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The Methodology for Supporting Land Use Management in Collective Housing towards Achieving Energy Efficiency: A Case Study of New Belgrade, Serbia

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Abstract: This paper aims to establish a methodology for urban land use planning and management that provides an insight into the hierarchy of priorities between a large number of activities for planning actions, thus contributing to the concept of energy-efficient housing. This methodology includes three aspects of sustainable development: Economic, ecologic, and social, which serve as an overall criterion within which urban planners could make assessments of planned activities. The assessments are the core of the methodology—every aspect is assessed by concerning its costs, consequences on the urban environment, and the effects on the citizens' quality of life. Ten experts were involved to prove the methodology's effectiveness. As a result, a hierarchy between the activities is created, which would help an urban planner prioritize and order further activities. The applicability of the hierarchy was tested through a simulation of a reconstruction process of a collective housing area in New Belgrade, Serbia, from the view-point of land use and accessibility. This methodology contributes to the creation of the prioritized groups of activities, and a finalized hierarchy of the activities, while its application is seen in the process of making urban plans, and defining recommendations for its implementation.

Keywords: sustainable development; energy efficiency; land use and accessibility; collective housing

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1. Introduction

Contemporary urban planning is under a strong influence of the sustainable development platform. This implies the involvement of economic, ecological, and social aspects in planning processes and management of urban space and urban land [1,2]. It is recommended that all aspects should be equally treated while initially analyzing urban space, while the hierarchy of the aspects (which could be different for different situations in the city) should be established in further elaborated urban strategies [3]. All this adds to the complexity of an already compounded situation within urban planning and management. Nevertheless, it is a common opinion that simplification of this situation would be wrong [4], but "there is a need for a more harmonized approach to ease the burden for public authorities and support the needs of policymakers" [5] (p. 7.).

In addition to that, in the period from 2005–2009, a great number of countries have adopted and ratified several international documents regarding energy efficiency, thus taking over the responsibility to reduce energy consumption within targeted values in a certain timeframe (2020–2030) [6–8]

In cities, energy efficiency issues involve actions within several sectoral areas: Systems for energy production and networks for its distribution (technology of infrastructure), traffic and transport, urban planning, and construction [6], while the domain of special

importance for achieving the energy efficiency is housing [5,9,10]. The goals of achieving energy efficiency within the urban concept are: 1/ To reduce energy running costs while maintaining comfort levels, 2/ to enable residents to enjoy affordable sunlight and warmth, 3/ to reduce global and local pollution and 4/ to preserve non-renewable energy sources [5, 6].

Concerning the aforementioned, the problem that arises is the occupation of public urban land by private capital, especially in ex-socialist countries, among other reasons due to insufficient public awareness, but also the lack of experts' skillfulness to arbitrate between the needs of investors, state pressure and the protection of public interest. The result is slow or stalled implementation of plans and a large number of informal initiatives [11,12].

The existence of a methodology that would help professionals to establish a hierarchy between the activities planned for implementation, would help for quality professional argumentation, and would stand as a possible support for the implementation based on the principles of sustainable development. Such a methodological tool would serve to: (a) Help professionals establish a hierarchy between the activities planned for implementation; (b) help for quality professional argumentation, and (c) as possible support for the implementation based on the principles of sustainable development Baum points out that planning should necessarily presuppose the negative behavior of users (e.g., of investors in urban planning: (Illegal) acquisition the public space for private interest, disregard for the public interest as a whole, the sole purpose of personal profit) [13]. A procedure that would establish the order of activities so that the result in the space is satisfactory from the viewpoint of investing, environmental consequences and customer satisfaction, can be helpful.

1.1. International Scope—Land Use and the Smart City

The idea of Smart City is directly related to modern technologies and their use, with the purpose of achieving a clean environment, reduction of carbon dioxide emissions and the use of renewable energy sources. [14]. Butryn K. et al. mention four elements that are important for the idea of Smart City. Intelligent mobility is one of them, and the others are intelligent environment, intelligent people, and intelligent life. [8].

In the sphere of urban land use, experts point to activities provoking the changes that will lead to the application of the idea of sustainable development into practice, and also to the implementation of the ideas of Smart City to attract citizens. These activities are in the field of: Changing stakeholder policies, changing rules and conventional decision-making methods, and changing patterns of land use in order to achieve sustainability, with the guarantee that the cumulative effect of changes will not interfere with the continuity of community development, but it will contribute to the strength of community change [2,8].

Urban land is treated as a commodity for trade inside societies of the market economy, and in this regard, it is possible to establish characteristics of a quality land market inside the field of theoretical discourse: Efficiency (it encourages rapid development and urban land transactions); accessibility (it ensures proportional land accessibility to all social groups); compliance with the environment (implies sustainable use of the land market, by current and future users) and compatibility (it is integrated with other areas that regulate land development—these are urban planning, a system of taxation and providing of public infrastructure and services) [15,16].

Alonso concludes that different urban contents have their own rent price gradient, and also that better conditions in the field of transport (possession of a personal vehicle, good road network) cause increased land prices in the suburban areas. Still, as long as there is a presumption of availability of one's own vehicle, there comes an increased possibility of the urban sprawl [17,18]. Alonso's point of view is particularly significant because a location attempts to explain the urban form through analytical observation of the rental potential (which means linking land use and morphology). This model has become one of the pillars of the urban economy since the 1970s [19].

The project *Land Use Management for Sustainable European Cities/LUMASEC* was conducted in the period 2008–2010, as a thematic project of the *URBACT* program [20] and, among other things, it has resulted in a publication on Management for sustainable urban land use in Europe, with recommendations for strategies and tools for all participants involved in the decision-making process concerning urban land. In the publication it is pointed out that land-use management is a key topic for sustainable cities. It is also stated that land use management unites discussions on norms and visions as bases for policy-making and sector planning, as well as issues related to spatial integration, decision making, financing, participation, implementation of plans and examination and monitoring of results and evaluation of consequences [21].

Contemporary policies adopted by the EU have a strong influence on land use, and especially when it is about urban land [22]. A particular emphasis is put on the importance of high-quality management of cities and land, and also on the increased influence of policies and pressures that planners may suffer in this sphere, which are reasons to emphasize a need for stronger horizontal integration of policies and instruments at all levels of management, and improved vertical integration inside policy structures. Furthermore, the stress is on the obligation for adjustment to local conditions, as the key to achieving sustainable development as a whole. The need for low-cost housing in the European Union is also recognized as a significant topic [23].

Several innovative topics have appeared in a contemporary context: Evaluation techniques of planning interventions including social housing initiatives in the context of real estate development, various methodological approaches for regeneration of a public and social housing buildings through a public/private/partnership operation [23–25]. Intelligent transport infrastructure and the introduction of motion control sensors as an element of intelligent mobility are also contemporary topics that have their base in the idea of Smart City [8]. The use of computers and modern technologies in a contemporary Smart City will certainly contribute to the accuracy of data, which is important especially in the cadaster realm [14].

There are numerous examples of theories dealing with the issue of land use management in the Smart City, which combine the economic aspect with the ecological aspect (dealing with brownfield locations and public greenery) and with social aspect (including active public participation) [14,24–26].

1.2. Explication of a Problem—Serbia

Serbian urban planning system is based on a strict hierarchy of urban plans, according to Law on Planning and Construction [27], and it is a legacy from the ex-socialistic period when urban plans were practically the only instrument of the implementation of public interest. In Belgrade, the Master Plan of Belgrade (2016) [28], subordinates all other plans and local regulations at lower spatial levels. The citizens still mainly do not take part in public participation and public hearing, presuming the institutions would implement urban plans and would protect the public interest. This way the important decisions about urban space are easily left to investors who act in agreement with state institutions and adjust the space to their needs at a local level, which is not always within the public interest [11].

