required according to the regulations (cm)	220 / 170	167 / 170	143 / 170	155 / 170	165 / 170	140 / 170	170 / 170	120 / 170

3. SURVEY

For the purposes of the research, a survey was conducted in one of the parts of the residential buildings where the analyzed apartment number 5 is located. This building, completed in 2018, was selected for the survey because one of its parts contains apartments of approximately the same area and similar organization, which was convenient to create a picture of how different users experience spaces with a similar functional organization. Building part consists of 4 residential floors, with two apartments each (of net area ranging from 46m^2 to 60m^2). Out of a total of 8 apartments, 6 were surveyed (the first floor was omitted, since its functional organization deviates from the functional organization of other floors). Figure 4 shows the plan of one building's floors. The apartments on one floor are mostly designed according to the principle of mirroring the scheme in relation to the longitudinal axis, with slight variations.

The users of the apartments belong to the younger and middle-aged population (up to 55 years of age), and are mostly married couples with and without children. The questions that were asked through the survey are as follows:

1. Does the functional organization of the apartment meet the needs of all users in the apartment?
2. Are you satisfied with the size of the apartment in relation to its current number of users?
3. Are you satisfied with the design of the entrance part in the apartment?
4. Are you satisfied with the size of the living room and dining room in the apartment?
5. Are you satisfied with the size of the kitchen in the apartment?
6. Are you satisfied with the size of the bathroom in the apartment?
7. Are you satisfied with the size of the bedroom/bedrooms in the apartment?
8. Are you satisfied with the size of the open area/open areas in the apartment?
9. Do you think that the absence of additional toilet in the apartments is justified?
10. If your apartment does not have a separate workroom, do you think that within some area of the apartment (bedroom, living room...), it is possible to organize a "work corner" that suits you?
11. Do you think that the day (living room and dining room) and night areas of the apartment (bedrooms) are adequately separated?
12. Do you think that your apartment is flexible enough to adapt to the future needs of users?

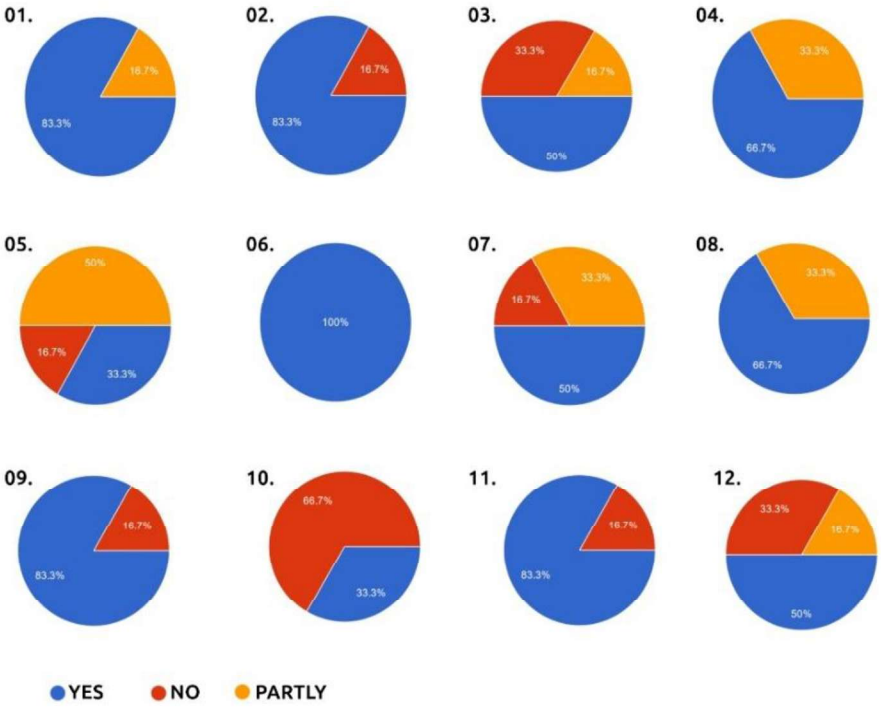

Figure 3. The results of the survey shown in graphics - answers to questions 1-12*, source: authors*

