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Trends in implementation of municipal development projects: the Kosovo experience

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Abstract

Municipal development projects in Kosovo implement local legislation and European standards and good practices. However, the issue of good quality remains a challenge in terms of both, procurement practice and technical standards. This paper attempts to highlight these challenges through analysing municipal audit reports in matters of public procurement of development project, and by identifying, grouping and interpreting key problems emerging from reports. Results show that challenges surface as early as in project inception phase. Also, the trend in addressing procurement challenges is slightly positive, while technical and environmental considerations including aspects of good design remain unaddressed. The paper is mainly trying to disclose the situation in implementing municipal development projects at a national level, and to draw attention about the need for enhancement in critical phases of project cycle management.

Key words: municipal development project, municipal audit report, good quality, Kosovo

1. Introduction

Municipalities have a key role in shaping up urban built environments through development projects. Kosovo Municipalities also enjoy great chances to develop sustainable public projects due to their legal mandate as basic units of local self-government, as defined in the Law on Local Self Government, Article 4 [1] and due to their right to manage their property Article 14 [1]. Based on this Law, other functional laws in Kosovo with a remit on the development of urban and architectural projects, give municipalities the responsibility for implementation of projects in their respective territories. Specifically, the Law on Spatial Planning attributes the municipalities the responsibility to develop and implement local level plans that is Municipal Development Plans, Municipal Zoning Map and Detailed Regulatory Plan, Article 13 [2]. The Law on Construction on the other hand authorizes municipalities to issue permits for all construction works [3], except for those defined in Annex No.1 as "of high risk and of national interest" reserved by the Law for Central Government Institutions [3].

This self-governance model provides for a favourable legal environment for municipalities to develop qualitative architecture and urban planning projects, similar to the majority of countries in South East Europe; nonetheless, although the transfer of land ownership to local governments is a process which most of countries in the region have undergone, the state still plays a dominant role in controlling the planning process, until further democratization. [4].

Kosovo legislation in general, and in the field of management of public urban architecture projects in particular, is not only compliant to but also promotes application of European standards and good practices. The Law on Spatial Planning stipulates that "international principles of spatial planning, sustainable development and governance should be in harmony with EU norms" Article 4 [2]. Also, the Law on Construction, , Article 6 stipulates that The Unified Construction Code considers the EU technical standards and international best practice [3]. In addition, the Law on Public Procurement, based predominantly in European models and practice, clearly defines requirements for compliance with European standards. Furthermore, the Law, in the Article 28 demands that Kosovo implement a European standard in training of Procurement Officers and in drafting of Technical Specifications; it refers to the aforementioned, or to any other technical reference system as produced by European standardization bodies [5].

Despite the solid legal base, which guides the implementation of development projects in

accordance with European standards and good practices, the issue of quality assurance in public procurement of municipal development projects remains a challenge. In the field of architecture and urban infrastructure, there is a perception that the lack of quality in implementation of public projects is largely conditioned by the municipal procurement practice which is awarding projects based mainly on the 'lower price' criteria, which according to architects, undermines largely issues related to good design and sustainability. Although the award decisions for architectural services in Kosovo favours the economic-financial criteria, the Procurement Law, in fact, allows for qualitative indicators to be considered. According to the Law, Article 60, the award of contract is based on (i) the least priced responsive tender, or (ii) the most economically advantageous tender. [5].

The problem of economic-financial criteria perceived as an obstacle to adoption of qualitative indicators in public procurement of architectural service is an issue that has been discussed likewise in well-established democracies, which generally develop good practices in public project management. Researches indicate that concerns arise for example in the Swedish experience in municipal procurement practice in the area of architectural and engineering services, which shows a higher focus on price, especially in smaller municipalities [6]. The same has been the case in the UK as well as in Spain, where not only construction but also designs were procured by local authorities based on lower price [7].

Although "best value" is the more commonly used awarding system, price still has high weighting [7]. In the Dutch context, the practice of design and construction procurement criteria during tender evaluation, in accordance with European Directive, has often been based on financial turnover rather than on quality [8]. In the case of Italy as compared to the UK, one research found that very few local authorities consider environment-related technical dimensions as a sustainability measure in awarding contracts [9]. In the case of Kosovo, previous research indicate that the problem of quality assurance is more complex, given that the issue of implementing existing procurement regulations prevails as a priority [10, 11, 12].

2. Materials and Methods

Challenges in implementing municipal development projects in Kosovo derive mainly due to weak law enforcement, which characterizes Kosovo since the termination of the 1998/9 war. The civil society organizations pressure [11, 12] to enhance transparency and accountability in municipal governance in Kosovo has raised public awareness on the need to re-examine issues related to quality of municipal development projects.

One solid source of information, which is used in this paper to identify and measure municipal performance in implementing urban and architectural projects is the package of Municipal Audit Reports, made available for public in the official website of the National Audit Office of the Republic of Kosovo [13]. The aim of the paper is to analyse these reports for (at least) two consequent years, in order to identify systematic deficiencies and challenges in managing municipal development projects. The municipal audit reports chosen randomly for the purpose of these analysis, address municipal performances for years 2015 and 2016, the first set of reports being published online in June 2016, and the second one in June 2017. Each set of reports consists of individual audit report for each of the 38 municipalities of Kosovo.

Analysis of audit reports of all 38 municipalities in Kosovo for 2015 enables us to identify issues that have direct impact on the management of municipal development projects, while audit reports of 2016 have been analysed in order to understand the trend of addressing these issues by municipalities themselves, based on the recommendations as provided in the previous years' reports. The analyses are focused on issues which the National Audit Office has presented as weaknesses in capital investment and in the procurement sector.

Although issues reported in the Municipal Audit Reports are common and specific, for the sake of analysis this study groups them into five basic challenges of similar nature: a) Inadequate planning of needs/funds; b) inadequate design brief/ project documentation, c) poor supervision/ project implementation, d) absence/disregard of municipal officials' ToR, e) noncompliance with legislation/ regulations. The table below provides these these five groups of challenges, each listing the most

commonly reported problems in municipal audit reports (Table 1). The first three groups of challenges are the main thresholds/phases that determine the quality of urban and architectural development projects, of which the first group illustrates the way municipalities manage capital investments, while the second and the third group consider the expertise needed to draft projects and contract, and to supervise construction works. The last two groups of problems are directly related to law enforcement.

The grouping of challenges into five basic challenges of the similar nature has enabled to cross-analyze municipal audit report findings and to understand the municipal annual performance trend in addressing auditor's recommendations, and by that, of the projects' implementation. Table 2. gives a general overview of deficiencies from the 2015 municipal audit reports for each municipality, aligned according to five challenges listed in Table 1, as well as the status of addressing these challenges in the following year, derived from the 2016 municipal audit reports.

Table 1. Challenges most commonly reported in Municipal Audit Reports of 38 municipalities in Kosovo

a) Inadequate planning of needs/funds	
	Inadequate Statement of Needs and Determination of Availability of Funds Misstatement of expenditures on / from capital investments Inadequate budget planning and/or spending of capital investments Missing procurement plan and/or procurement officer Municipality did not submit Procurement Plan to the Central Procurement Agency
b) Inadequate design brief/project documentation	
	Missing contract management plan Commitment of funds is smaller than the amount of signed contracts Contract annexes for positions outside the basic contract Changes in contract terms / conditions Procurement through minimal value procedures
c) Poor supervision/project implementation	
	The project is not completed as foreseen in the contract Discrepancies in Bills of Quantities Inadequate supervision / delays in execution of works Inadequate supervision / Non-compliance with contracted prices Commission Recipient Reports without notes on the concluded work
d) Absence/disregard of municipal officials' ToR,	
	The contract manager also makes the receipt of goods Same member is in the opening committee and in tender evaluation commission Member of the Supervisory Body is the Financial Director, non-expert in the field of construction, also is the executor of payments; Member of the Evaluation Commission is also contract manager/supervisor The drafter of the bill of quantity is also: contract manager, member of the Evaluation Commission, Supervisor of works & does technical acceptance
e) Noncompliance with legislation/regulations	
	Contract with non-responsive EO / does not meet the criteria Contract without procurement procedures Tender dossier differs from bill of quantity Payment without technical acceptance of works by the commission Payment executed for works not completed Payment of positions different from those contracted

Table 2. Problems in implementation of municipal development projects, as identified in 2015 audit reports and addressed in 2016 audit reports

	Inadequate planning of needs and funds		Inadequate design brief/ project documentation		Poor supervision/ project implementation		Absence of / noncompliance with municipal officials' ToR		Non-compliance with legislation / regulations	
MUNICIPALITY	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
DECAN	●	Δ	●	Δ						
DRAGASH	●	Δ	●				●	Δ		
DRENAS			●	X			●	X		
FERIZAJ	●	X	●	✓						
FUSHE KOSOVA	●	X								
GJAKOVA	●	Δ	●	Δ					●	X
GJILAN			●	Δ					●	Δ
GRACANICA	●	Δ							●	Δ
HANI I ELEZIT	●	Δ					●	Δ	●	Δ
ISTOG			●	✓					●	Δ
JUNIK	●	Δ	●	Δ			●	Δ		
KACANIK	●	✓	●	✓	●	✓	●	✓		
KAMENICA	●	Δ			●	✓			●	✓
KLINA	●	✓	●	Δ						
LEPOSAVIC	●	X	●	X	●	X				
LIPJAN	●	Δ	●	Δ	●	Δ	●	X	●	Δ
MALISHEVA	●	Δ	●	✓						
MAMUSHA	●	Δ	●	Δ			●	Δ		
MITROVICA	●	Δ	●	Δ	●	Δ	●	Δ		
MITROVICA NORTH			●	X					●	X
NOVOBERDA	●	✓	●	✓	●	✓				
OBILIQ			●	✓	●	Δ			●	✓
PARTESH	●	X								
PEJA	●	✓								
PODUJEVA			●	✓						
PRISHTINA	●	✓							●	✓
PRIZREN	●	Δ	●	Δ					●	Δ
RAHOVEC	●	Δ	●	✓						
RANILLUG			●	✓						
SHTERPCE			●	✓			●	✓	●	✓
SHTIME	●	X	●	✓						
SKENDERAJ	●	Δ	●	Δ					●	X
SUHAREKA	●	✓								
VITIA			●	Δ	●	Δ				
VUSHTRRI			●	✓			●	Δ	●	✓
ZUBIN POTOK									●	✓
ZVECAN	●	✓	●	✓						

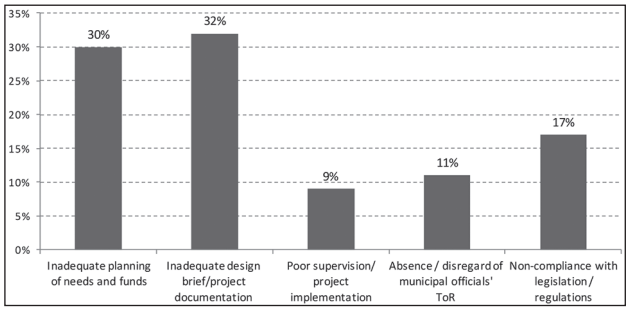
● problems identified in 2015 ✓ addressed in 2016

Δ addressed partly in 2016 X unaddressed in 2016

3. Results and Discussion

3.1. Deficiencies in implementation of municipal development projects

Analyses of Municipal Audit Reports from 2015 highlight the level of deficiencies in implementation of development projects at the national level. The graph below (Graph. 1) shows that out of all identified problems: 32% relate to inadequate design brief and/or project documentation, 30% are related to inadequate definition of needs and funds; 28% relate to law enforcement issues and the lack of good practices in in determining official duties, while the remaining 9% relate to poor supervision and project implementation during project implementation This indicates that the most significant deficiencies/problems at the national level are found in the initial phase of planning for capital investments and their translation into matching urban and architectural project proposals.



Graph. 1. Challenges identified in audit reports 2015 for 38 municipalities of Kosovo

3.1.1. Inadequate planning of needs and funds

Almost all municipalities of Kosovo suffer the problem related to inadequate planning of needs or funds, as identified from analysis of the municipal auditing reports. Reasons for this range from low level of accountability and law enforcement to the lack of professional municipal staff. In terms of law enforcement, continuous reforms are ongoing in order develop and strengthen contract law framework and systems [14]; however, there is no political will to empower and professionalize local administration, which is an important factor for rendering efficient, accountable and transparent local administration [15]. Within this framework of competencies, municipalities often lack expertise in the task of transposing urban planning provisions into development projects. Urban development plans provide projections on demand and supply for municipal technical and social infrastructure, which ensure that residents' needs are met over the course of the planning timeframe. The weakest point of municipal level plans in Kosovo is the section on implementation of plans, in which case provisions on priority projects are poorly articulated during the project planning processes. Weakness in project selection in the municipal level is part of the overall national challenge on prioritization of projects in Kosovo. This has been also identified in the IMF Reports, which usually emphasizes that the project selection in Kosovo has a generally low level of effectiveness, as well as it suffers weak and fragmented decision-making on project prioritization and selection. According to IMF, this contributes to the 45 percent efficiency gap" [16].

3.1.2. Inadequate design brief and/or project documentation

Design briefs for urban and architectural projects are usually compiled by municipal officials, i.e. project officers, procurement officers or urban planning officials. In most cases, design briefs incorporate technical considerations but rarely do they include contextual and cultural aspects, or do they stipulate requirements for good and sustainable design. Projects selected during the procurement process are often insignificant in terms of good design and innovation, as they are considered more practical and more appropriate due to the lower architectural complexity and lower price. Hence, constructed facilities are often striped from symbolic, cultural or contextual aspects.

The issue of design quality was debated in recent years, following the addressing that was made in the framework of the Public Procurement Package issued by the EU in October 2017. This discussion among other concluded that architectural design contests should be included in a Guidance note on Public Procurement of Innovation, given that "architectural design contests are best suited for the award of architectural contracts as they allow for quality assurance" [17]. Arguably, architectural design contests would need to be ad-

dressed and promoted in discussions on quality assurance in the case of Kosovo as well, however, the issue of implementing existing procurement regulations prevails as a priority at the present. It is worth noting that similar concerns deriving from unbalanced implementation of procurement regulations are raised in discussions regarding EU Public Procurement Package too [17].

3.1.3. Poor supervision/project implementation

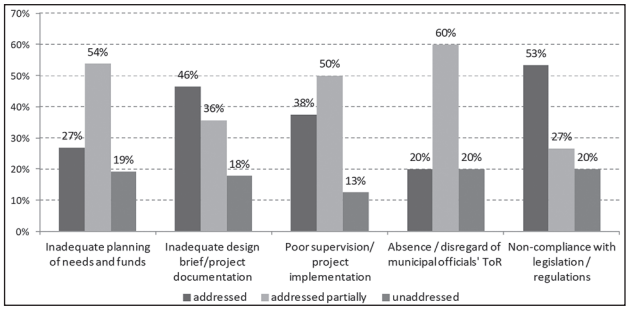
Inadequate implementation of architectural projects is mainly associated with the problem of poor quality of the main design documentation, and often with the implementation of constructions based on schematic design projects. Poor supervision/project implementation comprises 9% of total problems as identified in Audit Reports and is mainly present in smaller municipalities which according to reports, need improvement in the structure of procedures for management of implementation and supervision of construction works. As IMF notes: "The law requires project implementation to be monitored and explanations for delays or cost overruns to be given, but in practice, monitoring is limited and explanations are rarely provided even when delays or overruns are substantial." [16].