One of the examples is a recent procedure of reconstruction and street organization in the traditional core of Belgrade. At the info points, the works have been announced as a renewal of the infrastructure (hydraulic installations, lighting, and greening) within the existing street regulation. For most citizens, this was the first information that this intervention would take place. The result of the reconstruction is the transformation of several streets into pedestrian ones, without qualitative improvement of the traffic matrix and public space in the city center and without considering the wider traffic context.

The works were realized during the period from September 2017 to June 2019, and the legal basis was "Decision on determining the streets for pedestrian traffic in the city of Belgrade—pedestrian zones" [29], which was signed by the deputy commissioner of the

city administration of the city of Belgrade. This document was adopted in a closed session without public participation, graphics, and without explaining the stages of implementation. The document lists the streets in Belgrade that are designated for the repeal of motor traffic, including streets within the traditional city center. It has been stated that in certain streets, the movement of passenger vehicles for special needs, supplies, or adaptation works can be exceptionally allowed, provided they do not endanger the pedestrians. It has also been stated that elements of urban equipment and urban furniture can be placed according to the Catalog of urban equipment of the city of Belgrade [29,30].

It is important to point out that the valid planning documentation does not envisage the formation of a pedestrian zone in the form in which it was implemented. From the very beginning of the realization, there was a protest of the residents of this zone due to the difficult living conditions caused by the works, such as problems with waste collection, problems with electricity and water supply due to failures, reduced accessibility and mobility, and longer walks to public transport stations. The dissatisfaction of the local population continues even after the realization due to difficulties regarding the access to firefighters, ambulances and persons with special needs, and the unresolved problem of parking vehicles for local residents [30].

It is assumed that the urban planning practice would greatly benefit from the tools that would directly indicate the harmful consequences of the activities of this reconstruction—high costs and small environmental benefits, as well as all the consequences regarding the dissatisfaction of the citizens. With such a tool, it would be possible to prove the need for planning preparation, which includes the sequence of implementation phases and priority activities. Planning professionals in Serbia are, without a doubt, able to implement such a modern and valuable idea of relieving the city center from car traffic.

This work is structured as follows: In the initial chapter, the paper explains the wide scope and problems of actual urban planning, concerning sustainability issues, especially from the viewpoint of energy efficiency. The global scope of Land use and the Smart City is elaborated before the explication of the protection of public interest at a local level; it was discussed in the context of the countries that have undergone socio-economic transition, as is the case in Serbia.

Hereafter, the term Land Use and Accessibility is explained, as well as the terms Walkability and Pedestrian accessibility, since the focus of the elaboration of the proposed methodology in the paper is precisely in this thematic area.

In the next subsection, the selection of the case study—residential units of the modern urbanism superblocks for elaboration, was explained. After describing the aim of the paper and reviewing the literature, an explanation of the methodology was given as follows:

1/ A broad thematic framework for assessing the state of energy efficiency for residential units of the modern urbanism superblocks, was explained while stressing the choice of a specific thematic subgroup (land use and accessibility); and

2/ the proposed methodology was explained in detail and the steps are described. This part is divided into three sub-sections: The introduction about the methodology, the criteria for evaluating, and the assessment process.

The following is the elaboration of the methodology on a concrete example; the participants in the verification of the methodology are ten selected urban planning experts who deal with this part of the city. The final chapter contains concluding remarks, identified advantages and disadvantages as well as proposals for improving the methodology and its application.

2. Land Use Management of Collective Housing—Definitions, Notion

2.1. Urban Land Use and Accessibility

Within chapter 7. of Agenda 21, there is a suggestion for promoting "sustainable land use planning and management". Promoting "sustainable energy and transport systems in human settlements" is proposed, among other things, with an activity to "integrate

land-use and transportation planning to encourage development patterns that reduce transport demand" [31].

The interdependence that develops between traffic and land use in cities, introduces the notion of accessibility. Basically, users can access goods, activities, and destinations. Litman summarized factors that affect accessibility: Transport demand, mobility, transportation options, user information, integration, affordability, land use factors, transport network connectivity, roadway design and management, prioritization and inaccessibility [32]. Consideration of the quality of transport, according to accessibility criteria includes road and public transport improvements, improved conditions for walking and cycling, balanced land use distribution, and a developed telecommunications system. Changes in travel requirements have a significant impact on the development of new transport networks and services, and these changes also affect accessibility [33–35].

Land use-transport integration has been recognized as one of the factors that may cause a preferred means of transportation, different to car driving, to change and in that way: Reduce the need for travel, reduce the length of trips, provide easier and safer access to services and facilities, reduce the impacts of transport on communities, and provide efficient distribution of goods and services [35,36].

2.2. Walkability and Pedestrian Accessibility

The notion of walkability is, essentially, connected with health issues and its foundation lies in understanding the relationship between urban design and physical activities. It deals with: Physical access, places, and proximity [37–39].

The basic criteria for measuring walkability are the presence of safe and attractive streets and paths, block lengths or street connectivity and their location, diversity, and frequency of destinations [40]. Factors affecting walkability are numerous: Street connectivity, pedestrian accessibility, land usage, residential density, presence of trees and vegetation, frequency and variety of buildings, entrances and other sensations along street frontages, transparency (amount of glass in windows, doors, orientation and proximity of homes, etc.), places to go to near the majority of homes, placemaking and retail floor area ratio [39].

Among other factors that affect walkability, Pedestrian Accessibility is of great importance. As Kelly et al. suggest, there are many problems faced by pedestrians (concerning health, safety, perceptual problems, and issues with travel delays and inconvenience). Factors affecting the decision to walk are distance, time, security, road traffic, the urban form, the pedestrian environment, the effort required, and the weather [41].

2.3. Elaborating the Choice of Urban Development of Collective Housing for the Study

In European urban planning professional circles, as a model of urban development that can contribute to the sustainable development of Europe and more energy-efficient areas, more compact, more densely populated urban units with mixed-use are emphasized, as well as the activation of neglected and devastated areas and brownfield locations [42–44]. The obligation to mix urban use such as housing, work, education and recreation within urban neighborhoods is emphasized as a desirable, sustainable form of urban development, especially given the need to conserve energy resources [45]. Therefore, the selected case study for the application of the proposed methodology—the superblock of modern urbanism treated as an urban cluster of collective housing, represents an appropriate framework that is in line with modern ideas in this field.

3. The Goals of the Research and Literature Review

Interpretation of human activities through the balance of economic, ecological, and social aspects, as proposed by sustainable development concept, opened the practice of studies that are dealing with complexity, many data, and a lot of foreseen scenarios, as a result, and provides the possibility of achieving the most adequate one for the specific space in a specific time. To observe and manage complexity with the aim of sustainable living in our cities seems to be the main course of all today's studies.

Today, expensive and time consuming standardized environmental assessment methods are suggested for the consideration of energy efficiency in existing and planned residential units. Some of the most used and most known certification programs for sustainability qualities in the built environment are BREEAM, LEED, DGNB, European Directives on Energy Efficiency (EED), Energy Performance of Buildings (EPBD), INSPIRE, etc. [5,46]. Their common feature is operating with a large amount of data. Given the needs imposed by the concept of sustainable development, it is expected that the amount of data will increase further. At the same time, the rapid development of appropriate software tools provides an adequate platform for working with such a large amount of information [47,48]. Recently, innovative research is emerging intending to reduce a large amount of data to a smaller one, simultaneously maintaining the desired quality [49].

As the main problem is data availability, there are theoretical papers that deal with means on how to gather, select, systemize, and operate with them. The usual approaches are: Organisational, legal, technical, and semantic [50]. The field of "Energy Performance Assessment", regarding singular locations, areas, and even urban clusters, is more elaborated in theory and practice, especially through the project "The European Union Location Framework" [51].