The following results emerged from the survey (Figure 3): About 80% of respondents estimate that the functional organization of the apartment meets the needs of all users in the apartment. 20% deem that the functional organization partly meets the needs of all users, and the small area of the children's room is cited as one of the reasons. Compared to the current number of users, over 80% of respondents are satisfied with the size of the apartment. When it comes to individual parts of the apartment, 50% of the respondents consider the entrance part not being designed according to their needs. As an explanation for this answer, they state: "problem in hygiene", due to the overlapping of the paths, as well as the fact that it is not clearly separated. 1/3 of respondents are not completely satisfied with the size of the living room and think that it is small when there are also guests staying in the apartment. Only 1/3 is satisfied with the size of the kitchen in the apartment, while the rest of the respondents believe that the kitchen is small and that there is a lack of work space in it. The size of the bathroom was assessed by all respondents as satisfactory. Half of the respondents said that the bedrooms are small and not enough functional. 2/3 of users rate the size of the open areas in the apartment as adequate, but cite comments such as: "it would be nice if the loggia was larger" and "if open spaces were bigger, they would be more functional". More than 80% of respondents do not think that the lack of a toilet, in addition to a bathroom, is unjustified. They agree that it is better to increase the area of other facilities at the expense of the omitted toilet. 2/3 of respondents states that there is no place in the apartment to insert an adequate work corner, 83.3% say that they are satisfied with the zoning of the apartment, and 50% are of the opinion that the apartment is not flexible or is partially flexible to adapt to the future needs of users: "The apartment is

ideal for a family of four while the children are younger and can share a children's room”; "due to the minimal dimensions, it is difficult to add any content".

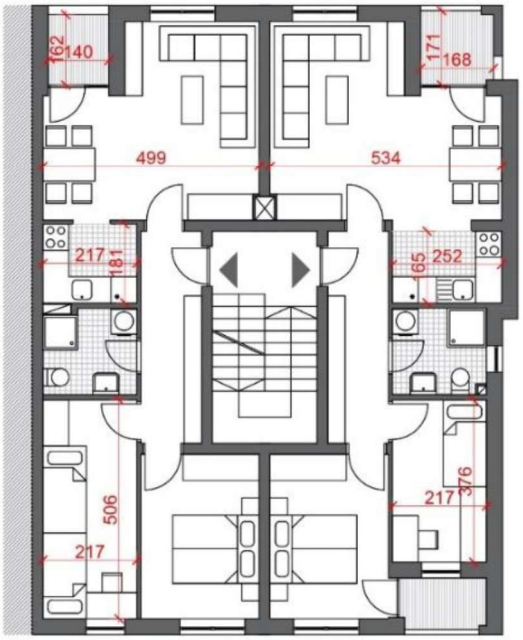

Figure 4. Apartment number 5 within the floor assembly, source: drawing is authors' interpretation

4. DISCUSSION

The analyzed apartments were taken as a representative of the currently most demanded apartments in terms of net area on the market. Their structures are such that they correspond to the number of users from 2 to 4, which would mean that they correspond to the needs of those who most often buy them, namely young married couples at the beginning of family formation. By comparing the total net area of the apartment and the contents placed in it, it can be concluded that the degree of utilization of the space of the apartment is maximal, but, in that regard, the question can also be raised as to whether this affects the quality of the living space. Based on the previous analysis, we can look for an answer to that question.

In the largest number of analyzed apartments, it is noticeable that the surfaces of daily contents are below the minimum, while in the rest of the examples they are on the border with the minimum. This is also logical, given that the emphasis in all design solutions was placed on the formation of as many bedrooms as possible, so the surfaces of the daily contents had to be reduced. In all examples, an open space variant of the organization of daily contents is observed, that is, the unification of the kitchen, dining room and living room into one unit. This also affects the more rational use of surfaces, because the communications within the given spaces overlap and compress each other. According to G. Jovanovic [6], the number of seats at the table in the dining room, as well as the number of seats in the living room is determined by increasing the number of household members by two. However, in many examples, in the dining area, there is no possibility to extend the table for two additional places for guests. In 5 out of 8 analyzed apartment designs (Figure 6), the