3.1.4. Official duty and implementation of legislation

Problems related to these two issues, namely, official duty and implementation of legislation, are systematic in Kosovo since the end of the 1998/99 war. Lack of transparency and politicization of recruitment at municipal levels has created situations of lack of professionalism [15]. Moreover, as reported frequently by CSOs in Kosovo such as BIRN's Public procurement monitoring report in Kosovo "municipalities suffer from dubious ethics of their staffs*"* [10]. In Municipal Auditor's Reports mentions are made of suspicious cases where the drafter of bills of quantities is simultaneously a contract manager, a member of evaluation commission and a supervisor of works, or part of the technical acceptance body, which according to the applicable law qualifies as clear conflict of interest. In smaller municipalities these problems arise due to the size of the administrations, that is small number of staff and their inability to separate the roles. But in larger municipalities these problems are systematic and manifest in almost all development areas.

3.2. Deficiencies in implementation of municipal development projects

Municipal Audit Report of a consecutive year, namely 2016, are further analysed in order to understand the level of implementation of audit's recommendations given to the municipalities for the previous year. The analysis was also carried out with a view of helping us understand the trend of annual performance improvement in the implementation of development projects. Chapter "Annex III: Progress in the Implementation of Prior Years Recommendations" in the 2016 Reports' findings suggest that auditor's recommendations on procurement procedures and practice are partially addressed, while those related to legal framework compliance are more substantially addressed (See Graph 2).



Graph. 2. The progress of addressing of 2015 challenges in the Audit Reports of 2016 for 38 municipalities of Kosovo

While compliance with regulations remains the main focus when discussing trends and performances in implementation of municipal development project, technical and environmental considerations, including aspects of good design remain unaddressed by Municipal Audit Reports. Unsatisfactory progress in addressing auditor's recommendations sheds light on the limited power of the National Audit Office to ensure enforcement. This issue is mainly attributed to the lack of Auditor's institution financial independence and this is considered to be the main limiting factor for the i Audit Office to performing the two roles: that of monitor-

ing, and the role of giving recommendations. [11]. At the same, the alleged corruption in public procurement is not being sufficiently fought by state mechanisms [10] while politicization and favoritism in the procurement field persists in budget institutions. [10]. Cases of misuse of urban and architectural tenders receive light penalties, which doesn't serve in the interest of the betterment of municipal performance in the procurement area [10].

An important aspect that needs to be considered when discussing the enhancement of the process of project implementation by Kosovo municipalities is citizens' opinion. Public participation in Kosovo is guaranteed by Law, Articles 68-72 [1] but it merely translates into practice of opening municipal development projects for public consultation purpose. This deprives the citizens, including professionals, to actively participate in the selection process, which in turn affects their awareness of their role in collective decision-making about the quality of public architecture that would best represent their identity and expectations. [18].

4. Conclusion

As this paper shows, implementation of municipal development projects in Kosovo is based on solid regulations that mirror European standards and good practices, yet, good quality of public projects remains a challenge. Municipal Audit Reports register problems at the earliest phases of project planning, which indicates that problems related to weak implementation are not solely limited to law enforcement. The issues of common goals of transparency, openness, as well as identification of problems that stimulate innovation through procurement, as emphasized by the Architects´ Council of Europe, are key to the improvement of current project implementation practices in the case of Kosovo municipalities. In order for these practices to take place, Kosovo municipalities should consider the use of professional advisory bodies in critical phases of project cycle management. This can play a critical role in improving the phase of project selection through transposition of planning provisions into development projects, as well as in drafting design briefs to include sustainability indicators that would ensure good quality in municipal development projects.

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Window frame materials and window size: parameters that influence energy efficiency in buildings

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Abstract

When it comes to finding a suitable closing for the openings on the building envelope, the choice of proper windows and doors is crucial because it directly affects the energy gain and loss and consequently also the costs.

This paper aims to demonstrate how the window design, in terms of material and size, significantly affects the climatic conditions inside the building, such as temperature, humidity, light, and the quality of living in the space. A combination of quantitative and qualitative methods will be used to conduct the research. Data collection and analysis have been done for aluminium and PVC-U window types. To perform data analysis, the collected data were used for description and comparison. Qualitative analysis can reveal the efficient window property and demonstrate the difference using a deductive method. The heat transfer analysis will be performed using the software Winiso combined with SchuCal version 2020 R2. The test results are presented in the form of tables and diagrams, and explained additionally.

Key words: *Thermal transmittance, U-values, Aluminium windows, Vinyl (PVC-U) windows, Window frames, Window size*

1. Introduction

In the last several decades, European countries pay greater attention to energy use and sustainability in the construction industry. From 2021, new buildings must implement the nearly zero-energy standard across Europe – the EU Building Directive prescribes this. With that in mind, the importance of properly selected and designed windows in buildings is essential [1]. By the year 2050, approximately 6.5 billion of the 9.5 billion people on Earth will live in cities. Cities today already consume around three-quarters of all resources and are responsible for approximately 70% of all harmful greenhouse gas emissions [2]. The implementation of properly selected windows plays a vital role in sustainability. Sustainability features are becoming more significant in the valuation of property, too. Confirmation of this can be noticed in sustainability certificates, which are increasing in demand, particularly in the commercial sector.

It is estimated that windows alone contribute from 25% to 40% of the heat loss through a typical building assembly [3]. This research aims to investigate how aluminium and PVC-U windows perform when it comes to saving energy. For this purpose, Schueco aluminium and vinyl (PVC-U), window frames are chosen. It was decided to focus on profiles that are rated by the Passive house Institute in Germany. To achieve the Passive house requirements, the window frames need to have Uf values (window frame) so that Uw ≤ 0.80 W/m2K (window as a whole) [4]. Additional elements applied in window frames such as glass, spacers, or type of insulation that have high significance for window performance were taken into consideration as well. Note that a U-value of 0.5 W/m²K was chosen as the required performance level, simply based on the fact that the best commercial insulated glass units (IGU) on the market now have a U-value of 0.5W/m²K.

1.1 Research methodology and research approach

The research will be conducted through the combined quantitative and qualitative methodology. The outcome is based on data collection and analysis.

The window profile combinations and their Uf values were analyzed for two widely available

window frame materials: PVC-U, and aluminium. Each window was designed having the same volume of a material, spacer, and glazing system; their U values and thermal performances were calculated and compared.

Two-dimensional heat transfer analysis of the frames will perform for different profile combinations and the windows' size using the software WINISO in a combination with SchuCal version 2020 R2. WINISO is software used to solve two-dimensional heat flow and steam diffusion flow, isotherms, Uf-Values, and Psi-Values. SchuCal project planning program can make preliminary calculations for windows, entrance doors, sliding doors, and curtain walling made from composite aluminium and steel profiles.

For analyzing window profile combinations, the base aluminium and PVC-U window system were chosen. Generally, window systems are divided based on the outer frame's installation depth (marked with the blue arrow in Figure 1). For this case study, the window system of 90 mm outer frame for aluminium and 82 mm for PVC-U was used with triple glass Ug 0,5W/m²K including a suitable glass spacer.

Changes in the outer frame and vent frame dimension (marked with the green arrow on Figure 1) were analyzed using heat transfer analysis software WINISO and SchuCal version 2020 R2. The collected outcome data were analyzed and presented for further discussion and conclusion.

2. Development of aluminium and PVC-U windows and material properties

Even though traditionally windows with wooden frames were used for many centuries, with industrialization and the beginning of modernist architecture, aluminium as a window frame material became more popular. Windows with aluminium frames were slimmer than those with wooden frames and gave a more elegant appearance to the window opening and the entire building. Nowadays there is a variety of materials used in the window production industry including affordable and low maintenance aluminium and PVC, both in the scope of this research, but also traditional material such as timber, and more specific and rather costly steel and fiberglass.

2.1 Aluminium windows and material properties

Aluminium as a construction material was introduced already at the beginning of the 20th century but due to the high production cost, it was not widely applicable. Just in the 1920s after certain innovations in the production process were applied and aluminum became more affordable for investors it began to be used for many purposes in the construction industry [5]. The first aluminium windows began to be produced in the 1930s. Their great advantage was their lightweight and slim appearance. However, aluminium as a metal

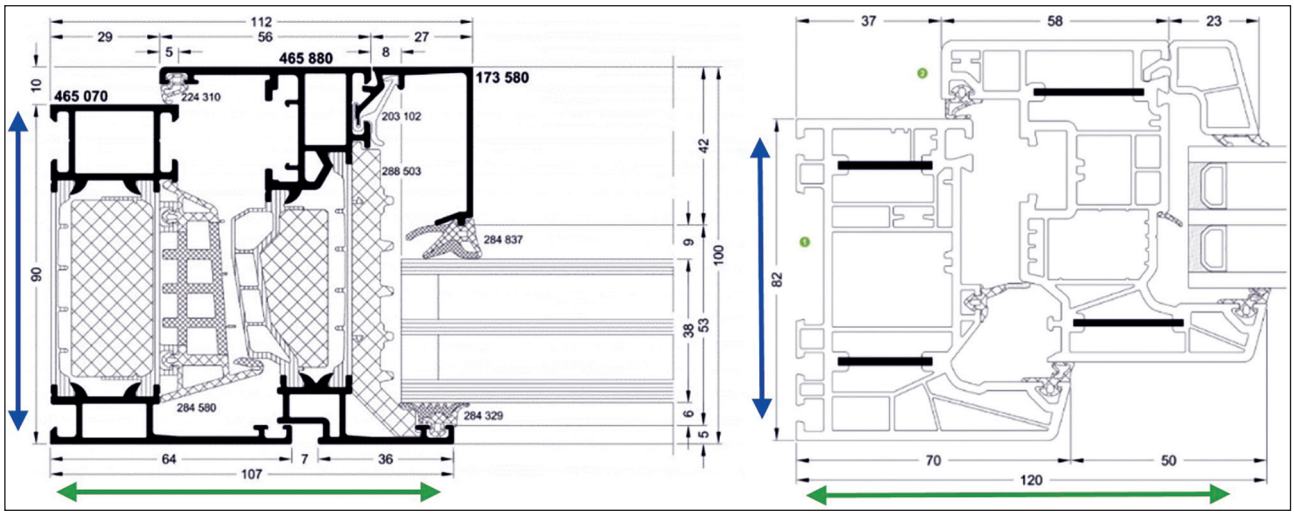

Figure 1. On the left side cross-section of aluminium window and on the right side cross-section of PVC-U window (Schuco, 2020)

is an excellent conductor of heat. Due to this feature, aluminium windows were very uneconomical, and the areas they closed did not provide the desired internal comfort in the building.

The most important reason for the use and production of aluminium windows was their lightweight. At the same time, aluminium is a material that does not corrode and has relatively high strength, so it is also suitable for larger window surfaces. For a long time, aluminium windows were "reserved" for office and retail buildings due to the elegant and severe appearance, which architects streamed to achieve in these building typologies. Over time, aluminium windows were improved. Double-glazing was introduced in 1980 [6]. Nowadays, aluminium windows answer to the low energy requirements thanks to advanced insulation technology and the extreme durability of the material itself. Another good characteristic of this material is that it can be remelted and reused again without losing its quality which is very important considering the fact that the construction industry is one of the main environmental polluters [5].

Aluminium is durable, light and relatively easy to handle, produced from ore, bauxite. Aluminium windows are corrosion-resistant and require little maintenance. It is generally known that aluminium production requires a large amount of energy, and it produces environmentally hazardous pollutants. The construction and utilization of buildings are also the leading cause of greenhouse gas emissions. The building sector offers twice as much potential for cutting CO2 emissions. Governments are responding with stricter regulations for the building sector [7]. Aluminium can be recycled an unlimited number of times without changing quality. Recycling requires just around 7% of the energy needed compared to production from its ore. Windows made from aluminium are light and long-lasting. To improve the characteristics of aluminium frames so that they can be resistant to seawater, acids, or corrosion, different alloys are added such as magnesium, copper, zinc, silicon, manganese, etc. Additionally, the frames are coated using two different coating techniques: powder coating and anodizing. The coating serves to protect the material and alloys and also to change the color of the frames.

2.2 PVC-U windows and material properties

The first PVC-U profile was made in 1954 which served to assemble the first plastic window from it. The first coextruded colored profiles appeared in 1972, and the profiles from recycled raw materials in 1988. One of the advantages of plastic profiles is the power of thermal insulation and affordable price, which has made it a customer's favorite choice. However, the ability to retain heat in the room or prevent penetration of cold air from outside has not always been a property of PVC windows. The original mass-produced frames were without chambers and were single glazed which caused high energy losses. Partitioned air circulation cavities in the profiles, which are the essential thermal insulation instrument, had become an integral part of them since 1967 when the first three-chamber window was created. Three-chamber profiles were the only available option for a long time until the issue of energy efficiency began to impose itself extensively among experts who came up with constructing a passive house that requires, among other things, appropriate facade shutters. Today, PVC windows have between five and eight chambers and multiple glass layers, while those with four chambers are almost no longer considered [8].

The material which is used to produce PVC-U windows is Polyvinyl chloride (PVC), the most widely used polymer in the world. German inventor Friedrich Klatte in 1913 was granted the first patent for the process of polymerization to produce PVC. In 1933 commercial production of PVC started. Around 20% of all plastic made worldwide refers to polyvinyl chloride, second only to polyethylene. The essential raw elements for PVC are derived from salt and oil. The saltwater's electrolysis provides chlorine blended with ethylene (obtained from oil) to form vinyl chloride monomer (VCM). Molecules of VCM are polymerized to form PVC resin, to which suitable additives are combined to create a customized PVC mixture.

PVC uses less non-renewable fossil fuel to produce than any other plastic materials because other thermoplastics are derived from oil entirely, while PVC is produced from two materials. 57% molecular weight is derived from common salt and 43% is derived from hydrocarbon feedstock [9].

Material has to be combined with a variety of specific additives before PVC can be made into products. Mechanical properties, color, clarity, weather-fastness, and flexibility, are determined by these additives. This method is described as compounding. PVC's compatibility with various additives is one of the material's many strengths and makes it such a highly adaptable polymer. PVC is ideal for construction product because of good impact strength and weatherproof attributes. PVC has a relatively small carbon footprint compared to other materials. PVC windows help to cut energy bills and are fully recyclable. Their properties are reprocessed well and recycled into second (or third life) applications with ease.

They are also easy to maintain, are durable, and recyclable which is an important characteristic contributing to the protection of the environment. Additionally, the manufacturing process of PVC windows has low levels of pollution and consumes less energy than the production of wooden windows [10].

PVC-U windows are additionally constructed with metal reinforcements to improve the rigidity. However, that is a weak spot of a standard vinyl window frame. There are two typical methodologies to tackle this problem: either replace the reinforcement with a better insulating material with comparative strength or replace the frame material with a more robust material by which the reinforcement becomes redundant [11].