It can therefore be concluded that the available research work remains within the field of quality selection and data representation, but it rarely shows the means of attaining results and achieving the desired state. Coordination between activities aiming to establish an order of their usage so to harmonize the existing state with the planned one is left to an individual's decision (an urban planner and/or a municipal official and/or politician) [47,52].

This paper aims to establish a methodology that would provide a clear insight into the hierarchy of significances and priorities between a large number of activities for planning actions, thus contributing to the concept of energy-efficient housing. By reviewing the literature, it can be concluded that there is no methodology by which this can be achieved, so this paper aims to overcome the observed problem.

4. Proposed Methodology for Supporting the Energy Efficiency in Urban Clusters of Collective Housing

4.1. Wide Thematic Framework for Assessing the State of Energy Efficiency of Existing Urban Clusters of Collective Housing

The proposed methodology in this paper was developed by relying on a predetermined wider based thematic framework for the research of sustainable urban land use, from the perspective of urban morphology in typical residential urban clusters of modern urbanism that would also be possible to use to achieve energy efficiency [53].

An analysis of land use was conducted on selected examples of housing communities in European cities that were built following the idea of sustainable development. Reducing the analyzed data to common (prevailing ones) resulted in the formation of "recommendations for sustainable use of urban land for housing communities in the European cultural area" [54].

Specifically, this wide thematic framework was formulated through the following thematic sub-groups (Table 1), and it is presented here only for illustration of the complexity of the thematic issues that land use planner and manager have to deal with:

Table 1. Wider based recommendations and urban indicators for achieving energy efficiency of urban clusters—thematic sub-groups. (*Sources for defining the recommendations:* [10,55–63]).

Recommendations and urban indicators for 1EE **/Surface in a topological context**: 1a—for the topic of "Position/layout/ objects on terrain" the recommendations are: - Orientation: On a long east-west axis within +/- 15 degrees of geographical east-west; [56,63] - In north-south direction buildings should be distanced at least twice their height; - Position lower buildings on the south edge of the site and taller buildings on the north. 1b—for the topic of "The state of occupied surface areas": The urban indicators are: - Percentage of occupancy within a range of 30–60%; [54,57] - Percentage of unbuilt terrain that must be water permeable, within a range of 60–80%. [54,57]
Recommendations and urban indicators for 2EE /"**Land use and accessibility**" 2a—for the topic of "Proximity of urban functions" the recommendations are: - To ensure the presence of everyday needs within a walking range of 400m and 800; [60] (p.5,6); [62] (p.44) - To ensure the presence of cultural and fun activities, recreational and green areas within a range of 400m and 800m; [60] (p.5,6,26), [62] (p.44) - To ensure efficient, safe and comfortable public transportation and public transport stops in diameter of 400m. [60] (p.5,6,26), [62] (p.44) 2b—for the topic of "Quality of traffic flow of driving and pedestrians' mobility" the recommendations are: - To plan two-way streets in the zone; - To avoid dead-end streets; - To realize bicycle lanes. 2c—for the topic of "Parking availability in the zone", the recommendations and urban indicators are: - To provide car-sharing vehicles on-site; - To reduce parking provision (max 0,5/apartment); - To provide parking space for bicycles.
Recommendations and urban indicators for 3EE /**Interactions (public/private):** 3a—for the topic of "Using energy-efficient technologies in public spaces" the recommendations are: - Use energy-efficient street lighting; - Use solar energy and wind energy in public spaces. 3b—for the topic of "Urban furnishings", the recommendation is: - Materialization of urban furnishings must be mostly of autochthonous materials. 3c—for the topic of "The control of waste as a means of achieving energy efficiency", the recommendations are: - To provide recycle technologies for wastewater management; - To form/build underground recycling waste containers; - To provide a waste disposal system for making organic compost.
Recommendations and urban indicators for 4EE /**Sustainable architecture—Energy Efficient Building** 4a—for the topic of "The availability of standards for energy efficiency in architecture" the recommendations are: - To establish the buildings' energy category; - Certify the buildings so that every building obtains an energy passport; - Conduct an energy efficiency review of every building and conduct an Energy efficiency elaborate; - Establish the energy efficiency class of every building, following the European standard EN 15232; - Achieve class A energy efficiency buildings. 4b—for the topic of "Project, applied materials and technologies in buildings" the recommendations are: - The sun-facing glazing area should be at least 50% greater than the sum of the glazing area on the east- and west-facing walls; - At least 90% of the sun-facing glazing should be completely shaded (by awnings, overhangs, plantings) at solar noon on the summer solstice and unshaded at noon on the winter solstice; - To maximize solar gains, bedrooms and communal living areas should be south-facing; - Service areas, e.g., stairways and kitchens, should generally be on the north facade; - Control building depth to a max of 14m—for thermal capacity; - North facing spaces should be designed with a layout and material finishes that support passive solar design; - Install panels for solar energy usage in apartments; - Use floor and wall areas to store heat; - Install the technology of smart buildings; - Build "passive houses/buildings".
Recommendations and urban indicators for 5EE /**Changes (of the space form and urban function distribution through time):** 5a—for the topic of "Activating abandoned locations" the recommendations are: - Provide activities for reviving brownfields and abandoned locations; - Allocation of measuring stations and/or educational units for applying an innovative approach that will lead to a more energy-efficient environment. 5b– for the topic of "Urban planning versus illegal building" the recommendations are: - Removing illegal buildings from collective housing's parks while also preserving and maintaining existent greenery; - Self-organizing the citizens by using the bottom-up planning method (formulating requests from citizens and their needs for resolving energy efficient infrastructures and urban furnishings); - The participation of citizens in implementing energy-efficient solutions.

From the listed thematic sub-groups, the first and second ones ("Surface in a topological context" and "Land use and accessibility") are prioritized as necessary planning set for forming quality spatial solutions; it is then possible to build an "Energy-efficient building" (fourth sub-group). Otherwise, even in case of implementing very expensive solutions for buildings, their energy efficiency level could end up being lower than what was expected.

The third sub-theme ("Interactions (public/private)") can follow the construction, and some elements can be realized after the buildings move in. The fifth sub-theme ("Changes") is of secondary importance, but it represents a qualitative leap in space planning and management.

Thematic Sub-Group for Further Work

The intention was to elaborate on current issues concerning topics targeted in Agenda 21 which belong to the corpus of contemporary ideas on urban development [31]. These issues are of great importance for analyzing and planning energy-efficient urban clusters. Well-implemented solutions of this subgroup are those that lead to the reduced use of private vehicles, and thus contributing to the overall energy efficiency of the observed urban area.

The sub-group "Surface in a topological context", targets another significant issue. This issue refers to a building's position on the site to achieve better energy efficiency results. This subgroup also deals with lot coverage and the percentage of the water-permeable surface of the site. The final effects are related to microclimatic conditions (heating and cooling of indoor spaces, solar irradiance of the terrain and objects, etc.) that affect the total energy efficiency of the system.

Two wide and independent research areas together form the basis for quality spatial solutions strategy. Simultaneous focus on both of those areas in one paper would demand substantial widening of the theoretical background in two different independent directions, one of which deals with the space content, while another with the consequences of the allocation of buildings.

As the paper aims to explain the approach and steps in the proposed methodology, the choice of one sub-group is important so as to remain focused on the main goal. Namely, the methodology implies basic steps, but it must be adapted to the specific topics of a particular sub-group, and the specific goals for achieving energy efficiency that are related to that sub-group.

Further elaboration, as it is already stressed, is positioned in the sub-group 2: "Land use and accessibility". Under the general goal to decrease private vehicle usage, the topics of interest for analysis are the proximity of urban functions within the pedestrian diameter, the flowability quality of vehicular and pedestrian movement, and parking availability in the zone.

4.2. Description of the Methodology

The suggested concept of methodology relies on the FMEA (Failure Modes and Effects Analysis) approach, which allows for the possibility of detecting (and therefore, avoiding) unwanted consequences in the examined system. Many professions (medicine, engineering, automotive industry, etc.) have taken upon this approach to help them prioritize risk mitigation efforts.