widths of the living rooms are below the minimum (in apartment number 4 the deviation is as much as 70 cm), which cannot be justified in any way, having in mind the importance of these contents in the functioning of an apartment - the living room and the dining room are gathering places for all family members, and sometimes guests too. Deviation in the prescribed dimensions of the bedrooms, especially double parental bedrooms, is evident in 6 out of 8 analyzed examples (Figure 5), which affects the non-functionality of the spaces themselves, that is, results in tight communications and inadequate working dimensions of the usable spaces. According to the Rulebook [5], in two-and-a-half-room and larger apartments, it is necessary to design at least one room for two people with a minimum width of 280 cm. Also, 6 out of 8 analyzed examples have a problem with the inadequate width of the kitchen, which disables adequate work in the kitchen, and which, due to the minimal area, barely manages to accommodate the most basic kitchen elements. The dysfunctionality of the kitchen was also shown by the results of the survey, in which users highlighted the lack of a work surface as the main comment. Slight increasement in dimensions in the kitchen could significantly improve its functionality, without particularly affecting the final area of the apartment. If we look at the sketch of the two neighboring apartments in Figure 4, we will see how a slight overhang in the part of the apartment number 5, of only about 30 cm, in the part of the dining room and kitchen, made for the reasons of architectural shaping of the building, significantly influenced the improvement of the functionality of the mentioned spaces. The kitchen was provided with a larger work surface, which, when it comes to spaces on the border of minimal dimensions, is significant, even though it was only half of the modular size.

In all cases, children's rooms are designed as rooms for one person, which is justified considering the total net area of the apartments. However, in certain examples, in which the rooms are not reduced, but their width enables the formation of two-bed organizations, with minor interventions in their length, there is a possibility of creating children's rooms in which two children could fit. Again, the question of the durability of such a solution arises here, because children should be separated after a certain age. According to D. Ilic [7]: "It can be considered optimal that a child after the third year should have his own room, which first of all represents a bio-physiological need, but it partly satisfies the needs of other natures, and at the latest with the sixth year, because over that age, the parents objectively perceive the child's stay in the parents' room as a disturbance, with all the negative consequences that such a feeling can cause. With the birth of the second child, the need for a separate room for the first child is immediately actualized, regardless of age. Children of different genders should be in separate rooms from the beginning, and at the latest when the older child reaches the teenage age (10 years). In the teenage years, there is an intense need for independence, which is why children of the same genders should have their own separate rooms (at the age of 12-14 at the latest).

As a positive comment on the analyzed designs, it can be singled out that all apartments are designed with an open area, despite the fact that the Rulebook does not set any condition for this. If we take into account that apartments, unlike houses, do not have yards, the open area is an element that plays an important role in the apartment, as a basic connection with the outside environment. However, what is debatable are the dimensions of the designed open areas, which to a large extent, inadequate sizes, can reduce the functional value of open spaces.

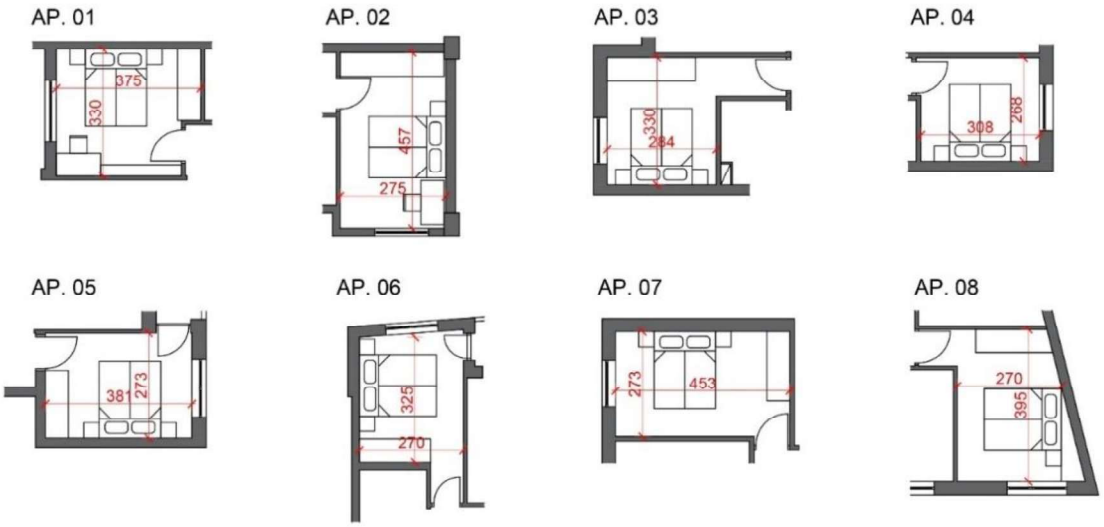

Figure 5. Analysis of the dimensions of the parents' bedroom in apartments*, source: drawings are authors' interpretation*