In the beginning, the PVC-U windows were available in three colors only: white, golden oak, and rosewood. Today, the color palette is rich even though white window frames are still the most popular because they are also the cheapest option on the market. The methods of PVC-U window frames surface treatment are different: PVC-foils, acryl color, painting, and aluminium cover profile. From all the above-mentioned methods, the most popular solution of frame treatment is with foils even the aluminium cover caps are desirable, too. Advantages of surface treatment of the PVC-U window frames are:

- protection of weather influence,
- increasing the attractiveness and versatility of the PVC windows,
- optical embellishment,
- increasing the value of the real estate.

However, non-white PVC profiles result in higher surface temperatures and can even reach the softening temperatures of 79-81°C. To avoid possible deformation, these frames must be ventilated.

3. Simulation methods

An examination of the properties of a series of window frames currently available on the market resulted in two different frame materials: aluminium and vinyl. All test models were created in collaboration with the building industry. For the aluminium frames, the current standard reference is a three-chamber profile with a thermal break in glass fiber reinforced polyamide (Figure 1). The system is made airtight and watertight using a central gasket, typically combined with an interior gasket. Similarly, common vinyl window frames are composed of five or seven chambers, and a steel profile is inserted to ensure adequate strength and stiffness. Two gaskets, one at the interior plane and one at the exterior plane, ensure weather tightness. For this examination, seven chamber profiles are going to be used. Besides chambers, window systems are divided based on the outer frame's installation depth (marked with the blue arrow in Figure 1). For this purpose, Schueco window system of 90 mm outer frame for aluminium and 82 mm for PVC-U will be used with triple glass Ug 0,5W/m²K with a suitable glass spacer. Various profiles with different dimensions of the outer frame and the vent frame will be combined and tested. It was decided to focus on profiles that are rated by the Passive house Institute in Germany. To achieve the Passive house requirements, the window frames need to have Uf values (window frame) so that Uw ≤ 0.80 W/m2K (window as a whole). The European standard EN ISO 10077-2 provides a numerical calculation method to calculate the frame's U-value (Uf). Which is typically done by using 2D heat transfer programs. For this analysis, the software WINISO with a combination with SchuCal version 2020 R2 will be used. WINISO is software used to solve two-dimensional heat flow and steam diffusion flow, isotherms, Uf-Values, and Psi-Values. SchuCal project planning program can be used to make preliminary calculations of U values for windows, entrance doors, sliding doors, and curtain walling made from composite aluminium and steel profiles.

3.1 Window frame thermal transmittance

Based on the criteria defined for window frames, the following part refers to the profile combination testing for aluminium and vinyl (PVC-U) windows. All acquired data is analyzed with Minitab statical software.

3.1.1. Aluminium

Various profiles have been selected for testing with a basic installation depth of 90 mm. Profile combinations refer to the dimensions of the outer frame and vent frame. Five outer frames have been chosen with face widths 64, 84, 104, 155, and 205 mm. This is shown in Table 1. Four vent frames with face widths 36, 46, 56, and 61 mm are shown in Table 1. A total of twenty combinations was made and tested with SchuCal version 2020 R2 heat transfer program following the European standard EN ISO 10077-2. All possible combinations tested are shown in the Table 1.

Table 1. Profile combination for aluminium frames

ALU	Outer Frame (face width outside mm)	Vent Frame (face width outside mm)
1	64	36
2	64	46
3	64	56
4	64	61
5	84	36
6	84	46
7	84	56
8	84	61
9	104	36
10	104	46
11	104	56
12	104	61
13	155	36
14	155	46
15	155	56
16	155	61
17	205	36
18	205	46
19	205	56
20	205	61

3.1.2. Vinyl (PVC-U)

Unlike aluminium profiles, vinyl profiles have fewer choices for outer frame and vent frame. The basic installation depth of 82 mm, chosen outer frame face widths 70, 80, 90, and 100 mm and vent frame face widths 73, 83, and 110 mm, is shown in Table 2. A total of twelve combinations was made and tested with the software PlanSoft 4 heat transfer program following the European standard EN ISO 10077-2. All possible combinations tested are shown in Table 2.

Table 2. Profile combination for vinyl frames

PVC-u	Outer Frame (face width outside mm)	Vent Frame (face width outside mm)
1	70	73
2	70	83
3	70	110
4	80	73
5	80	83
6	80	110
7	90	73
8	90	83
9	90	110
10	100	73
11	100	83
12	100	110

3.2 Window size and thermal transmittance

To assess the impact of window size on building energy load, different window sizes for aluminium and PVC-U have been tested. Calculation of Uw values was performed with software Schuco PlanSoft version 4.5 for PVC-U windows and Schuecal 2020 R2 for aluminium windows following the DIN EN 10077-1. In general, The Schüco PlanSoft software offers all kinds of calculation and representation options for planning plastic windows and doors. On the other hand, Schuecal 2020 R2 is used for aluminium windows, doors, sliding doors, facades. The aluminium window size is changed in 13 scenarios. All combinations tested are shown in Table 3. The same three-layer glass was used for the calculation of isotherms with an Ug value of 0.5 w/m2K and a super spacer with a PSI value of 0.038 W/mK, with an outer frame of 104 mm and a vent frame of 56 mm.

Table 3. The aluminium window size

	Width of the window (mm)	Height of the window (mm)
1	600	600
2	650	800
3	700	1000
4	750	1200
5	800	1400
6	850	1600
7	900	1800
8	950	2000
9	1000	2200
10	1050	2400
11	1100	2600
12	1150	2800
13	1200	3000

The initial dimension of the window is 600x600 mm because it is not possible to make a smaller window due to technical reasons. The largest window dimension is 1200x3000mm. The dimensions of the windows have an increase of 50 mm in width and 200mm in height. The PVC-U window size is changed in 13 scenarios. All combinations tested are shown in Table 4, with a slight difference in dimensions due to technical limitations. The glass and the spacer characteristics are the same as on the aluminium window, with an outer frame of 90 mm and a vent frame of 83 mm. The initial dimension of the window is 600x600 mm, and the largest window dimension is 1200x2600mm. The windows' dimensions have an increase of 50 mm in width and 150-200mm in height.

Table 4. The PVC-U window size

	Width of the window (mm)	Height of the window (mm)
1	600	600
2	650	750
3	700	900
4	750	1050
5	800	1200
6	850	1400
7	900	1550
8	950	1700
9	1000	1850
10	1050	2000
11	1100	2200
12	1150	2400
13	1200	2600

4. Results

4.1 Profile combinations

Based on the analysis of case studies, the profile combination of window frames simulation results shows that window frame thermal transmittance Uf can be improved up to 30% with the right profile combination in aluminium window construction. The test results for all aluminium profile combinations are given in Diagram 1. Test recorded the highest Uf value of 1.1 W/m²K in the narrowest face width profile combination, the outer frame of 64 mm, and the vent frame of 36 mm.

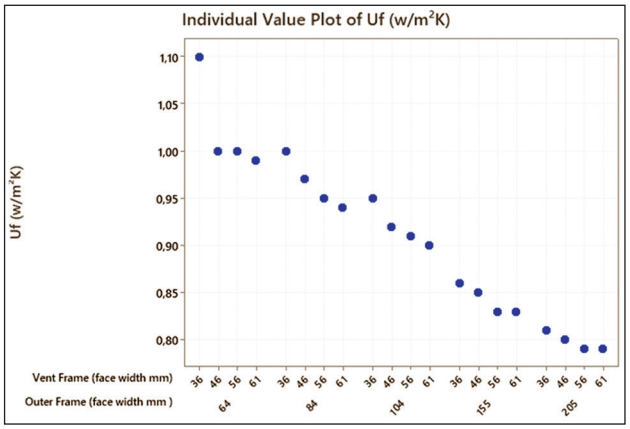

Diagram 1. Profile combination for aluminium frames results of testing

The best value is in the largest face width profile combination. The outer frame of 205 mm and the vent frame of 56 and 61 mm with a value of Uf 0,79 W/m²K. On the other hand, simulation results for profile combinations of vinyl profiles in each combination have the same thermal transmittance result Uf of 1.0 W/m²K. The test results for all vinyl profile combinations are given in Diagram 2. All acquired data is analyzed with Minitab statical software.

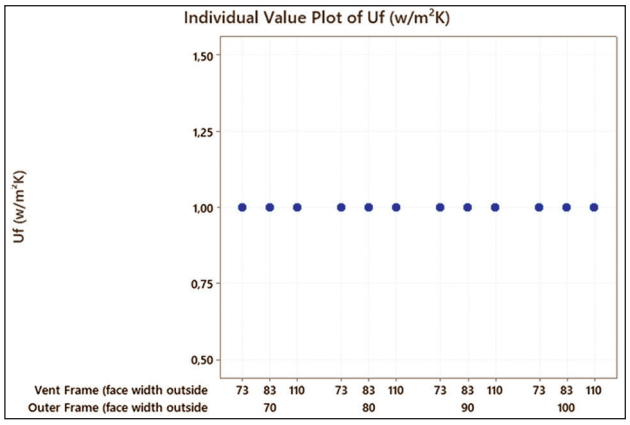

Diagram 2. Profile combination for vinyl frames results of testing

4.2 Window size and thermal transmittance

Based on the analysis, the impact of window size on thermal transmittance is evident. Window size simulation results show that aluminium window thermal transmittance Uw can be improved up to 23% with the proper window dimension. The test results for different aluminium windows sizes are given in Diagram 3. For the initial dimension of the aluminium window, 600×600 mm listed the highest thermal transmittance of Uw 0,95 W/m²K, and the largest window tested 1200×3000 mm records the best value of 0,73 W/m²K.

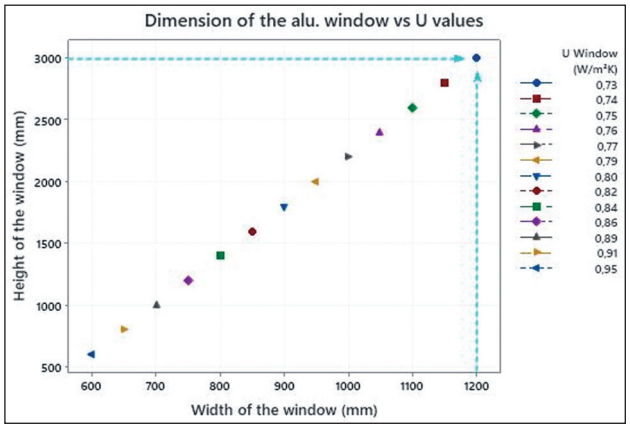

Diagram 3. Aluminium window size results of testing

On the other hand, PVC-U window thermal transmittance Uw can be improved up to 25%. The test results for different PVC-U window sizes are given in Diagram 4. For the initial dimension of the PVC-U window, 600×600 mm recorded the highest thermal transmittance of Uw 0,99 W/m²K, and the largest window tested 1200×2600 mm records the best value of 0,74 W/m²K. All acquired data is analyzed with Minitab statical software.

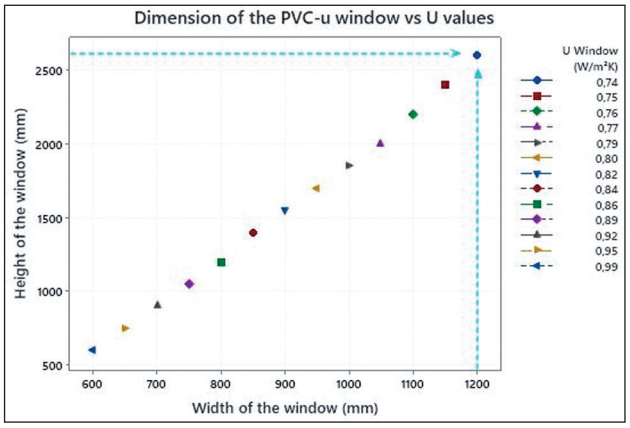

Diagram 4. PVC-U window size results of testing

5. Conclusion

The conducted test showed that the right choice of the window frame for aluminium and PVC-U windows as well as their size contribute to energy saving. In general, referring to the thermal characteristics of windows size, larger openings have better characteristics compared to smaller ones.

The results showed that the right choice of aluminium profile combination could improve thermal transmittance up to 30%, while vinyl flames have constant Uf values. Test recorded highest Uf value of 1.1 W/m²K in narrowest face width profile combination, the outer frame of 64 mm and the vent frame of 36 mm. However, the best value is in the largest face width profile combination. The outer frame of 205 mm, and the vent frame of 56 and 61 mm with a value of Uf 0,79 W/m²K. On the other hand, simulation results for profile combinations of vinyl profiles in each combination have the same thermal transmittance result Uf of 1.0 W/m²K.

It was found that aluminium window thermal transmittance Uw can be improved up to 23% with the proper window dimension. For the initial dimension of the aluminium window, 600×600 mm listed the highest thermal transmittance of Uw 0,95 W/m²K, and the largest window tested 1200×3000 mm records the best value of 0,73 W/m²K. On the other hand, PVC-U window thermal transmittance Uw can be improved up to 25%. For the initial dimension of the PVC-U window, 600×600 mm recorded the highest thermal transmittance of Uw 0,99 W/m²K, and the largest win-

dow tested 1200×2600 mm records the best value of 0,74 W/m²K.

As a result, this project can be a quick and user-friendly tool for the early design and optimization of thermally efficient aluminium and PVC-U windows.

It can be a guideline for architects and investors likewise when it comes to the choice of window material and size. With the right decision, energy costs can be decreased, and it can also influence the aesthetics of the building since each window type has its specific characteristics. This is equally important for the refurbishment projects on existing buildings as well as for new construction.

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The importance of variability (flexibility) in multi-family apartment buildings

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Abstract

The variability of building structures can be achieved from the outside and inside, as well as with extensions or partitions. The degree of variability is proportional to the independence of the primary from the secondary structure.

The relationship between the structure and the role of installations in the practical application of flexibility has been considered in a number of studies (SAR method, etc.), and all come to the conclusion that it is necessary not only to differentiate the primary from the secondary structure, but also to make the installations less fixed.

However, differentiation does not mean that development can be inconsistent. The main mistake of the current development in construction technologies is in fact that there was a lack of relation to the secondary structure and that the connections in the construction process were not defined. Thus, the development of technology has limited the growth of the quality of housing, rather than improving it.

Today the primary structures are built very quickly, their durability is practically unlimited, but if we compare them with the first beginnings of the application of the skeleton in residential construction with "endless possibilities", burdened with various restrictions and regulations, today we have extremely unadjustable constructions, which do not allow nor minimum flexibility (similar to structures where a massive building system with load-bearing reinforced concrete walls is applied).

This paper aims to provide a historical overview of research closely related to the importance of flexibility in multi-family apartment buildings in general, with reference to and analysis of experiences in the construction of flexible housing in the former SFR Yugoslavia.

Key words: *flexibility, multi-family residential buildings, variability.*

1. Introduction

Among all human needs, the needs related to housing are one of the most complexes, because they are repeatedly conditioned by a number of factors (psychosocial, biological, integrative, individualized, etc.).