The approach was invented by NASA early in the U.S. Apollo space program, to assess possible problems that could cause major failures on rockets [64]. Essentially three descriptive criteriums are used, relating to the issue and possible mistakes it could make. Assessments are carried out via a numerical scale, and the product of these three numbers (every grade corresponding to one criterion), gives a numerical result that determines the state of the specific error being estimated. It is through this number that is possible to identify errors in the system and simultaneously create a hierarchy between them concerning the severity of their effects and the likelihood of their occurrence [65]. Therefore, it is

a method that determines the risk that something will go wrong—failure in the system, which can cause damage if not noticed on time [66].

When this idea is translated into an urban area whose goal is energy efficiency, the following analogies and appliances are possible:

- Relying on three factors in the concept of sustainable development—economical, ecological, and social;
- aiming towards the energy-efficient areas require a lot of activities, and for now, no known method would form an order by which they would be realized; and
- in the context of an urban area, failure is seen as an untimely realization of activities; such realization would be too expensive, and it would not bring about the expected environmental or social effects, so it can slow down the realization and further attempts at creating energy-efficient urban areas. This can also apply to an activity that cannot be appropriately financed so it cannot be completed appropriately, as well as to an activity that does not yield satisfying results in reducing harmful effects to the environment or one that does not improve the citizens' quality of life in the given moment.

The methodology consists of theoretical and practical parts. The theoretical part involves determining specific goals and activities following the specific sub-group. The knowledge framework for each examined location is derived from the valid planning documentation or strategic documents.

Given the recommendations and urban indicators within the specific sub-topic, specific activities that need to be implemented to create an energy-efficient environment are identified. We should bear in mind that the activities are identified by their importance for a specific location; it is not recommendable to define the list of activities without considering the characteristics and needs of the location.

Then follows the practical part—assessment, which consists of two steps

4.2.1. Description of the Methodology—The Criteria for Evaluation

In the proposed methodology, the criterion which quantifies the possibility of achieving energy efficiency in an urban cluster is "**P**riority **A**ctivity for **E**nergy Efficiency" (PAEE), namely:

PAEE = M (material investment) x **E** (ecological consequence) x **S** (effects in the social sphere)

Where the values **M**, **E**, and **S** for the specific sub-group "Land use and Accessibility" (as a means of achieving energy efficiency in an urban area in case an activity is realized) are the following:

M—material cost/ economic consequences: Material resources needed for investing;

E—ecological consequences: An estimate of activities' influences on the reduction of automobile usage; and

S—effects within the social sphere/ social consequences: An estimate of the citizens' satisfaction.

The criteria **M, E** and **S** are evaluated in the range from 1 to 5, where the value of 1 corresponds to the most favorable, and the value of 5 to the most unfavorable consequence. These are descriptive values of consequences since absolute values cannot be established as relevant at all times, primarily due to socio-economic impacts on the urban space and the constant changes that life in the city implies.

In accordance with every individual criterion, the values **M**, **E**, and **S** are established as so:

M—material cost (investments) (1 minimal cost; 5 maximal investment).

The amount necessary to invest to meet the activity:

1—Investing in current upkeep and urban furnishing (traffic signs, public transport stations)

2—Investing into existing objects—reuse of ground floors for new activities

3—Investing only into the infrastructure (reconstruction of existing and the building new streets and parking)

4—Investing in the construction of new buildings, while using existing transport network and infrastructure

5—Complete reconstruction—new street network, new and improved infrastructure, new buildings.

The explanation of M (material cost):

Material investments which would be shown in their absolute values—the amount of money that has to be invested, are subject to inflation and market conditions, so they are not constant and therefore do not represent a suitable criterion for evaluation. On the other hand, assessing investments through the described activities secures a reliable answer/estimates of investments (M) from minimum to maximum.

E—ecological consequences (1–100% from the expected reduction; 5 unreduced usage of cars)

Assessment of effects on the reduction of automobile usage (in case the activity is realized):

1—A car will not/is not being used for this particular activity;

2—car use is reduced by 2/3 from nowadays;

3—car use is reduced by 1/2 from nowadays;

4—car use is reduced by 1/3 from nowadays; and

5—car use will be as per usual.

The explanation of E (ecological consequences):

For the specific sub-topic "Land use and accessibility", we are interested in reducing the car use, since this directly affects the reduction of fuel use and it improves the state of the environment by reducing air pollution. The professional who implements this methodology is qualified for this assessment, with their knowledge and experience.

S—effects within the social sphere (1 very satisfied occupants; 10 very dissatisfied occupants)

Assessments of inhabitants' satisfaction (after the activities realization)

1—Inhabitants will be very satisfied (quality of life will be greatly improved);

2—inhabitants will be satisfied (quality of life will be improved);

3—inhabitants will not feel a difference (quality of life will not change);

4—inhabitants will be dissatisfied (quality of life will decline); and

5—inhabitants will be very satisfied (quality of life will greatly decline).

The explanation of S (social consequences):

Regarding the social consequences of the implemented activity, the satisfaction of the tenants is assessed. Like for the environmental impact assessments, the professional implementing the methodology is qualified with their knowledge and experience to conduct this evaluation.

4.2.2. Description of the Methodology—the Assessment Process

The process we have developed employs a two-step approach. In the first step of the methodology, the consequence of the realization of activities is assessed from the point of view of the stated three criteria: (M), (E), and (S).

For each of the activities, the expert provides an assessment of the consequences for the case of implementation at the time of the evaluation. It is not advisable to adopt in advance a hierarchy between the factors that are the basis for the formation of PAEE (economic, environmental, social factors), so as not to affect the final result.

This is why the first step of the evaluation is carried out by equal treating these three factors; in the next, second step, when the priority groups of activities are determined, the hierarchy of these factors is introduced in certain cases. This way, the least influence of the subjective attitude on the importance of certain criteria is achieved and the assessment is harmonized with the characteristics of the urban space.

The PAEE can range from 1 to 125. Establishing a hierarchy is the part of the second step of this methodology and is as follows: Activities with higher PAEEs have lower potential—harder to achieve, more expensive and with poorer environmental and social consequences, and vice versa, activities with lower PAEEs are recommended for earlier implementation. Those activities that have PAEEs from 1 to 3 are mostly aligned with the goal, so their implementation generally involves ongoing maintenance to nurture its state. Thus, the expert in the city administration receives a list of activities sorted by their priority of action.

There is the probability that a certain number of activities that we assess have identical PAEE value. In principle, this method indicates the "priority field", i.e., the grouping of activities and the position when they should be implemented in relation to others.

Within the group of different activities with identical PAEE, two situations are possible during the hierarchy assessment (second step of the methodology):

1// All three factors (M, E, and S) are identical in each of the activities within the group

The decision on the order of realization of the activities from that specific group is up to the assessment of the professional (they will not make a mistake whichever one they choose according to the order, it is only important to realize all activities from this group first, before moving on to the next group).

2// factors (M, E, and S) within PAEE are of different values for individual activities

In this case, the proposed methodology includes the establishment of a hierarchy between the criteria. This is carried out based on the characteristics of the examined urban zone, for example: // for CBD (central business districts), the most important is the economic, then the social and finally the environmental criterion; // for residential zones, the most important is social, then the environmental and finally the economic factor. The assessment of this hierarchy can be the result of an independent decision of a professional in the city administration and can also rely on the method of a survey between experts. Further dealing with this issue goes beyond the scope of this paper.