Figure 6. Analysis of living room, dining room and kitchen dimensions in apartments*, source: drawings are authors' interpretation*

What is noticeable in all the examples is the problematic design solution of the entrance part. Again, due to the tendency to reduce the total area of the apartment, the entrance part is usually merged with the corridor, which is the main communication through the apartment. From the entrance door, one enters the apartment directly, there is no vestibule that would serve as a buffer zone between the inner private space of the apartment and the common communications in the building. In the survey, there are also comments that dirty and clean paths in the apartment intersect at the entrance, which affects the hygiene of the apartment (Figure 7a).

Figure 7. a) The entrance as a place where communications are intersected*; b)* Potential modifications within the daily zone; *c)* Potential place to form a work corner*, source: drawings are authors' interpretation*

When it comes to the flexibility and adaptability of the space to new needs of the users, it can be said that its degree is very low, and the reason for this is found in the minimal areas of each individual room. However, some smaller changes can be made, which could affect the improvement of the original design solution. An example is given for the apartment number 5 (Figures 7b and 7c). By inserting a counter between the kitchen and the dining room, it is possible to increase the working surface of the kitchen, as well as the storage space that would be found under the counter. In this way, the kitchen gets another lane to work on, which relieves its initial workload. By combining the living room and the dining room as a whole, it was possible to compress the communication spaces in these rooms, leaving enough space to add two more seats to the dining table. By rotating the direction of door opening towards the living room, in addition to better views when entering, the space on the left side of the entrance to the living room becomes more functional, and if necessary, it can also be used to create a work corner. (Figure 7b) It is possible to create a mini work corner in the bedroom, on the side of the window, by throwing out the bedside table, using a bed with a smaller width (140 cm) and moving it as far as possible towards the closet. (Figure 7c)

5. CONCLUSIONS

Regardless of diversity of the design solutions, it can be concluded that the functional schemes of *medium-sized apartments* are essentially very similar:

- The daily zone is separated and designed according to the principles of the open space concept, combining cooking, dining and living area. These 3 contents are usually linearly connected to each other, so that the dining room is located between the living room and the kitchen and has indirect lighting. A more favorable variant, in terms of natural lighting and ventilation, is the one where the living room and dining room are lined up so that they both lie on the façade plane.
- The rooms in the apartment are most often accessed through the same corridor. The central position of the entrance divides the corridor into two

zones that form the day and night part of the apartment. If the position of the entrance is moved peripherally, the zoning is broken.

- *Medium-sized apartments* are the most comfortable if they contain only one bedroom. As the tendency in practice is to gain the maximum number of bedrooms for the same net area, apartments generally have two bedrooms, one of which is at least 210 cm wide, the so-called reduced room. This certainly affects the reduction of the area of other content in the apartment.
- The toilet is often left out of the design solution, even though its necessity in certain apartment's structures is prescribed by the regulations.
- An open area occurs next to the living area, and can often be additionally accessed from bedrooms.

In practice, it has been shown that when designing two-room and larger apartments, toilets are often omitted. User experience shows that in apartments with two bedrooms, there is no need for an additional toilet. At the expense of the toilet, the areas of other contents can be increased, which can be considered justified when designing medium-sized apartments. In this regard, as one of the conclusions of this research, stands out the proposal to omit the requirement that two-and-a-half-room apartments must have a toilet in addition to a bathroom from the Rulebook. Also, due to the importance of the existence of open areas in the apartment, what was especially imposed as important during the lockdown situation caused by recent global COVID pandemic, the proposal is to introduce to the Rulebook an obligation to design open areas within the apartment, and to define their minimum dimensions, in order to make them be functional. The problems encountered at the entrance to the apartment indicate that during the design process, special care should be taken to give greater importance to this part of the apartment, because it is the first contact with the apartment and the place of transition from one environment to another.

In a large number of medium-sized newly built apartments, there is noticeable a deviation in terms of area and dimensions from the minimum values prescribed by the Regulations, that is, the apartments do not meet the minimum conditions prescribed by the Regulations. In this regard, as a general conclusion of the research, it is stated the necessity of engaging professionals, which would carry out a detailed control of the facilities before granting the use permit.

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