So, the apartment is not a "housing machine", but a space that should allow complex processes to take place, whose shapes are practically unpredictable.

Therefore, it is necessary to possess the spatial solution which enables at least partial adaptation of the dwellings to different and unpredictable needs.

Instead of a permanent unchanging organization of the apartment, based on "infallible" rational functionalist assessment, one should strive for open solutions, unfinished, which will give the space accommodation, i.e. it is necessary to design a "changeable" (flexible) apartment. The word flexibility has the etymological root of the Latin adjective "flexibilis" and the noun "flexibilitas", which translates as easily foldable, easily changeable, adjustable (for a person).

There are different definitions of the term flexibility when it comes to living space. Numerous authors use the term "development" to fully denote the variability and adaptability of the apartment.

The interest in flexibility is not as new as it sometimes appears. The dilemma: whether and what kind of functional determination of the apartment is constantly present in the activities of the prominent protagonists of the so-called functionalist architecture. Somewhere, the very tradition of building has long pointed to flexibility.

For example, it is an American tradition for the house to never be considered finished and unchangeable, unlike in Europe where, on the contrary, there is an attempt to define the future need (meaning family construction), which naturally means resistance to flexibility.

In 1927, the architect Miss van der Rohe in the Weisenhof residential area stands for an "elastic house" and achieves the application of flexibility.

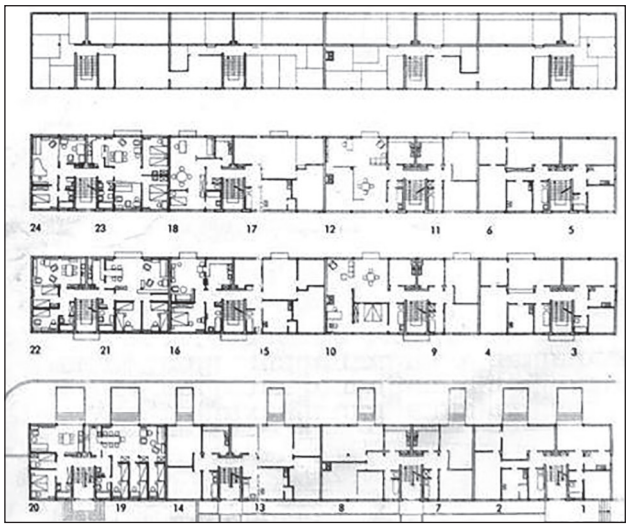

Figure 1. Miss van der Rohe: Weissenhof residential area, 1927, one of the first examples of a flexible organization. [1]

In this Weissenhof apartment building (Figure 1), designed in 1926, Miss begins to address the contrast between structure and form with the meaning of the steel frame, the first time he has actually applied it to one of the projects or to a realized structure.

The exterior walls of the three-story apartment block consist of masonry, covered with smooth plaster, large windows, and glass doors. The steel frame was crucial to Miss's architectural vision for this project. He refers to the frame as the most appropriate system of construction.

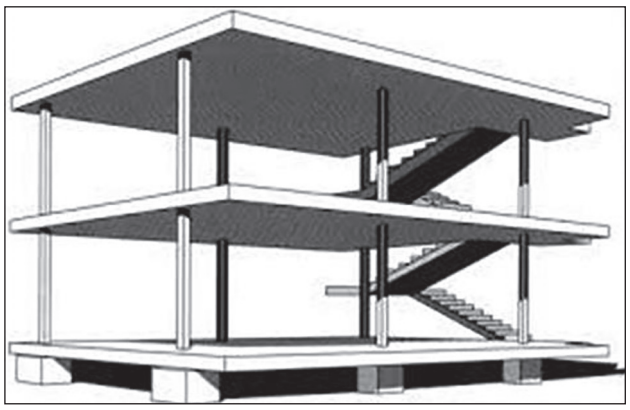

Figure 2. Le Corbusier, project for "Dom-ino" construction, 1941. [1]

"It can be produced rationally and allow any freedom for the division of the interior spaces. It enables him to limit the use of massive walls to divide the apartments, to introduce the partition walls, and to open wide facades with glass". [2]

With this initial belief, he remains faithful practically throughout his work, striving for adaptability not only to the residential contents (as in the towers of Lake Shore, 1951), but to a neutral, multiplicatively used space in the architecture of all contents.

Even (usually quoted as the most prominent representative of functionalism) Le Corbusier in his project "Dom-ino" (Figure 2.) gives a very specific proposal of flexibility with all the necessary assumptions (the structural system of the skeleton is completely independent of the solution of the apartment).

One of the most complete approaches, as well as practical results in the field of flexibility of the apartment and urban structures, was achieved by the organization SAR (Stiching Architecten Research), founded by the ten largest architectural bureaus in the Netherlands (started research in 1965 with only ten researchers). From this source arose a movement that encompassed several countries (Germany, USA, Austria, England, Canada etc.).

The basic characteristics of SAR systems can be defined as:

– systems developed on the basis of "classic" constructions, i.e. transverse load-bearing walls,
– on the basis of extensive surveys, it is suggested that there are two concepts in modular coordination: "tartan" (strip) grid and the concept of fitting dimensions in the horizontal and vertical direction [2]. It is a grid of lanes alternately 10 + 20 cm in both directions (Figure 3.) with 3M transmission module. The preferential 3M module is explained on an anthropological basis, as a natural measure found in all human movements and at rest (Figure 4.).

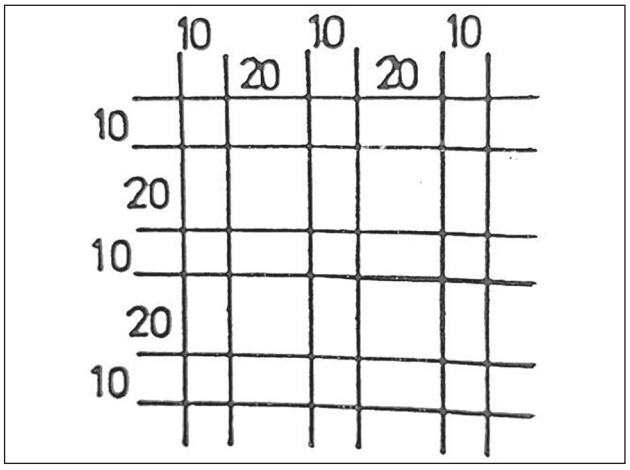

Figure 3. A grid of lanes alternately 10 + 20 cm in both directions. [2]

Of course, the most important conclusion and the basis of the SAR method is the division of the functions of the apartment according to the collective features, i.e. the division of "zones" and "margins" (intermediate lanes) and the claim that the differences between the apartments are obtained by varying within those features.

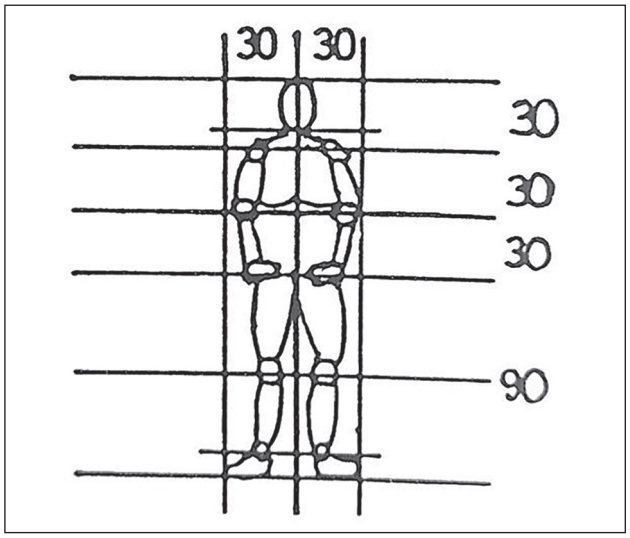

Figure 4. The preferential 3M module, as a natural measure found in all human movements and at rest. [2]

Partition elements, closets, installation lines are situated in the intermediate lanes. By connecting residential units across the intermediate lanes, it is possible to change the structure of the apartments at the time of planning, during the granting of use and during the process of use. It is sufficient to leave a door opening in the construction wall (temporarily or permanently walled) at the point of penetration of the inter-lanes and flexibility is possible in a relatively wide range.

2. Division and types of flexibility

The problem of flexibility is subject to the engagement of a large number of authors, which (taking into account of their initial attitudes and difference) they give different divisions.

However, this is only a matter of fundamental differences, so the division that is closest to the practice of realizing objects is adopted:

1. ***relative flexibility*** (some call it apparent),
2. ***absolute flexibility*** (some call it total),
3. ***enriched (increased) relative flexibility***.

Under item 1. is meant everything that is limited by the physical volume of the apartment, where changes are possible only inside a certain "shell".

This means that the relative flexibility can be internal (inside the apartment) and external (occupies the space outside the residential unit). External relative flexibility by volume can occupy two or more apartments, in one or two (rarely more) levels, so it is possible as "horizontal" and "vertical".

Under item 2. is meant that flexibility which is not predetermined by the physical volume of the building. It is flexibility that consists of physical addition or subtraction, flexibility that contains the possibility of self-construction or decomposition.

From the point of view of reality and operability, "relative flexibility" belongs to the needs of the moment, and "absolute flexibility" is in the domain of the strategy of development of construction, and especially of the development of housing construction.

Under item 3. means the relative flexibility which has limited possibilities for self-construction, so it is a rudimentary form of absolute flexibility, it is in fact a transitional form between the two basic types. [3]

2.1. Flexibility in relation to the apartment structure

The structure of the apartment is a very important and essential, objective problem in terms of family needs. It is directly determined by the activities that family members perform in the apartment.

By moving into the apartment, the users enter their social functions and oppose them to the functions of the apartment and the individual rooms of the apartment.

If the organization and structure of the space of an apartment successfully accepts all the functions of the family and individuals (those functions that people perform in an apartment) it is usually said that the apartment is functional, or vice versa. Therefore, the social functions of individuals and groups are correlated with the apartment as a specific organized space.

As the needs are changeable and dynamic, so people also expect a possible change in the organization of living space.

The apartment is a product that lasts the longest and its depreciation is a long period, during which

there are changes in the lifestyle, the standard and the perceptions of aesthetic values.

The interventions that come into consideration during the use of an apartment can be:

– improvement of living conditions by introducing installations and
– change of size and spatial relations in the apartment.

The problem of changing the spatial relations in the apartment is not a specific problem, but is of a general nature and also applies to the traditional way of building apartments.

It can be said that the prefabricated system has an advantage over the traditional one. Lightweight partitions, interior and exterior walls in the prefabricated system can be dismantled and moved.

If from the very beginning of the design of a residential building, its adaptability and the choice of the construction system are taken into account, very good results can be obtained.

In order to free the prefabrication from the ballast of rigidity, it is necessary to first allow more freedom in solving the floor plans of the apartments, and this mainly comes down to the problem of determining the optimal sizes and the optimal number of different types of elements, which can be combined. within reasonable and necessary limits, while further preserving the advantages provided by the prefabricated building system.

One of the most important factors contributing to the quality of housing, understood as an evolutionary process, is the variability of the disposition of the apartment.

In essence, this notion introduces a fourth dimension in architecture, i.e. - time component.

The variability of the disposition of the apartment, as a term, appeared as a function of the development of the family and its housing needs.

The variability implies a dynamic concept of the disposition of the apartment. It assumes apartments built in an industrial way.

The variability can be:

- **internal,**
- **external** and
- **internal and external**.

Internal variability is the possibility for one or more changes in the disposition of a group of rooms or an entire apartment, provided that the total area is not changed and no changes are made in the structural system of the apartment.

External variability is an opportunity to change the disposition of the apartment in order to reduce or increase the total area, i.e. the number of rooms in the apartment, but also provided that no changes are made in the structural system (except partially in the facade walls and partitions walls between two apartments).

A third case is when both internal and external variability is possible.

The degree of variability depends on:

– the proper selection of the construction system,
– the number of fixed determinations - all constructive, dispositional and installation elements (front door, stair and elevator core of the building, kitchen installation block, sanitary facilities, floor structures, etc.).

Proper selection of the construction system is one of the first and most important prerequisites for variability, with the most important to meet the following two conditions:

– free disposition plan with vertical load-bearing elements, preferably in plane with the facade walls and
– flat floor construction without visible underlayments or other structural elements.

From the new construction systems, especially for large apartments, are suitable:

– system of hanging floor slabs and
– system of raised floor slabs.

Adverse systems that exclude any possibility of variability include:

– panel prefabricated system and
– cell prefabricated system,

Which today are most often used in industrial construction methods. It sounds overwhelming that these systems, which are based on industrial methods, exclude variability, which in itself is a method of industrial and prefabricated construction.

However, given the above and the fact that these systems with their rigidity negate the first and basic condition of variability - free disposition plan - these systems are a step backwards even

compared to traditional building systems. In terms of variability, these systems have no perspective.

Variability excludes arbitrariness and presupposes a certain discipline based on modular coordination. Apartments that have any variability will most often be able to meet the new needs of the family, and these are above all the apartments built in open systems. The systems that provide internal variability in the apartment, in addition to being able to respond to the always new needs and the changed family structure, only to a certain extent, such apartments provide quality of an important sociological dimension in housing, which is - the identification of the person with the apartment.

The identification of the person is possible through the direct contacts of the designer-user relationship, where the future user directly participates in the definition of the project task. This is the only way to get to know the individual desires and requirements (profession, age, affinities, desires, cultural heritage, health status, etc.), which further represent a direction for solving the residential space tailored to a particular person.

When designing buildings for individual housing, the identification of its user is enabled, while when it comes to multi-family residential buildings, contact of the future users with the designer is disabled, and the mediators are the organizations that define the needs of the future users expressed through numbers. We can not talk about the identification of individual characteristics of a particular person, which is of great sociological importance for the humane living of the future user.

Determining the desires and needs of users in multi-family residential buildings, due to diversity - does not lead to the goal, because it would be difficult to find at least two families with equal desires and needs, and in addition - they are subject to change over time. Thus, the possibility remains for the users in some real physical frames to create their own narrow living space.

The solution is in the separation of the collective and the individual sphere, ie the primary and the secondary structure.

By applying the above division we come to the concept of "open" systems, which in addition to providing internal variability - and production of components for a wider market, as well as the development of the industry for built-in components.

The primary sphere consists of the structure of the building with the load-bearing elements, communications and equipment devices of the building.

The physical boundaries of the individual sphere represent the contours of the apartment.

The layout of the premises, their connection and equipment are in the exclusive competence of the user, who thus subordinates the structure of the apartment to the structure of his family and his needs.

The user of the apartment is enabled to perform the equipment of his choice with built-in components, the so-called finalization packages. The elements should be compatible, i.e. they can be easily moved, supplemented and changed in the apartment. So, by forming the apartment, i.e. creating in their own way their living space, it can be rightly said that the user creates his "home".

3. Experiences in the construction of flexible apartments from the countries of the former SFR Yugoslavia

Open prefabrication systems that have been used successfully in the former SFR Yugoslavia are: the IMS system and the NS-71 system implicated in housing construction in the town of Novi Sad.