Accordingly, in the case where different values of factors M, E, and S are within the same PAEE, the professional, in the second step of the methodology, can form a hierarchy of activities according to the abovementioned. Depending on the zone in question, activities with a better result for a specific factor are implemented first (e.g., for housing—activities with a lower number (better grade) from a group for the Social aspect will be implemented first, then activities with a better grade from a group for the Ecological aspect, and finally those that have the best result within the group for the Economic aspect). The sequence of the activities is important: Activities which have a better result for a more significant criterion for a specific zone should all be implemented before moving on to activities with a better result for a criterion of less importance.

For example, it is possible that during the evaluation in the first phase of the hierarchy of activities for the residential zone, three activities get the same value of PAEE (for example PAEE = 15, for each). In the case that all three activities have the same grade of individual criteria M, E, and S (for example, each is evaluated as (3, 1, 5) / M=3, E=1, S=5 /), then it is possible for a practitioner who decides on the order of implementation to decide at his discretion, only taking care to carry out first all the activities that have a PAEE of less than 15. The mistake would not be made, as the relation of economic, environmental, and social consequences are identically graded.

If, for example, there are three activities, each with PAEE = 15, with different values of economic, environmental and social criteria:

- "activity A" (5, 1, 3) / M = 5, E = 1, S = 3 /
- "activity B" (3, 1, 5) / M = 3, E = 1, S = 5 /
- "activity C" (5, 3, 1) / M = 5, E = 3, S = 1 /

Proposed hierarchy of evaluation criteria for a residential area in the second phase is as follows: First the activities with the lowest value (which is the best grade) from the domain of social aspect are to be realized, afterwards those with the best grade from the domain of

the ecological aspect, and finally activities that have the best grade of the economic aspect will be implemented.

The result of the example that we have given would be as follows:

1. The social aspect has the greatest importance—in this case, "activity C" has the best grade, S = 1, so it should be realized first (since we do not have another activity that has the same best grade for this criterion);
2. The ecological aspect is next ranked (in this case, "activity A" and "activity B" have the same lowest value for this criterion E=1; in order to determine the hierarchy between these two, we note that "Activity A" has a lower value (better grade) for the social aspect, S = 3, which qualifies it for the second place in the hierarchy, since the value of the Social aspect is primary for this zone.
3. The economic aspect is the last in this assessment. "Activity B" has the lowest value (best grade) for the economic aspect, M = 3, and practically it is the only one remaining since we have established a hierarchy for the first two activities.

In this way, we are minimizing the impact of the subjective attitude about the significance of certain criteria, so the assessment is harmonized with the characteristics of the urban space. In the example developed in the next Chapter (Section 5), 18 activities have been examined, so this process is specifically explained through the application.

4.2.3. Description of the Methodology—Methods

The problem that we observed and decided to deal with was noticed in the practice of implementing strategic planning documents.

Perceiving possibilities that the FMEA method provides, and reviewing the relevant literature, have helped us to conclude that it is possible to adjust this method to urban practice. We have focused on sustainable development and its three aspects (environmental, economic, and social), as important determinants for further methodology development.

We have noticed that it is not possible to form a unique matrix for spatial evaluation, for each important area of urban planning (there are five of them, previously adopted because of their significance for achieving energy efficiency of urban clusters: Surface in a topological context, land use and accessibility, interactions—public/private, sustainable architecture—energy-efficient building and changes of the space form and urban function distribution through time).

We have chosen the current issue of Land use and accessibility for our further work, because achieving energy efficiency and also improving the quality of the environment, are consequences of a quality solution to this issue.

We have adjusted the methodology to this domain and applied it to a specific example, with the inclusion of the expert's opinion method. In particular, ten experts were included in verification.

We have received input data on the location from the expert services. It is also important that all the involved experts are well acquainted with its problems (they were engaged or are still dealing with this zone of Belgrade).

After the evaluation, our team has processed the data.

We can conclude that it is not recommended to apply the methodology without prior adjustment to the needs of a particular location, because it aims at the quality of residents' life, the state of the natural environment and the economic status of the community. However, it is clear that, as a basic approach, this methodology provides a wide application.

5. Results—The Application to the Case Study of the Superblock (Urban Cluster of Collective Housing) in New Belgrade, Serbia

A team of ten experts was gathered to support and participate in the elaboration of this methodology.

Four members of the team are academic professors (architecture, civil engineering, transport and traffic engineering), while six are working in prominent urban planning public institutions and private companies: Urban Planning Institute of Belgrade, City Sec-

retariat for Urbanism, Centre for Urban Development Planning, The Institute for the Protection of Cultural Monuments of Belgrade, and Municipality of New Belgrade, sector for Urban planning.

The chosen experts were targeted bearing in mind their competency—professional involvement with the problems and characteristics of the examined zone. The four academic professors are included in studies regarding the urban structure of New Belgrade, each corresponding to their domains (physical structure, morphology, traffic/transport, construction). Six experts from practice deal with the problems of New Belgrade and a specific location in their daily work, whether it is the field of urban planning, decision-making process about urban space or the urban planning implementation.

The experts met at the traditional group meeting, with the method of expert opinion involved. In the preparation stage, experts were introduced to the methodology. Then an evaluation was performed, and at the end of the meeting, brainstorming session to decide on the hierarchy of criteria for the next step of the methodology. Data processing and analysis of the results has been done after the meeting, by the authors of the paper [67].

5.1. Description of the Area

Residential superblock ("Blok 7"), on which, in the period immediately after the Second World War (1947–1950) started the construction of New Belgrade, is "a neighborhood of modern urbanism with about 3000 apartments" [68] (see Figure 1).

Figure 1. Location of Block 7_ position within New Belgrade (left) and overview (right) (*Google earth*).

The total area of the superblock is 21 ha. The population density in the superblock is 370 persons/ha with 20–30% of the built area [68]. Special characteristics of the superblock are the presence of several non-residential urban functions: Post office, public children's hospital, and a commercial building. The basic needs of the superblock's inhabitants were fulfilled by the construction of a primary school and kindergarten (1950–1955), together with the other facilities, such as local shops, located in the ground floors of the residential buildings. There is also one supermarket within the superblock.

The selected superblock is interesting as a case study for several reasons: (a) Its morphological concept of urban land use has proven to be very favorable, adaptable for the implementation of activities that would lead to sustainable development [69]; (b) poor air quality was detected in the whole area of New Belgrade in the period from 2012 to 2015, as well as for 2018; specifically, the characteristics are: "Unhealthy" and "very unhealthy", with the presence of a prohibited concentration of SO2, NO2, soot and heavy and toxic metals [70,71]; (c) intersections in the immediate vicinity of the examined location (Zemun and Studentski grad), have an increased concentration of carbon monoxide on an annual basis (Studentski grad by 0.57 mg/m^3 and Zemun by 2.65 mg/m^3 more than a maximum allowed annual concentration (which is the 3 mg/m^3) [72]; (d) the existing building stock has deteriorated due to lack of maintenance (energy consumption in apartments is above 150 kWh /m^2 per year), so more extensive systematic reconstruction measures are needed, aiming to improve the residents' quality of life [9].

Accessibility of primary schools, kindergartens, and everyday supply is satisfactory. Likewise, sports and recreational facilities and areas are accessible for the territory of whole New Belgrade. Within the walking distance of up to 10 min of walking, there is no

cultural, local health, or entertainment facilities. For seasonal supplying and other needs, inhabitants have to walk further or rather, use their vehicles or public transport. Streets in the superblock have a width adequate for two-laned traffic but, due to cars that are parked along the street, the traffic operates as a one-lane. There is a dead-end street. Bicycle lanes are not designated in secondary streets within the superblock. There are no organized parking lots for bicycles. Inhabitants report parking problems, it is not uncommon to go about in circles for a few minutes within the superblock, to find an available parking space (see Figure 2).