The "open" prefabrication is a building system with elements that are produced independently of a particular project and that can be applied in a number of combinations. The construction system is made of prefabricated elements, and other things such as: processing, equipment, installations, devices and finalization, are also made of prefabricated elements - specially made or interconnected. The modern prefabrication system tends towards an "open" construction system. This system includes the skeletal structural systems, as well as the panel system with a span between the walls greater than 6 meters.

In the "open" prefabrication, the architect assembles the apartment with elements - panels offered by the market, and whose dimensions are standardized.

These panels are the result of a research procedure that determines their degree of compatibility. The obtained assortment is checked through a series of solutions on the floor plans of the apartments.

Smaller elements are characteristic of "open" prefabrication. The rule "the larger the elements, the smaller the combinations" can not be avoided.

In the case of "open" prefabrication, first of all, a constructive module should be chosen, within which the sizes and shapes of the prefabricated elements will be examined, researched and selected.

In that sense, the design remains as a process that precedes for each different building, which allows to meet the different requirements conditioned by social, technical, economic and climatic differences, as well as habits that prevail in certain areas.

Architecture in general, and residential architecture in particular, is an overly complex activity that could survive without compromise. The "open" prefabrication in today's conditions represents that compromise. Only systems in which the structural elements are completely separate from the elements of the equipment, and that is above all the skeletal systems - have the prospect of maintaining the openness of the system. [1]

3.1. "IMS" system – Žeželj

The IMS system is a skeletal structure composed of prefabricated elements and was widely used construction technology in the former SFR Yugoslavia for industrial housing construction, and refers to areas of seismicity of 7° and 8°.

It is used in the construction of residential buildings, but also in schools, hospitals, administrative buildings, garages, shopping malls and buildings of light industry.

The IMS system was developed in the Institute for examination of construction materials of SR Serbia, based on the idea of prof. Branko Žeželj. In the former SFR Yugoslavia, the IMS system was applied by fifteen construction companies.

Figures from 5. to 9. show floor plans of characteristic apartments and photos of the realized residential buildings (built with the IMS system) in the residential settlements "Borik", "Hiseta" and "Starčevica" in Banja Luka, "Alipašino Pole" in Sarajevo, and "Lenin Boulevard" in Niš.

In addition (Figures 10. and 11.) are shown the characteristic floor plans of the buildings and a display of the flexibility of the apartments in one of the buildings, as well as photos of the constructed buildings from the residential settlement "Cerak-Vinogradi" in Belgrade.

Figure 5. Residential settlement "Borik"- Banja Luka. [4]

Figure 6. Residential settlement "Hiseta" - Banja Luka. [4]

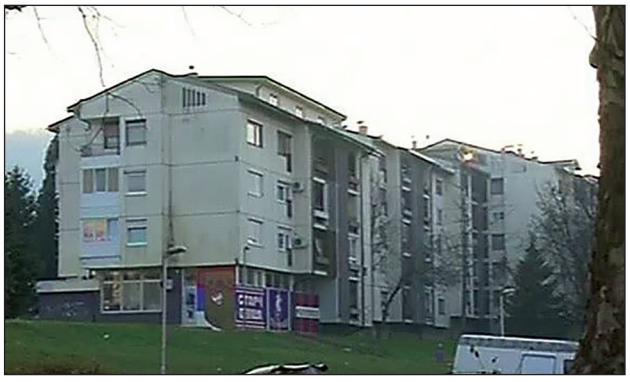

Figure 7. Residential settlement "Starčevica" – Banja Luka. [4]

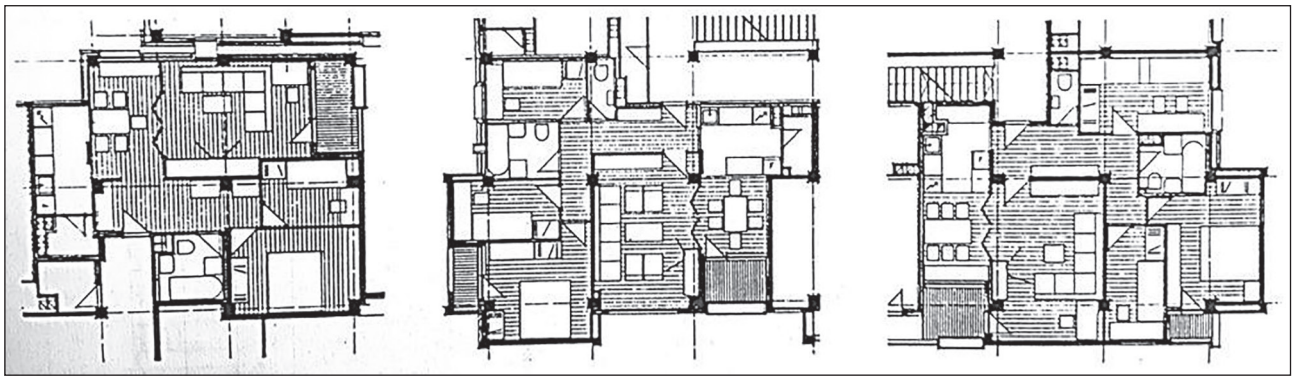

Figure 8. Residential settlement "Lenin Boulevard" – Niš. [4]

Figure 9. Residential settlement "Alipašino polje" – Sarajevo. [4]

This urban plan has been awarded the "October Prize" of the city of Belgrade for 1981. [4]

The same technology (IMS system) has been applied to a greater or lesser extent in Italy, Hungary, Austria, Cuba, Egypt, Angola, China and the former USSR. In order to more easily understand the concept of the IMS system, the elements can be divided into three categories:

- primary elements - parts that carry the loads of the structure: columns, floor structures, retaining (rigid) walls, etc.
- secondary elements - non-bearing parts: facade panels, partition walls, kitchen and bathroom units, etc.
- tertiary elements: finishing, carpentry, etc.

An important feature of IMS construction technology is that a relatively small number of industrially produced elements can be used in order to build a skeletal structure for buildings with different purposes. There is complete architectural and urban flexibility of the system.

The prefabricated prestressed reinforced concrete skeleton system IMS contains all the features of a monolithic skeletal structure, which offers designers a large and wide field of freedom in selecting the plan of the building, an aspect that is more an exception when it comes to prefabricated structural systems. [5]

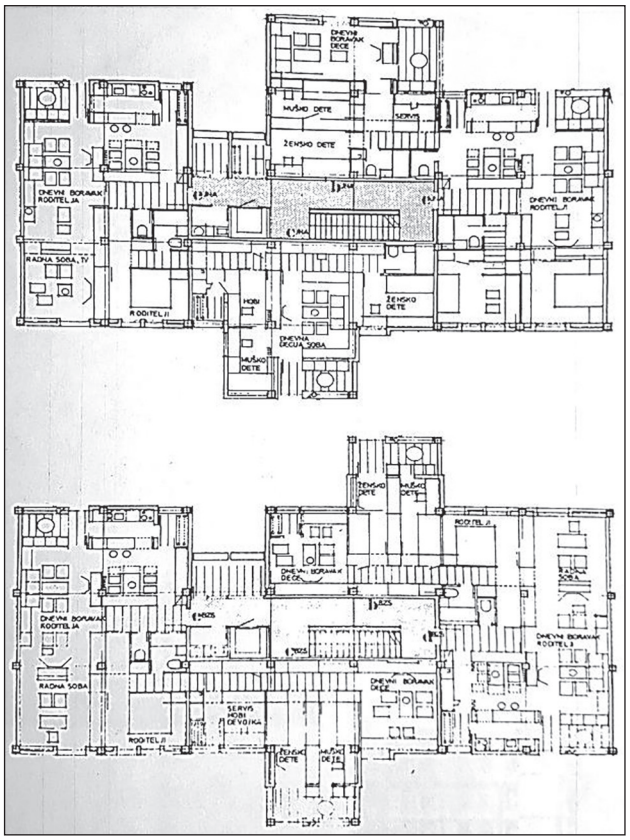

Figure 10. Residential settlement "Cerak-Vinogradi" in Belgrade, an example of internal variability of apartments with a change in the disposition of a whole group of rooms, without changes in the structural system, and with a small change in the total area of the apartments achieved by adding 1/2 module in one and a whole module in the other apartment. [4]

Figure 11. Residential settlement "Cerak-Vinogradi" in Belgrade, photos of realized buildings. [4]

3.2. System "NS - 71"

The system for industrial production of apartments "NS-71" is a fully-installed and at the same time "open" system.

The constructive conception is a skeletal system with modular spans from 3.00m to 5.40 m, from prefabricated hollow profiled columns with modular dimensions 60/60 cm and floor elements with ready-made ceiling.

Of the non-constructive elements, the system uses the following:

- brick or "sandwich" railings with various materials with facade cladding and thermal insulation from the inside,
- exterior walls of "keramzite" concrete with a height of one floor, with appropriate facade processing,
- wall curtain as a variant of the external facade walls at a height of one floor,
- internal partition walls of "keramzite" concrete d=7cm, between two apartments d=20cm or some other material,
- sanitary cabin with built-in installations and equipment,
- ventilation and smoke ducts with built-in "shunt" elements, at a height of one floor,
- carpentry - windows, doors, closets, etc.

This system takes care of adapting it to different architectural solutions by enabling the system to design in a grid with the most diverse combinations of standard spans.

The specificity of the system is in the way of installation, the reduction to a minimum of the installation of concrete on site and the use of "dry" installation. This installation indicates a rationalization in terms of time and labor, because concreting is reduced to a minimum, and medium-heavy and heavy-duty mounting elements generally have a small number of joints.

The system "NS-71" enables a variety of applications of rational spans, as well as a great opportunity in shaping and playfulness of apartment blocks vertically and horizontally.

Figure 12. Residential settlement "Limak 3" in Novi Sad, photos of realized buildings. [4]

The first buildings constructed in this system were: Block 3 in Novi Sad and blocks 2, 3 and 4 in the new residential complex Liman 3 also in the city of Novi Sad (Figure 12.). The designers of these buildings, who are also designers of the system, paid special attention to the selection and artistic processing of the elements in order to cre-

ate opportunities for the construction of special types of buildings.

The goal of the designers was clear and unique: to create a variety of ambient content that, despite the typification, will not be monotonous, and in the architectural expression will correspond to each other based on equally treated and important artistic properties. [1]

4. Conclusion

The fact that housing construction is becoming more of an economic than a technological problem is becoming undisputed. There is a misconception that the basis for economically rational housing construction is the condition that the elements of the apartment adapt to the conditions of industrialization.

Today, however, the technological system of industrial construction is more important than industrialization itself. Some possible preventive measures to eliminate the negative consequences of the mass application of standardized structures:

1. Recognizing that mass housing construction can not only aim at satisfying the quantitative and physical-qualitative needs of the inhabitants of the new settlements - and also encountering organizational and economic difficulties, many countries have opted for an "open" system that can be defined as mass, specialized and balanced industrial production of all building elements and subsystems whose compatibility is ensured.

The process of industrialization, in addition to increasing productivity in production, construction efficiency and achieving economy, must meet the requirements for aesthetics and high quality of human living space.

2. The flexibility of the internal and external elements of the apartment is praised as much as attacked: both as a principled approach and as a functional-technical method for solving certain problems arising as a result of the mass construction of standard apartments.

However, regardless of the (un) principled views of the professional experts: on the essence and methodology of flexibility in housing - the fact remains that the "ordinary" user of a serially built apartment (as well as any other) has, and will have, indisputable needs for adapting its basic environment to its specific needs.

"Closed" building systems with their incompatible primary and secondary structures (and "closed" economics), even when they could, did not provide such opportunities - so there is reason to believe that "open" systems of primary structure and with a greater degree of freedom for the secondary structure, and with a greater technological connection, would be significantly more suitable for it.

In the evaluation of the apartment and the settlement, the users in the first place, even in terms of aesthetics, will put their functional values, the general atmosphere in the settlement, rather than, the architecture of a separate residential building or a larger ensemble of buildings.

Therefore, architecture as a creative discipline, should be fully in function of these social requirements and enable us to build both rationally and close to the needs and desires of users.

The ultimate goal of a settlement in our time is to provide the inhabitants with a creative and inspiring environment in which they live. Creative means a settlement with great diversity, which enables freedom of choice; that settlement in which there is the most vivid connection between the inhabitants and their surroundings.

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Contemporary city as an organism –green city strategies

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Cities can be regarded as organisms, and analyzed as such, in an attempt to improve their current environmental performance and long-term sustainability.

E. T Graedel

Abstract

The modern city is the residence of various organisams. Therefore, the city becomes an organisam that has a metabolism. This metabolism creates waste that is fatal so the city becomes both a criminal and a victim. Although quiet and shy, the idea of developing a green city began as early as the late nineteenth century; the self-sustainability of cities, viewed through the prism of today as the technology and possibilities of the modern age, is a popular topic in the last few decades. This paper looks into with the issue of green city, green urbanism as well as self-sustainability. Demonstrated through the classification of degradation, history, vision and principles, the paper gives examples of the possibilities and achievements that a green city has.

Key words: *green city, self-sustainable city, eco city, sustainable urbanization*

1. Introduction

The future of urbanism and the development of the city itself largely depends on new technological achievements and primarily the understanding of new urbanism. The new urbanism is based on the theories of eco-cities, and in the last few decades, urban planners, architects and many other scientists have been actively dealing with this issue. The Archigram Group (Figure 1) bases its theories on the New City on the theories of Technical Utopianism; also called techno-utopia, it is a theory that refers to an ideology that is based on the assumption that science and technology will lead to utopia and that the utopian ideal will be fulfilled [1].

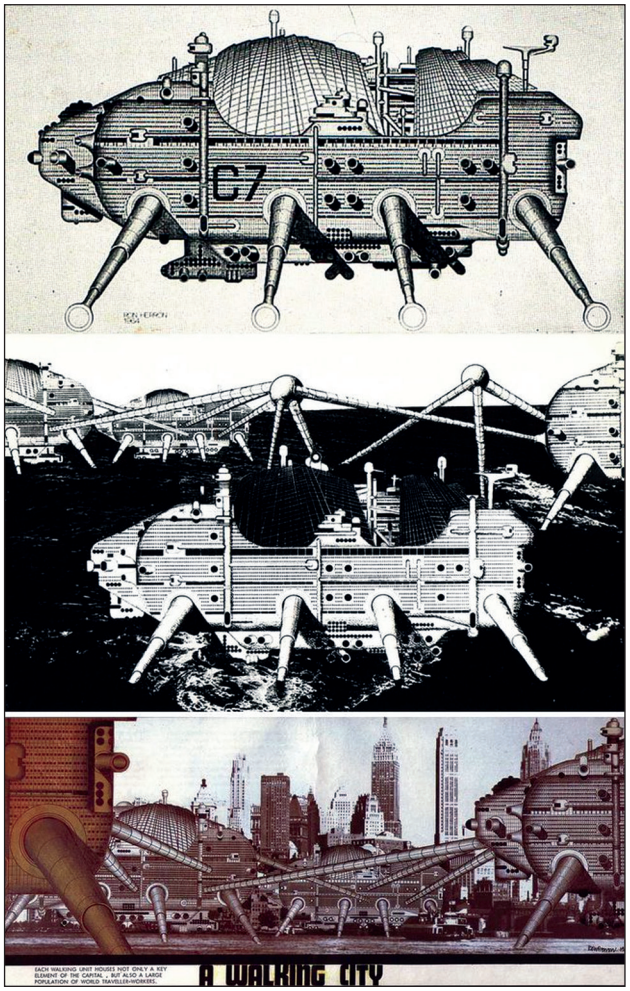

Figure 1. Archigram, Walking city, 1964 [2]

Hypothetically speaking, techno-utopia is an ideal society in which, with the help of science and technology, ideal conditions for social welfare have been created. In Britain in the late nineteenth and early 20th century, Ebenezer Howard founded the Green City movement. This type of city is breaded as an independent community surrounded by a green belt and containing proportional areas of housing, industry and agriculture. Garden City theory has become very popular in many ways.

Although not enough, the idea of a green city and green urbanism is part of public opinion. Today, it is common knowledge that uncontrolled development leads to deteriorating living conditions not only locally but also globally. In the last few decades, some American cities have tightened urban legislation and set boundaries for construction, which has hampered the uncontrolled expansion of the suburbs (urban sprawl) at the expense of green spaces. As it was popular to live in the suburbs in the 1980s, fashion is changing cyclically and today an increasing number of young couples want to stay in the cities [3].

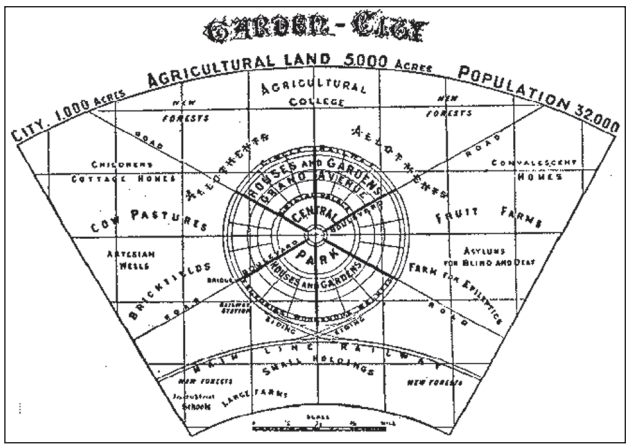

Figure 2. E. Howard, Garden City, 1902 [4]

With the emergence of mega cities (cities with a population of more than 10 million), urbanism got a new face. Cities like Tokyo with 37,900,000 and Delhi with 26,600,000 inhabitants and like many other mega cities, face problems of crime, homelessness, gentrification, inertial slum creation as well as problems of air, land, water pollution; and all as a consequence of rapid urbanism.

The very beginning of the twenty-first century brings us new concepts of urbanism whose essence is a green city, an eco-city, a smart city; new concepts try to provide answers to the existing "rotting" of cities and return their fragmentation to a compact form. The new theories focus on improving the connection between the city and the countryside, between the urban and the rural. Many well-known sociologists, urban planners, architects and others consider this emerging problem from the standpoint of globalization, urbanization, ecology, information, technology and others. In response to these reflections, realized projects emerged as a silent revolution and a turning point in the new urbanism; Solar cities ie settlements in Austria and Germany as well as BedZED (Beddington Zero Energy Development) a settlement in south London (Figure 3) that has zero coal emissions [5].

Figure 3. BedZED, London, 2007 [6]

Just as the mass use of cars has resulted in the need for wide roads and a complex network of roads and thus a certain type of urbanization, so the realization that climate is changing will have equally great changes in urbanization; a new typology of urban living. Cities can and must become as ecological a model as possible for the settlement of the globe [7].

2. Urbanisation and environmental degradation

Urbanization and environmental degradation have always gone hand in hand. Scientists and ecologists clasify the cities as "parasites" in the natural environment because they do not produce food, pollute the air and purify only small amounts of water. This way of exploitation and disharmony will undoubtedly lead, and has already led, to catastrophic consequences. Although the negative impact of urbanization on the environment began earlier, industrialization (early nineteenth century until the middle of the last century) is actually the beginning of real degradation and destruction of the environment at the expense of urban sprawl. The use of energy from non-renewable sources has rapidly increased in this period due to the use of mechanization, and with it the pollution and degradation of the environment. In the middle of

the last century, this situation began to change with the development of the global city; rapid population growth in cities and the globalization of the economy. Cities have become hubs of materials, waste, and labor [8]. Thus, environmental problems have become both local, and regional and global; and cities became the main causes of it.

As Raydin suggests, cities have become both victims and villains at the same time [9]. Cities, megacities, generate huge amounts of heat (urban heat) which affects the climate cycle and thus creates unfavorable living conditions. With this, the circle of the villain and the victim is constantly turning. Opinions are divided, but it is believed that the cause of major weather disasters, tsunamis, cyclones, major storms as well as coastal erosion and sea level rise as well as instability and large changes in biodiversity are precisely urbanization and megacities. This whole scenario is in a critical state and requires urgent action in order to establish a new, ie save the existing urban ecosystem and primarily the human factor in it.

3. History of the green city

Green or eco-city is a city that was created with the aim that housing in it has a minimal impact on the environment and whose inhabitants minimize pollution and use of water, air and land. Although "green urbanization" began in the late 19th century with the introduction of drinking and sanitary water systems, the term green city or eco-city was first used in the 1970s [10]. There is no fully defined theory of what a green city really is and what paradigms are included in its framework. In general, experts agree that a green city should respond to the needs of today without compromising the needs of future generations. The ambiguity of this idea leads to many variations in the ways of sustainability in cities. A green city, in that sense, should be able to sustain, feed itself with minimal reliance on the environment. The core of this is the creation of minimal waste as well as the efficient use of land and the use of recycled materials. In this way, all municipal waste will be reduced and thus the impact on climate change will be reduced.

It is assumed that half of the world's population today lives in cities and urban centers [11]. These large urban jungles are the basis for developing new environmentally sound theories and approaches. Due to the fact that people are social beings and tend to cities as centers of social development and life, these are the places where interactions and ideas come to the fore. These urban systems can be sustained even more easily than in rural eras. The fact that cities and urban eras are densely populated goes in favor of saving energy, transporting certain things ....

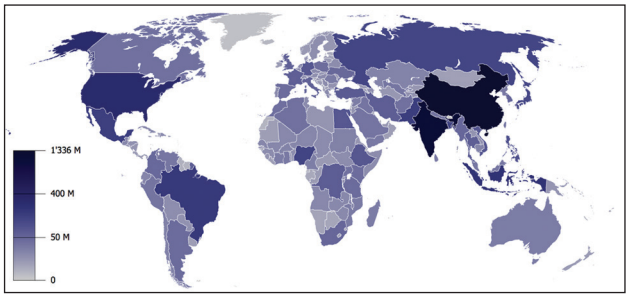

Figure 4. Mapping of the worlds population [12]

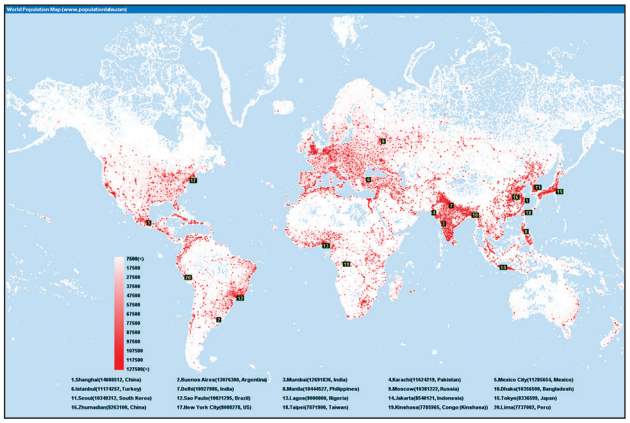

Figure 5. Urban centres [13]

With the arrival of the new urbanisation, the global city is in competition with itself, as well as, with each other. Lehmann believes that there are three basic parameters on the basis of which cities compete; first they must be attractive, beautiful, creative and cultural centers in order to attract a qualified population; secondly they must be recognized as a place of secured investment and thirdly they must have a vision of a green city and an eco-frendly approach to lifestyle [7].

4. Vision of the green city

Figure 6. Vision of the green city – Philadelphia [14]

The vision of green urbanism and thus the green city includes programs, legislation and design for renewal and environmental sustainability. As Lehmann suggests, a proactive vision of what zero CO2 is and a future with renewable energy sources should be added: the overlap of multifunctional facilities, typologies of living and working facilities, infrastructure systems for sustainable development, public transport and effective energy efficient design [7]. Social sustainability and a healthy society are prerequisites for the vision of a green city. The basic guidelines in the framework of developing a vision of a green city are:

- to live within its ecological limits, reduces its pollution
- to operate in parallel with nature; climate, location and context, optimizing natural resources
- calm and clean with a healthy microclimate
- to reduce or no CO2 emissions;
- to eliminate the concept of waste; create an ecosystem of recycling, composting and reuse
- has local production of food ; local gardens and urban agriculture
- to supports a healthy life
- water quality; usage
- uses green areas, gardens and green roofs to increase urban biodiversity and mitigate heat.
- uses a multidisciplinary approach as a guide to city government.
- it has facilities that are located and oriented so that the facilities are cold in summer and warm in winter.
- uses solar energy through the application of solar panels
- creates an authentic cultural experience
- uses local and regional construction materials
- has easy access and mobility; public transport on alternative propulsion
- uses new technologies such as solar cooling
- uses the principles of urban ecology

In front of these, above mentioned principles, in Graedel's words, a green city must be conceived and planned so that it can grow and develop as the population in it changes and grows [15]. This is very important from the principle of infrastructure. These infrastructural networks must be designed so that they are easy to modernize and upgrade.

5. Principles of the green city

The definition of green urbanism and thus the creation of a green city is the creation of communities that are beneficial to people and the environment. It is a way of creating self-sustaining places, communities and lifestyles in general; a way to rely less on nature and live more with it. This way of urbanization is achieved by interdisciplinarity in which urban planners, architects, engineers, ecologists, sociologists, economists and many others collaborate and are equally involved. Green City strives to minimize the use of energy, water and materials; as well as the use of materials in the construction of buildings that can be recycled once the life of the building is over. The principles of the green city are within the "three zeros"; zero use of non-renewable energy sources, zero waste and zero CO2 emissions. According to Lehmann [7], the self-sustainability matrix contains certain principles that are important as a precondition for the creation and development of green cities:

• Climate and context

The urban development of a city must be in harmonious connection with the specific character and context as well as many other factors of the location. The process of design and urbanization should take advantage of the advantages that a particular location offers, be it cultural, historical, social, geographical, economic, political. The main element in this process is climatic conditions; they are a decisive factor in generating the form of a green city as well as in optimizing the architectural form and using materials.

•Renewable sources of energy

It is vital that the systems currently running our cities, which are based on the use of fossil stocks, grow into new ways of using alternative forms of energy; renewable sources. Optimization and balancing of energy consumption, and thus pollution and pollution, can be reduced or avoided by the use of smart technologies, the use of energy efficient standards and increased thermal insulation in buildings as well as the use of solar, wind and water power.

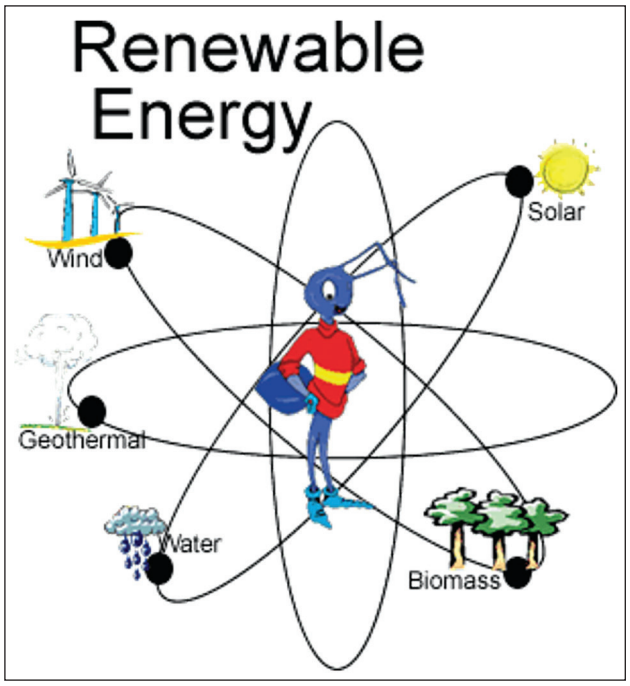

Figure 7. Renewable energy sources [16]

• Zero waste

A city with 0 waste is a city that is a closed ecosystem. Sustainable waste management means reusing waste. This includes waste reduction, recycling, reuse and composting all for the purpose of energy production. All materials including those used to build facilities and infrastructure as well as those used in everyday life should be recycled and reused. With this system, zero CO2 emissions and thus zero waste can be achieved.

• Water

Generally observed reduction of water use as well as its reckless use are the main aspects of sustainable water consumption. Concepts such as water reuse, recycling and the use of rainwater for irrigation are just some of the techniques that contribute to the concept of sustainable water use. Algae-based and biofilter-based water purification systems can be used to reuse rivers and lakes as swimming sites. Urban water recycling systems as well as the planning and maintenance of these systems are crucial and require appropriate infrastructure. At the level of household needs and water use, reducing the amount of water per household member can be achieved by installing a system with a lower water capacity in the bathrooms (toilet bowls), catching rainwater.

• Gardens and biodiversity

Urban planning should include and maintain green spaces; parks, gardens, green weeds. By introducing concepts such as city center gardens, urban agriculture as well as the concept of green roofs and roof gardens, biodiversity is increasing. Planting trees as the largest air purifier should become a common practice. Easy access to parks and recreation centers are the main components of a green city.

Figure 8. Example of the roof garden simbrown. wordpress.com [17]

• Sustainable public transport

The transport sector, both public and private, is responsible for much of CO2 emissions. Changing the fuel of public transport, as well as its increased use and reduction of the use of personal vehicles, contributes to a significant improvement in air quality. Alternative modes of transportation such as using a bicycle or walking are some other ways to improve. Planning walking zones, electric cars and buses are just some of the ways a green city should have.

• Use of local materials

Use of locally produced materials that require less energy for manufacturing as well as for transportation; use of prefabricated modular systems. In order to achieve green improvements the city needs to improve and redefine material use specifications. New technologies and the study of materials and thus prolonging the durability of the building, as well as the reuse of all materials when the shelf life of the building expires are the principles of sustainability.

• Population density and reuse of abandoned parts of the city

Proper planning and urbanization of green areas are important factors in reducing agricultural land. Transforming centers into compact communities and creating flexible typologies for life and work. This is achievable through multifunctional urban interpolations, by revitalizing abandoned parts of the city in order to create housing units; self-sustaining communities.