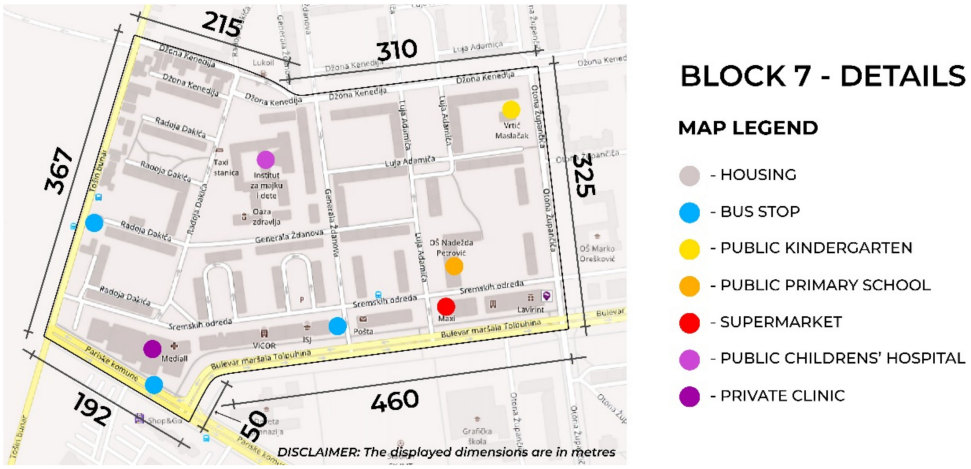

Figure 2. Block 7—Details (Distribution of non-residential urban functions).

5.2. The Procedure

Following the theoretical part of the methodology given the recommendations and urban indicators within sub-topic on "Land use and accessibility" (see Table 1), 18 activities have been identified to be implemented in order to create an energy-efficient urban cluster (Table 2.):

5.3. The Results

The results of the first step—evaluation of the consequences of activities—are shown in Figure 3a, where M, E, and S are grades for **M**aterial, **E**cological, and **S**ocial aspect. The product of grades M x E x S, which equals PAEE—Priority Activity for Energy Efficiency, is the number written beneath the grades. Activities are marked with numbers 1–18. Symbols of experts in the elaboration of the methodology are as follows: AF—Faculty of Architecture, TTF—Faculty of Traffic and Transport, CEF—Faculty of Civil Engineering, CEP—Centre for Urban Development Planning, UZB—Urban Planning Institute of Belgrade, ZZSK—The Institute for the Protection of Cultural Monuments of Belgrade, MS—Municipality of New Belgrade, sector for Urban planning, CSU—City Secretariat for Urbanism.

By consensus, the experts have established a hierarchy between the criteria necessary for work in the second step of the methodology, after completing the evaluation. Considering that we are dealing with a zone mainly designated for housing, the social aspect is dominant and the most important, followed by ecological, then economical. Results after the completion of the second step are shown in Figure 3b. after having established order of activities from every respondent individually (in columns).

The PAEE score as a whole and for every respondent ranges from 1 to 100, but most often in the range of 3 to 80. The PAEE activities that range from 1 to 3, as aforementioned (Section 4.2) already correspond with the goal and their implementation mostly assumes current maintenance, while activities with higher PAEE assume later implementation.

For example, if we take a look at the last column that refers to the evaluation of CSU representatives (City Secretariat for Urbanism):

PAEE values are ranked from minimum to maximum:

- First there are activities 3 and 4, with PAEE = 1, with identical values of criteria M, E and S;
- then there are activities 8 and 9, with PAEE = 3, with identical values of criteria M, E and S;
- next there are activities 10, 11 and 12, with PAEE = 6, with identical values of criteria M, E and S;
- afterwards PAEE = 10, for activity 5;
- then PAEE = 12, for activities 6, 2 and 18—in that order, because activity 6 has the best grade (lowest value) for S = 1, while activities 2 and 18 have identical values of M, E and S; and finally,
- PAEE = 16, 24, 25, 30, 40, 50, and 75—for activities 7, 15, 13, 14, 1, 17, and 16.

Obtained results indicate that, while applying the proposed methodology, experts have defined mutually coordinated hierarchies for 18 activities in question. Not all respondents had identical hierarchies, but a priority-based division would be possible.

Table 2. Activities.

– For the field of "**Proximity of urban functions**": Within walking distance, 400 m (5 min walk) and 800 m (10 min walk): 1—Building of new shopping malls /presence of shopping malls 2—Building of new shops /presence or adaptation of vacant spaces on ground floors into shops for everyday supply 3—Building of new kindergartens /presence of kindergartens 4—Building of new primary schools /presence of primary schools 5—Building of new high schools /presence of high schools 6—Building of new community health centers /presence of community health centers 7—Building of new cultural facilities /presence of cultural facilities 8—Building of new entertainment facilities /presence of entertainment facilities 9—Building of new sports and recreation facilities /presence of sports and recreation facilities 10—Efficient public transport—bus line frequency corresponds to needs (waiting time max.5min) 11—Establishing safe and comfortable public transportation 12—Establishing new public transport stops /presence of existing public transport stops within a diameter of 400 m from the furthest locations of the examined zone
– for the field of "**Quality of vehicle and pedestrian flowability**": 13—Removal of parking and regulation of traffic in streets with a width of at least 6 m, as two-way streets 14—Redefining the network so that dead-end streets are eliminated 15—Provision of bicycle lanes
– for the field of "**Parking accessibility in the zone**": 16—Provision of the system of "carsharing", for apartments in the zone 17—Reducing the number of parking spaces in the zone (max 0.5/apartment) 18—Provision of bicycle parking

First six activities (order: 1–6) would only need monitoring in general since they already exist and require ongoing maintenance and improvement of existing qualities. These activities are: Easily accessible kindergartens, primary schools, entertainment, sports and recreation facilities, and provision of efficient, comfortable and frequent public transport.

The following group for the realization would be for the next six activities (order: 7–12). Their characteristics are as follows: a) Activities could be carried out with small investments (slightly higher than for the previous group); b) the infrastructure for their implementation already exists; c) at the same time they could greatly affect the inhabitants' quality of life and their decision not to use their automobiles as a means of meeting these needs. These activities are the adaptation of spaces on the ground floor for daily supply shops and cultural facilities, improving accessibility for high schools and health centers in

the near vicinity, the establishment of public transport stops within a diameter of 400m and providing parking spaces for bicycles.