• Green architecture; using the principle of a passive house

We need to see the importance of the city as a whole. Passive houses are individually observed as a base, the beginning of the creation of a green city through green architecture. It is necessary to create objects that are functionally "neutral" and that last longer. Facilities that, in addition to using solar energy and new technologies of facade systems (bio-climate architecture), generate more energy than they consume, which have water collection and purification systems are achievable.

• Healthy society and multifunctional facilities

Focus on affordable housing, as well as the integration of various activities (economic, cultural, social, sports ...) and avoidance of mono-functional facilities. Demographic change is key to urban planning and in this context housing projects need to meet these needs and be flexible. User diversity is key. Flexible typologies and 24-hour facility use are one option to maximize facility utilization.

• Locally produced food

The green city should have adequate areas for growing and producing food as well as its exchange; in this case the transport of food is reduced. Composting is part of this process. Bridging the gap between urban and rural contexts is essential.

• Cultural heritage, identity and sense of place

The city should support a healthy life, various activities as the safety of its citizens. Cultural heritage is an integral part of new projects. Each city has a special character depending on where it is located (next to the river or the sea or in the mountains ...) depending on the climate, each situation is different. Green city design takes all these aspects into account.

• Good management

Cities are the collective responsibility of all citizens but the authorities need to play a major role in managing and running cities. The Green City Legislation should contain updated building regulations; to raise the world about the green city, to provide education, to improve the conditions for planning, to implement environmental management .... A city that thinks and plans on holistic principles, that implements every change harmoniously without destroying what has already been created and where decision making is the responsibility of citizens , is a city located on the path of a green city.

• Education, research and knowledge

The city is the center of institutions, galleries, libraries and museums. All these institutions are centers of knowledge. It is necessary to have good and easy access to education and opportunities for training and retraining of citizens. In this way, their knowledge will contribute to the creation of a green city. The way in which architects and urban planners have traditionally acquired their knowledge may need to be redefined.

• Strategies for cities in developing countries

Develop specific sustainability strategies for cities in developing countries, such as, training local people, creating new jobs as well as creating business structures that are in line with the impacts of rapid urban growth, urbanization and globalization.

6. Principles of efficient design

The principles for creating a green city should be based on a holistic strategy; the basis for this design is a combination of principles and solutions of traditional construction from previous experience with the principles of a passive house that have proven successful [18]. The largest consumers of electricity in buildings are technical installations for cooling, heating and lighting. Before buildings were heated, cooled, and lit in the way we know it today, architects used the principles of passive design to create interiors that were sufficiently lit and heated / cooled, without the use of mechanization. Typologies that developed in the middle of the last century, mostly public buildings and administrative blocks, changed the approach to design. Glass skewers as well as closed shopping center typologies are facilities that still dominate urban centers and require large amounts of energy for their maintenance. By considering and redesigning these types of buildings, and on the principles of passive design, the use of electricity would be drastically reduced. Green city architecture needs to go back and re-apply the principles of architecture from the past; we need solutions that can deliver the same or more with as little use of technology as possible.

The microclimate of each location can be modified. Through careful planning, optimization of outdoor and indoor spaces is possible; natural ventilation, orientation and natural space heating as well as room cooling are just some of the results of careful design. Vernacular architecture and traditional ways of building provide a good basis for this. Typologies of residential buildings of certain cultures have already been adapted to local climatic conditions and are creating optimal urban forms. Traditional courtyards in one-story buildings are a good example of cooling; for effective ventilation as well as air circulation there are several techniques for cooling the space, such as hidden courtyards and atriums, holes in the roofs, solar or thermal chimneys are just some of the ways to establish optimal design principles. The main principles of efficient design are (passive house principles): optimal orientation as well as adequate openings to control the entry of water and sun. (here one should pay attention to the ways of obscuring the space, ie placing the blinds); the architectural form should correspond to the location; cross ventilation and maximum use of daylight (use of vertical blinds or sunshades); a building designed to increase air flow and thus air exchange in all parts of the building; passive heating in the winter months; careful selection of materials (pay attention to the thermal properties of the material); green roofs (in this way the micro climate is maintained and heat is reduced); cooling through the system of the floor labyrinth (cold night air is brought through the openings on the facade which enters the space between the floor and the ceiling, and thus cools); appropriate colors on the facade; optimal dimming systems; well insulated facade and roofs. Combined, these design principles provide a variety of variations and possibilities and provide an answer to the effective planning of architecture as a green city base.

7. QUIET REVOLUTION - implemented elements of the green city

Although, to date, there are no green cities in their entirety, there are cities that have adopted development strategies in the direction of a green city. In Europe, the Scandinavian countries are at the forefront of accepting and implementing these strategies. Every green city has its own rules and principles in the implementation of sustainable elements. These principles or criteria vary depending on the location and climate zone of the city, and include the reduction or zero emission of CO2 or the revitalization of certain units and their conversion into green zones; greening of roofs, use of electric public transport and the like.

Through the presentation of the four cities and their initiatives, we will introduce ways of sustainable systems that have been implemented.

• Vancouver, Canada - use of energy from renewable sources

Vancouver in Canada is considered one of the most optimal places to live and by 2020 the city aims to become the “greenest city” in the world. The city is already a leading power in hydroelectricity where 90% of its needs are met through the use of energy from renewable sources; wind, sun and sea [19]. The city also has an extensive net-

work of bike paths (approx. 400km). As part of its 2020 target, Vancouver, although currently having the lowest CO2 emissions, has set a reduction of an additional 33%. This is supported by stricter construction legislation for the use of certain materials, as well as the construction of only carbon-neutral facilities. Although electric buses are already used in public transport, as part of the plan, the city plans to increase the network of pumping stations and the number of vehicles to 15% of the total number of buses.

Figure 9. Solar panels in Vancouver [20]

• San Francisco, USA - electric vehicles

The wider area of the city of San Francisco is classified as the number one green city in America. The city recycles 77% of waste and 20% of its area is covered by parks and other green areas. But what puts San Francisco at the forefront is the use of electric vehicles. The city owns 160 public electric pumping stations with a plan to build another 2,750. The San Francisco taxi also goes on electricity. The city has over 1,000 electric vehicles and 5,000 hybrid vehicles [21].

Figure 10. Electrical vehicles in San Francisco [22].

• Curitiba, Brazil - green areas

As part of many years of planning, Curitiba changed its legislation in the 1970s when it comes to green spaces. Unlike that period when there was only 1 m2 per capita in the city, now there are 52m2. Over a million and a half trees have been planted in the city, along the streets, and 28 parks and wooded areas have been created. In addition to these fascinating facts, the inhabitants of the city use a transport service that has become a world-famous example of efficient transport. Ninety percent of the population recycles two-thirds of its garbage on a daily basis and the city has even devised a system by which waste is exchanged for transport tickets or fresh produce [23].

Figure 11. Green areas in Curitiba, Brazil [24]

• Copenhagen, Denmark - bike paths

Copenhagen has set itself the goal of becoming the world's first coal-free city by 2025, and in addition, building regulations require that all roofs be greened, that all new construction include so-called pocket parks or pocket parks that are about half the size of a football field. all residents were allowed to be in the park in less than a 15-minute walk. Due to the check, Copenhagen tops the list of green cities is the fact that more than the weight of the city's population (approximately 1.2 million inhabitants) uses bicycles as their main means of transport. The city has over 350 km of bike paths and another 70 km is planned by the end of 2015. In addition to this, the whole of Norway uses 19% of the energy generated from wind power [25].

Figure 12. Cyclist in Copenhagen [26]

Conclusion

In concluding this text, it is important to emphasize that the several initiatives presented do not constitute a green city; they are just a sign that we are on the right path. Innovative solutions are the beginning because the problem of creating a green city is complex. The problems that every potential green city is facing are deeply rooted in all its structures. According to Girardet, as long as the city thinks linearly (input of raw materials into the city and output of raw materials, ie waste from the city) and not circular (input of raw materials into the city and recycling and output of waste from the city), the future of the green city is uncertain [15]. As mentioned earlier, city planning requires holistic principles and a layered approach as well as adapting green city strategies and principles to the context in which it operates.

Much of what makes a green city essentially simple and subtle urbanism. Such urbanism should become the basis for spatial planning in the future. A behavior matrix is needed to facilitate this type of design. With additional research and implementation of existing occupations, as well as more understanding and assistance at the local level, the green city is not far from us.

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Identification and valorization of elements of the Alhambra's authentic gardens

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Abstract

The aim of this paper is the identification and valorization of the gardens' authentic elements, in particularly observed through prism of ethic and religion. As an example, the paper uses the traditional elements and characteristics of the Alhambra gardens. The paper first presents the development of the Alhambra complex, one of the most famous in Islamic art. The Alhambra steadily developed in the 13th and 14th century thus gradually creating the entire complex. Such spatial conception relies on Islamic principles and the relationship between man and nature. Therefore, the analysis of this treasured space also explores the relationship between the philosophical ethics of nature and religion.

Key words: *Alhambra's gardens, open space, traditional elements, ethics of nature, Islamic art*

1. Introduction

Cultural interfusion of different civilizations and the intertwinement of their ideas have always existed in human creation. Humans assigned natural and supernatural characteristics to nature. They were creating cults, myths, sects, religions, and beliefs in whose center was almost always nature or some natural phenomenon.

Garden art in this paper is founded especially on the characteristics of Islamic culture in medieval Mediterranean Europe. Such gardens are the most recognizable in Spain (the Alhambra and Generalife in Granada).

In Islamic architecture, space is never separated from the form. Space is not only a frame where the form sets. Forms characterize the space they are set in. That means that the walls of the courtyard and arches determine the space within the traditional Muslim town or a house, typical for the Alhambra's gardens.

The space is cut in a manner that reaches the synthesis and unites different aspects of life. Islamic architecture is prone to the polyfunctional usage of architecturally designed space, Skliar concludes. The groundwork of formating in Islamic creation is derived implicitly out of a religious assumption of paradise [1]. Original, formed scheme emerged within Islamic creation, as a rule, geometrical frame, and an equally regular crisscrossed fragmentation within it. Vegetation is placed entirely irregularly. Therefore, water takes over the symbolic and practical role. According to Kalin, common features had always existed among the oldest civilizations. Sumerian, Babylonian, Assyrian, Egyptian, and ancient Indian and Chinese cultures did not formulate general rules and principles in their teachings about nature and the world. Motivation for observing nature was a practical need while the foundation of learning is empiricism - experience and observation. There is no question 'why' not even the answer to it. Therefore, the ideal in ethics is that one should live following the nature of the world and one's rational nature [2].

2. Philosophical ethics of nature and religion

Ever since civilization's beginnings, humans have been fascinated with nature, natural phenomena, and the realization they are a part of it. Hans Jonas describes nature as a 'person'. Nature could survive without humans but humans without nature could not. German ecologist Klaus Meyer – Abisch sees the continuation of nature within us, where it becomes language and art, while other beings live its life – that is the true existence of nature. Our lives and the life of the world around us are nature's existence. That *"natura naturalis"* – the creative force is all around us. That is the reality of the world's center [3].

"Isn't nature divine, and as such enriched with inner values, and man is not her master and ruler but a mere part of it?!" [4]

The history of Islamic thought sheds plenty of light on the logic of history. Controversies over the rules that govern history exist for a long time. Idealists like Max Weber, Windelband, and Rickert believe undoubtedly that historical events are exposed to the influences of biological, geological, and racial forces. However, those forces are always executed by human beings, who use and rule over them.

"Just like the divine laws are immutable but reflected in the changeable, temporal, and historical world, the eternal and immutable essences manifest following those laws but in changeable forms. Authentic achievements of Islamic art are based upon those essences…" [5]

This quote by one of the most renowned Islamic scholars, Eva de Vitray, guides us nicely into the topic of the role and significance of Islamic art and its reflection within the frame of the world's art.

Thereby, Islamic art was considered as a way of seeing the truth as beauty in history based on its transhistorical and timeless dimensions. Its essence and primordial character does not depend on temporal forms and temporary worlds of culture nor does it depend on what has manifested and that is prone to changes. It depends on what the world in its multitudes invokes from the bottomless pits of the spirit. The ideal in ethics is to live following the nature of the world and one's rational nature [6].

German ecologist, Klaus Meyer – Abisch states that existence of nature is expressed as our lives and the life of the world around us. Also, the creative force *"natura naturalis"* around us is the reality of the world's center [7].

Luc Ferry in his book The New Ecological Order analyzes practical consequences and political implications of ethics not based on humans but on nature itself. Those are defined as "ecological", as an organism of higher-order with particular interests and rights. *"The love of nature poorly concealed the hatred of men"*, can be pointed out as one of the book's highlights [8].

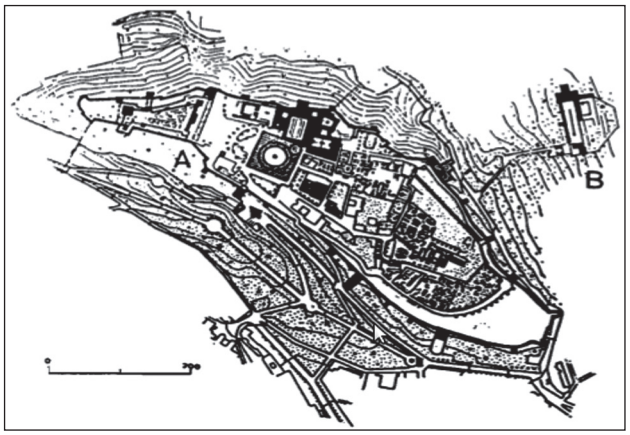
Aldo Leopold, an American naturalist, ecologist, conservationist, philosopher, educator, a writer is a man whom many consider a founder of wildlife preservation in America. He was one of the first who has based ethics on ecological examination of natural processes and contemporary theory of evolution, not on the spiritual, religious, and moral approach to nature. He is well known to millions of people for his concept called "The Land Ethic" [7].

3. The Alhambra

The Alhambra (El – Hamra) is a palace complex of the Nasrid Dynasty in Granada. It is one of the most famous examples of Islamic art and at the same time, the pinnacle of medieval Islamic culture on the Iberian Peninsula. The history of the Alhambra complex can be traced to the 9th century.

3.1 Formative architectural characteristics

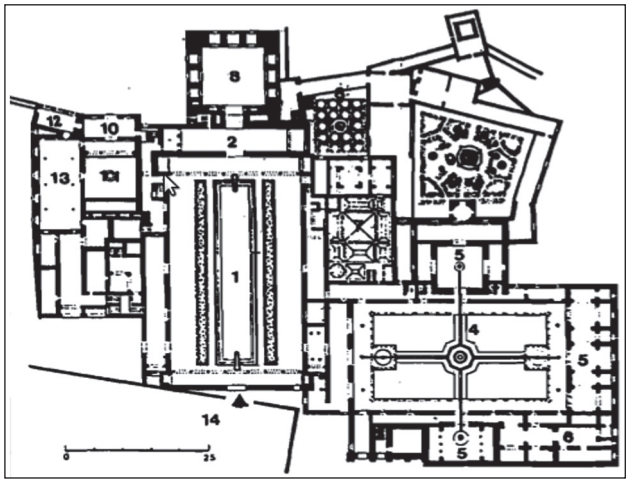
The Red Fortress is mentioned for the first time in the annals around the year 860. The oldest buildings in the complex of the Alhambra date from the 11th century and the Zirtians Dynasty. The Alhambra we know today started getting its configuration during the rule of the last Muslim sultan on the Iberian Peninsula during the first half of the 13th century. This Nasrid Dynasty proclaimed Granada as their capital.