Expert	AF			TTF1			TTF2			CEF			CEP			UZB			ZZSK			MS1			MS2			CSU		
Activity	M	E	S	M	E	S	M	E	S	M	E	S	M	E	S	M	E	S	M	E	S	M	E	S	M	E	S	M	E	S
1	5	4	2	5	3	2	5	3	2	5	4	2	5	2	4	5	4	2	5	4	2	5	4	2	5	3	2	5	4	2
PAEE	40			30			30			40			40			40			40			40			30			40		
2	2	2	2	2	2	3	2	2	3	2	2	2	2	3	2	2	2	2	1	4	2	2	3	2	2	3	2	2	3	2
PAEE	8			12			12			8			12			12			8			12			12			12		
3	1	1	1	1	1	3	1	1	3	1	1	3	1	1	3	1	1	2	1	1	3	1	1	3	1	1	3	1	1	1
PAEE	1			3			3			3			3			2			3			3			3			1		
4	1	2	1	1	1	3	1	1	3	1	1	3	1	1	3	1	1	2	1	1	3	1	1	3	1	1	3	1	1	1
PAEE	2			3			3			3			3			2			3			3			3			1		
5	1	4	3	1	5	3	1	5	3	1	5	3	1	5	3	1	5	2	1	5	3	1	5	3	1	5	3	1	5	2
PAEE	12			15			15			15			15			10			15			15			15			10		
6	5	2	1	2	2	2	4	1	1	2	1	2	2	1	2	4	3	1	4	2	1	4	1	2	2	2	2	4	3	1
PAEE	10			8			4			4			4			12			8			8			8			12		
7	4	2	2	4	3	2	4	2	2	4	2	2	2	2	2	4	3	2	3	3	2	4	2	2	3	3	2	2	4	2
PAEE	16			24			16			16			16			24			18			16			18			16		
8	1	3	4	1	1	3	1	2	3	1	1	3	1	1	3	1	1	2	1	3	1	1	1	3	2	3	1	1	1	3
PAEE	12			3			6			3			3			2			3			3			6			3		
9	1	2	3	1	1	3	1	2	3	1	1	3	1	1	3	1	1	2	1	1	3	1	1	3	2	3	1	1	1	3
PAEE	6			3			6			3			3			2			3			3			6			3		
10	3	2	1	1	1	1	1	1	1	1	4	2	1	4	2	1	3	2	1	3	1	1	3	2	1	3	2	1	3	2
PAEE	6			1			1			8			8			6			3			6			6			6		
11	1	1	2	1	1	1	1	1	1	1	4	2	1	3	2	1	4	2	1	2	1	1	3	2	1	4	2	1	3	2
PAEE	2			1			1			8			6			8			2			6			8			6		
12	3	3	1	1	3	2	1	1	1	1	4	2	1	4	2	1	4	2	1	2	1	1	3	2	1	4	2	1	3	2
PAEE	9			6			1			8			8			8			2			6			8			6		
13	1	5	4	1	5	4	1	5	5	1	5	4	1	5	4	1	5	4	1	5	4	1	5	5	1	5	4	1	5	5
PAEE	20			20			25			20			20			20			20			25			20			25		
14	4	4	1	3	4	1	5	4	1	3	5	2	5	5	1	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2
PAEE	16			20			20			30			25			30			30			30			30			30		
15	3	4	2	3	4	2	3	4	2	3	5	2	3	3	2	2	4	3	3	4	2	3	5	2	3	4	2	3	4	2
PAEE	24			24			24			30			18			24			24			30			24			24		
16	4	5	5	3	5	4	4	5	4	5	4	3	4	4	5	4	4	5	4	5	4	5	5	3	4	5	4	5	5	3
PAEE	100			60			60			60			80			80			80			75			80			75		
17	3	5	5	4	5	3	4	5	4	3	5	4	3	5	5	3	5	3	3	5	5	2	5	5	3	5	4	2	5	5
PAEE	75			60			60			60			75			75			75			50			60			50		
18	3	4	1	2	4	2	2	4	2	1	5	2	2	4	3	2	5	2	1	4	2	2	5	1	2	4	2	2	3	2
PAEE	12			16			16			10			24			20			8			10			16			12		

(**a**)

redosled	AF	TTF1	TTF2	CEF	CEP	UZB	ZZSK	MS1	MS2	CSU
1	**3/1**	10/1	10/1	**3/3**	**3/3**	**3/2**	11/2	**3/3**	**3/3**	**3/1**
2	**4/2**	11/1	11/1	**4/3**	**4/3**	**4/2**	12/2	**4/3**	**4/3**	**4/1**
3	11/2	3/3	12/1	**8/3**	**8/3**	**8/2**	3/3	**8/3**	**8/6**	**8/3**
4	10/6	4/3	3/3	**9/3**	**9/3**	**9/2**	4/3	**9/3**	**9/6**	**9/3**
5	9/6	8/3	4/3	6/4	6/4	**10/6**	8/3	**10/6**	**10/6**	**10/6**
6	2/8	9/3	6/4	2/8	**11/6**	**11/8**	10/3	**11/6**	6/8	**11/6**
7	**12/9**	**12/6**	8/6	10/8	10/8	**12/8**	9/3	**12/6**	11/8	**12/6**
8	**6/10**	**6/8**	9/6	11/8	12/8	5/10	**6/8**	**6/8**	12/8	5/10
9	18/12	**2/12**	**2/12**	12/8	**2/12**	6/12	**2/8**	18/10	**2/12**	6/12
10	**5/12**	**5/15**	**5/15**	18/10	**5/15**	2/12	18/8	2/12	**5/15**	2/12
11	8/12	**18/16**	**18/16**	5/15	7/16	**18/20**	5/15	5/15	**18/16**	**18/12**
12	14/16	14/20	**7/16**	**7/16**	15/18	13/20	**7/18**	**7/16**	**7/18**	**7/16**
13	7/16	**13/20**	14/20	**13/20**	**13/20**	7/24	**13/20**	**13/25**	**13/20**	15/24
14	13/20	7/24	**15/24**	14/30	18/24	**15/24**	**15/24**	14/30	**15/24**	13/25
15	15/24	15/24	13/25	15/30	**14/25**	**14/30**	**14/30**	15/30	1/30	**14/30**
16	**1/40**	**1/30**	**1/30**	**1/40**	**1/40**	**1/40**	**1/40**	**1/40**	14/30	**1/40**
17	**17/75**	**17/60**	**17/60**	16/60	**17/75**	**17/75**	**17/75**	**17/50**	**17/60**	**17/50**
18	**16/100**	**16/60**	**16/60**	17/60	**16/80**	**16/80**	**16/80**	**16/75**	**16/80**	**16/75**

(**b**)

Figure 3. (**a**) FIRST STEP—Elaborating the consequences of activities. (**b**) SECOND STEP—Hierarchy of activities with corresponding Priority Activity for Energy Efficiency" (PAEE) values

The last six activities (order: 13–18) are those that require big investments. Some of those activities have a little less obvious benefit to the quality of life of the residents and

hold negative connotations; they also have little or no influence on the inhabitants' decision whether they will use a car to meet their needs. These are: Building a complex new shopping mall, removing parking and regulating traffic in streets at least 6 m wide as two-way, redefining the street network to eliminate dead ends, provide bicycle paths, provide a system of "carsharing" for apartments on-site and reduced number of parking places in the zone (less than 0.5 per apartment). These activities should not be implemented before the previous ones are fully realized. It would be beneficial to repeat the methodology just for this group of activities and to establish a hierarchy that corresponds with the results which would be achieved within that specific time when the methodology procedure is repeated.

Nine out of ten experts have ranked the activities No. 1, 16, and 17 (defined in Table 2.) as last; activities 16 and 17 are the last two for all ten respondents. These are highly expensive (e.g., the planning and construction of shopping malls) or socially insufficiently accepted/promoted activities (e.g., providing "carsharing" system). The implementation of these activities at the moment will not lead to a quality result. The inhabitants will not give up owning and using cars, unless the time-consuming, long-lasting and strategic development policy is being introduced.

Considering the activities that are most repeated in the answers of the experts, the proposal of the hierarchy is as follows (the percentage in the table is the percentage of representation of respondents that have ranked a particular activity in that position) (see Table 3):

The expert from the Faculty of Civil Engineering (CEF) has 7 activities at the same place as in the final hierarchy, out of 18 positions. Out of 18 positions, the experts from the Faculty of Architecture and Faculty of Traffic and Transport (AF, TTF1, and TTF2) have 8 activities ate the same place as in the final hierarchy. The experts from the Institute for the Protection of Cultural Monuments of Belgrade (ZZSK) and the Centre for Urban Development Planning (CEP) have 9 and 12 activities at the same place as in the final hierarchy, respectively, out of 18 positions. Finally, experts from Urban Planning Institute of Belgrade (UZB), Municipality of New Belgrade, sector for Urban planning (MSU1 and MSU2) and from City Secretariat for Urbanism (CSU) have 13 activities at the same place as in the final hierarchy, out of 18 positions.

Therefore, the percentage of compatibility per expert—respondent, according to the final list is as follows:

CEF/ 7 out of 18 (39%);
AF, TTF1, TTF2, 8 out of 18 (44%);
ZZSK/ 9 out of 18 (50%);
CEP/ 12 out of 18 (67%); and
UZB, MS1, MS2, CSU/ 13 out of 18 (72%).