Picture 1. The Alcazaba Complex – sultan's fortresses in Granada with the monumental Alhambra (A) and the summer residence Generalife (B) [9]

There are very little data about the construction of the Alhambra, the costs, architects, or life within its walls during the Nasrid Dynasty. The first sultan who took over the royal seat in the Alhambra was Muhammad IV. During the rule of his

heir Yusuf I, the palace was lavishly decorated. The palace reached its highest glory during the reign of Muhammad V who ruled twice throughout the 14th century. In that period, The Palace of the Lions and the Mosque with the Courtyard of the Myrtles were constructed [10].



Picture 2. The ground plan of the Alhambra [9]

From the geographically most advantageous position at the high plateau, the Alhambra watches over the Kingdoms beneath. The Alhambra was the administrative and political center of Granada. Therefore, it was in the spirit of the typical Muslim palace complexes that consist of the ruler's residence and government buildings. The Alhambra's development followed the order of the architectural ideas of the medieval Islamic culture.

It is constructed as an independent fortified city, separated from Granada with the long walls, with about 30 towers of different sizes and functions. Granada and the Alhambra are two cities that complemented each other but that were independent. The only touching point was The Gate of Arms. The parties used it to enter the palace complex and plea for the royal reception, to finish administrative work, pay the duties, or run some other errands. The Alhambra's city walls have four big gates almost equally set, two on the northern and two on the southern side. The Alhambra is highly esteemed due to the Palaces of Comares and Lion, built during the 14th century. From the 16th century, both were renamed to Casa Real Vieja ("Old Royal Palace") to differ from Casa Real Nueva ("New Royal Palace") the grand renaissance palace of King Charles V built at that time [10].

3.2 Symbolically ethical messages of formating the Alhambra's gardens

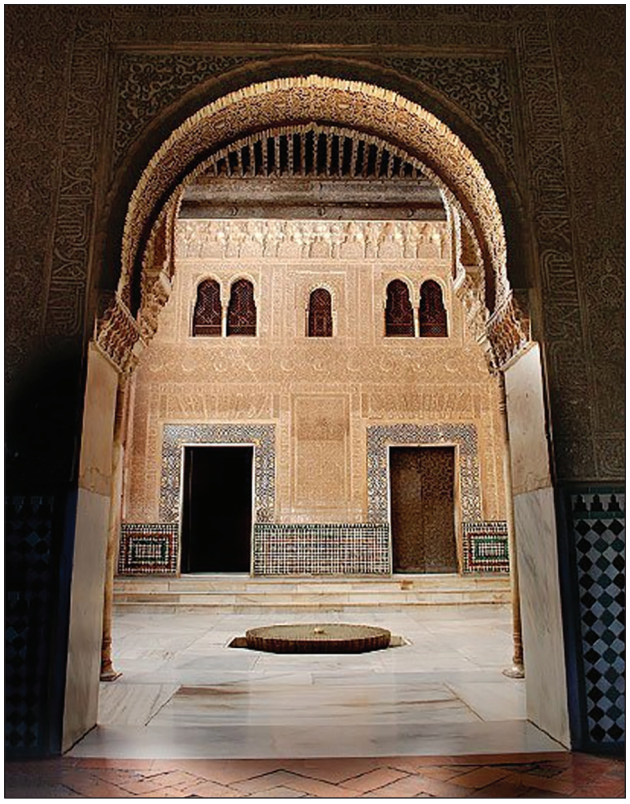
The strong contrast between the outer and inner courtyard where the rooms are is typical for the Islamic architecture on the Iberian Peninsula. The same applies to the palaces. The inner courtyard sweeps over the senses with the richness of colors, smells, light, and imagination.

The way palaces were divided into chambers helps us conclude they had administrative functions as well. That arrangement starts with a series of inner courtyards, arranged hierarchically to limit the entrance to those courtyards with controlled access. Different decorative styles of the palace express power and supreme rule, and they must have invoked reverence in everyone who would enter it.

At the center of the Myrtles courtyard is a rectangular pool. Nearby buildings reflect on the

Picture 3. The view from the hill of the Albaicin on the Alhambra's palace complex [10]

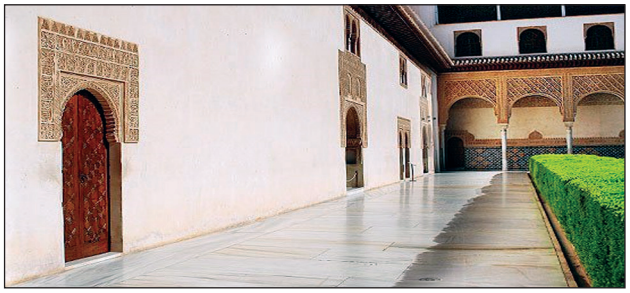
pool's calm surface, thereby creating the impression of spaciousness, which makes it a crucial architectural element. On the narrower sides of the courtyard, the water flows out of two fountains and runs by spilling through tiny openings at the corners. The water circulates making the surface of the pool smooth as a mirror which the Arabian poets call the sea.



Picture 4. The inner courtyard [10]

Picture 5. The main façade and the courtyard of the Comares Palace [10]

The most elegant residential spaces are mostly placed in northern parts, lit by the south. In general, the aspiration to keep the privacy and the intimacy of space meant that the rooms did not have openings on the outer walls, but were directed to the inner courtyards. There the portico marked the openings of the most elegant premises, almost always placed on shorter sides of the courtyard.



Picture 6. The southern side of the Myrtles Courtyard [10]

The most famous part of the Alhambra is the Court of the Lions, *Platio de Los Leones*, with its marble fountain supported by chiseled lions. Four water channels are projected from the fountain to all four sides of the world and they enter the palaces' premises. Those premises are encircled by 124 slender and elegant marble, ivory, and cedar columns. The walls are covered with popular and colored tiles called *azulejo.*

Picture 7. Fountain in the Court of the Lions [10]

Even in the 14th century, the hydraulic system ensured sufficient pressure and level of water in the fountain. Twelve lions with their jaws of running water, according to Hattstein, symbolize 12 zodiac signs, therefore the eternity [10].

The main illustrative conception of the Islamic garden the Arabs brought to the Iberian Peninsula is founded on the synthesis of two opposite tendencies. Its characteristics are the oriental richness of the motives and aspiration towards the abundant decorativeness; the classical clarity of the overall composition which we can also see on the Portal

Palace (*Palacio de Portal*), the oldest palace in the Alhambra built in the 14th century. The only remaining original structures are the big central pool and the portico with five arches, the reason the palace got its name. Arcades from that portico originate from that part. In front of it is the usual, elongated pool. By the end of the 19th century, this part of the Alhambra was divided into small, private parcels that the local governments gradually repurchased to encircle the memorial complex.

Milić concludes that in this general concept, already copiously elaborated by Persia, the Arabs brought in almost fanatical idolatry of water and greenery as its own genetical heritage of their nomadic ancestors. Water, an invaluable commodity and synonym for life in the desert homeland of Arabic culture, more than in any other historical period became part of everyday life and every religious ceremony. It is an integral part of any bigger architectural ensemble, the central motive of every garden composition [9].

Shelter, water, sanctuary, and shade are the heritage elements of the Islamic style. The garden is understood as a separate world, detached on purpose from the daily worries of the nomadic desert life. That is a place where the view on the water with an appropriate sound atmosphere has a crucial role.

It can be concluded that these practical forms of the Islamic garden, originally applied only in the hot, dry parts of the world have a deeper, philosophical meaning. The gardens mostly used the water. It represents the holy motive in the form of mirror fountains and pools. On the other hand, it expresses power and prosperity. Philosophically, the essence of creating the Muslim garden is infinite dawn stretched beyond the visible, material world. Maybe the most important channel is the one in the shape of a cross that cuts the garden into four parts. Symbolically, it represents four main rivers in Paradise written in the Qu'ran. In one river flows the water, in the second milk, in the third wine, and in the fourth one, purified honey.

Picture 8. The view on the Portal Palace and the garden details [11]

4. Conclusion

While tracing the philosophical thought through the history of human civilization, in this case, mostly the civilizations of the East, we encounter different, sometimes difficult questions and views. We have seen that Islamic art is abstract and that it combines the flexibility of the line while emphasizing the archetype. That is why mathematics has so strongly affected the Muslims. Its abstract nature has set the bridge between the multitude and oneness they sought.

Considering that nature had been creating some sort of fear, the man assigned to nature and its rhythm of life and death divine traits. First religions had tied their rituals to nature's rhythm and those religions adjusted a man to nature's rhythm. Therefore, the harmony between man and nature implies man's aspiration to submit to nature.

In modern times, man as a subject changes the relationship between man and nature. We no longer consider him as someone who has to adjust to nature. On contrary, we consider him capable of determining that rhythm. For him, nature becomes an object of exploration, planning, and exploitation thus becoming its sovereign. The initial relationship of adjusting disappears and in its place comes the submission of nature to the man's will.

When we think about the preconditions of life, we touch upon faith because faith lives only on the grounds of creation. Life was created. Our space is the space of nature and the outside world. Eastern philosophy perceives man as a secondary phenomenon, and art portrays him that way. In paintings, the scenery is in the focus while the human figure is small, somewhere in the background. Nature is primary.

As Isanović concludes, Islamic architecture emerges from respect for nature. It cooperates with nature, becoming its extension and complement [12]. Architectural and spiritual harmony of simple palace forms, carvings of inner arches, walls, and ceilings, reflect in square or rectangular pools of calm and green water. They intertwine with stone fountains and their subtle water flows. Series of courtyards and open chambers create the unity of outer and inner space joined by exquisitely decorated walls, sunlight that reaches inside with the murmur of water.

We can conclude that Islamic art is actually a constituent of the entire ecological harmony, considering that it has always emerged in consent with the powers and elements of nature. Therefore, it completely uses light and shade, warmth and coldness, wind, and aerodynamics, water, and its cooling effect, earth, with its insulating and protective qualities under stormy weather.

Islamic art influenced the basic principles of creating open spaces in the Alhambra. Islamic art developed on the principles of Islam, which can be seen on the principles of opened-closed, constructed-not constructed, as well as the relationship with nature, the connectedness of man with nature built for the measure of a man.

Comparing the landscape architecture of Spain to the one in medieval Europe, Spain represents a positive exception. Already in the VII century in Spain, regional Islamic architecture, known as Moorish style, developed. That style formed a special and striking style of gardens, based on the life that follows the principles of Islam. There was a multifaceted use of water: in the form of pools, fountains, water channels, etc. All of these elements were miniatures, like gardens. Water is an integral part of every big architectural ensemble, the central motive of every garden composition. Color is used on the principle of contrasts. Areas of lively colored flowers were in front of every tall greenery of the darker shade. Distinct shadows, even more, emphasized this contrast. This entire composition was in contrast with the white wall of the inner courtyard. The third element of the Moorish garden was the smell. It was emphasized by planting the oriental plants of pleasant and specific smells. Paths had also presented an important significance in the Moorish garden, which we can notice in the example of the Alhambra. By the rule, they were paved and elevated above the green planes because of the irrigation.

The Alhambra's gardens were resting places for the great Muslim kings. The Alhambra is a perfect example of harmony and beauty, architecturally reflected through light and water. Water, functioning as a mirror, contributes to the feeling of peace and airiness.

All these integral elements of the Alhambra's gardens may serve as guiding principles in the contemporary design of open spaces. Presented

elements follow the characteristics of traditional construction and confirm the suggested hypothesis of this work. The elements, regardless of the time of their creation, can still be used in contemporary design.

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Instructions for the authors

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Every sent magazine gets its number, and author(s) will be notified if their paper is accepted and what is the number of paper. Every corresponedence will use that number. The paper has to be typed on a standard size paper (format A4), leaving left margins to be at least 3 cm. All materials, including tables and references, have to be typed double-spaced, so one page has no more than 2000 alphanumerical characters (30 lines). Sent paper needs to be in the form of triplicate, considering that original one enclosure of the material can be photocopied. Presenting paper depends on its content, but usually it consists of a page title, summary, text references, legends for pictures and pictures. Type your paper in MS Word and send if on a diskette or a CD-ROM.

TITLE PAGE

Every article has to have a title page with a title of no more than 10 words: name (s), last and first of the author (s), name of the instituion the authors (s) belongs to, abstract with maximum of 45 letters (including space), footnote with acknowledgments, name of the first author or another person with whom correspondence will be maintained.

ABSTRACT

Second page needs to contain paper summary, 200 words at the most. Summary needs to hold all essential facts of the work-purpose of work, used methods (with specific data, if possible) and basic facts. Summaries must have review of underlined data, ideas and conclusions from text. Summary has no quoted references. For key words, at the most, need to be placed below the text.

CENTRAL PART OF THE ARTICLE

Authentic papers contain these parts: introduction, goal, methods, results, discussion and conclusion. Introduction is brief and clear review of problem. Methods are shown so that interested a reader is able to repeat described research. Known methods don't need to be identified, it is cited (referenced). Results need to be shown clearly and legically, and their significance proven by statistical analysis. In discussion, results are interpreted and compared to existing, previously published findings in the same field. Conclusions have to give an answer to author's goal.

REFERENCES

Quoting references must be in a scale in which they are really used. Quoting most recent literature is recommended. Only published articels (or articles accepted for publishing) can be used as references. Not-published observations and personal notifications need to be in text in brackets. Showing references is as how they appear in text. References cited in tables or pictures are also numbered according to quoting order. Citing paper with six or less authors must have cited names of all authors; if seven or more authors' wrote the paper, the name of the first three authors are cited with a note "et all". If the author is unknown, at the beginning of papers reference, the article is named as "unknown". Titles of the publications are abbreviated in accordance to Index Medicus, but if not listed in the index, whole title of the journal has to be written.

Footnote-comments, explanations, etc., cannot be used in the paper.

STATISTICIAL ANALYSIS

Tests used for statistical analysis need to be shown in text and in tables or pictures containing statistical analysis.

TABLES AND PICTURES

Tables have to be numbered and shown by their order, so they can be understood without having to read the paper. Every column needs to have title, every measuring unit (SI) has to be clearly marked, preferably in footnotes below the table, in Arabian numbers or symbols. Pictures also have to be numbered as they appear in text. Drawings need to be enclosed on a white paper or tracing paper, while black and white photo have to be printed on a radiant paper. Legends next to pictures and photos have to be written on a separate A4 format paper. All illustrations (pictures, drawings, diagrams) have to be original and on their backs contain illustration number, first author last name, abbreviated title of the paper and picture top. It is appreciated if author marks the place for table or picture. Preferable the pictures format is TIF, quality 300 DPI.

USE OF ABBREAVIATIONS

Use of abbreviations has to be reduced to minimum. Conventional units can be used without their definitions.