Participants in the elaboration of the methodology- the group of professionals in practice are unified—50% and more than 50% of their results coincide with the final. Practically, the concluding result is mostly achieved by the results gathered from six (out of ten) experts who work in practice. A likely explanation for this result is a different professional perception of given circumstances by the academics, whose primary orientation is towards the concept, and secondary towards current problems in practice. This serves as a good indicator, as it was expected that the methodology would first and foremost be applied by experts who actively participate in urban planning practice and urban management.

Table 3. Hierarchy proposal.

Hierarchy/Order	Activity (with Numbers from Table 2. and Its Description)	% Representation
1	3—Building of new kindergartens /presence of kindergartens	70%
2	4—Building of new primary schools /presence of primary schools	70%
3	8—Building of new entertainment facilities /presence of entertainment facilities	60%
4	9—Building of new sports and recreation facilities /presence of sports and recreation facilities	60%
5	10—Efficient public transport—bus line frequency corresponds to needs (waiting time max.5min)	40%
6	11—Establishing safe and comfortable public transportation	40%
7	12—Establishing new public transport stops /presence of existing public transport stops within a diameter of 400m from the furthest locations of the examined zone	50%
8	6—Building of new community health centers /presence of community health centers	40%
9	2—Building of new shops /presence or adaptation of vacant spaces on ground floors into shops for everyday supply	50%
10	5—Building of new high schools /presence of high schools	50%
11	18—Provision of bicycle parking	50%
12	7—Building of new cultural facilities /presence of cultural facilities	60%
13	13—Removal of parking and regulation of traffic in streets with a width of at least 6 m, as two-way streets	60%
14	15—Provision of bicycle lanes	40%
15	14—Redefining the network so that dead-end streets are eliminated	40%
16	1—Building of new shopping malls/presence of shopping malls	90%
17	17—Reducing the number of parking spaces in the zone (max 0.5/ apartment)	90%
18	16—Provision of the system of "carsharing", for apartments in the zone	90%

6. Conclusive Considerations and Discussion

This paper elaborates the recommendation for the methodology that would provide support for the implementation of activities in existing collective housing urban clusters of modern urbanism, with the aim of energy efficiency from the view-point of land use and

accessibility. The targeted group of uses of the proposed methodology should be professionals working in the city and municipality administration—experts for urban land planning and management, who make decisions about implementing activities following certain already adopted conceptual platforms (in this case, that would be the adopted concept of the development towards energy-efficient urban areas). Furthermore, the methodology could also be used in the process of making urban plans and defining the recommendations for its implementation. The application of the proposed methodology would also contribute to the standpoint of experts regarding the implementation of activities, while the arbitrary or inappropriate finalization of ideas would be avoided, as well as the dissatisfaction of the inhabitants. Furthermore, this methodology can be useful for investors to explain their goals more clearly and implement quality solutions, but also it can serve as a mean to protect the public interest.

Regarding the process of making the urban plans, the methodology is applicable as a support to the strategic orientation towards energy efficiency development. Specifically, an urban planning document would contain the recommendation of the hierarchy of urban activities and consequently the order of their implementation. However, the greatest contribution of this methodology should be during the process of the implementation of urban plans because it provides the possibility to assess economical, ecological and social consequences which would be caused by the planned activity, as well as comparisons with consequences of other planned activities.

The idea for creating a methodology that could establish a hierarchy between a large number of activities for action in urban space is based on the FMEA (Failure Modes and Effects Analysis) methodology, which relies on three factors in the evaluation process. Three factors are also important for sustainable development (economic, environmental, and social), and the analogy with the idea of FMEA proved to be a quality solution for establishing this methodology. The proposed methodology implies a numerically expressed "Priority Activity for Energy Efficiency" (PAEE). This number is the product of three influences: Estimates of required material investments (M) (in terms of a material burden to society and ability to carry out this activity), estimates of environmental consequences (E) (in a selected case, it is an assessment of reducing own car use which consequently means reduced fuel consumption) and estimates of the detection of the activity consequences, by the inhabitants (S) (whether the activity affects their quality of life). The expert evaluates each activity from the point of view of these three aspects. During the first step, evaluation is carried out by treating these three factors equally, in order to preserve objectivity supported by sustainable development. However, in the next step an assessment of the importance of aspects for the specific location has to be included. At that point, PAEE results are already obtained, and assessment of aspects' importance is needed in the case when several activities have the same PAEE.

The results of the application of the methodology confirmed its usability and usefulness. It has to be stressed that the chosen case study has examined only 18 activities, while the professional planning practice can contain many more of them. Albeit so, it was clearly shown by the hierarchy that the first recommended activities would be those that assume current maintenance (regarding existing kindergartens, primary schools, retail, as well as minimal changes in public transportation). It is also important to point out that cancellation or conversion of the aforementioned land use must not be allowed. The results also indicate that a supporting comfortable, efficient, and frequent public transport is of great importance for this zone. It is obligatory to keep the existing public transport bus stations, but it is recommendable to introduce new bus stations within the 400 m diameter from the furthest locations of the examined zone. The results aim to encourage the activation of the ground floor premises as local shops or cultural activities, as well as to improve the accessibility to high schools and local health centers. Providing parking spaces for bicycles is one of the measures that would be useful to implement as an activity for this zone.

It is expected that the implementation of these activities could significantly affect the quality of life of the residents, but above all else, to affect their decision not to use their cars to meet all the needs.

According to the results, only when the above-mentioned activities are implemented, it will be possible to enter the last phase—the implementation of the most expensive activities that are the least desirable for the residents at the present time.

The last ones would be those that are the most uncertain since they are expensive and require a big change in inhabitants' behavior; at the same time, the inhabitants would not perceive them as activities that would improve the quality of life during its implementation. As the aforementioned refers to a drastic decrease in parking lots and introducing of carsharing/carpooling concept, it is necessary to raise the public awareness of the proposed activities' desirability prior to their implementation. Hereafter, we suggest that the examination, based on the methodology, and the hierarchy establishment should be carried out again.

It is important to observe that the application of the methodology pointed out that its primary contribution is the creation of the priority groups of activities, and the second contribution is a finalized hierarchy of the activities. Namely, as the case study has shown, the most frequent case is that the grouped activities yielded identical grades. This appears to be a dilemma which should be resolved in future through the further elaboration of the second step of the methodology, by emphasizing the specific hierarchies between three aspects of sustainable development for specific city zones. On the other hand, it is still possible to leave this decision to an expert or a team of professionals who would use the methodology, as it would be expected that they possess sufficient professional knowledge and experience. Nevertheless, a deeper, more detailed elaboration of this problem would be of help.

The objective of the proposed methodology is to create a living document that becomes a basis for making strategic engineering/planning decisions. The social circumstances are prone to sudden changes and unpredictable situations. Therefore, the importance and contribution of the proposed methodology are significant—it can provide the continual monitoring of the introduced changes in the urban environment. The emphasis is not on finished, determined, "perfect" urban plans to be implemented, but on the process and future activities that should follow the everchanging conditions.

The quality of the suggested methodology can be viewed, possibly, as a means of formulating a computer program, so this too is a suggestion for further elaboration.

The suggested methodology in its core represents a means of solving a multicriterial problem through integration of qualitatively and quantitatively different elements of three criterion aspects (Economical, Ecological, and Social aspects) and through an evaluation of synergistic effects of different activities to achieve the main goal—energy-efficient urban environment. It can be concluded that the suggested methodology includes relevant biophysical (through topics concerning ecological aspects) and anthropogenic (through topics concerning economic and social aspects) factors in the process of decision making, which is a contribution to modern urban planning and management approaches.

Among other things, the proposed methodology provides a hierarchy of activities that aim to avoid failures in the implementation of urban plans. This refers to activities that are among the most expensive, with less positive environmental impacts and with worse consequences for the quality of life at that time of its implementation. The broad platform for achieving energy efficiency, as it is presented earlier in the paper, also includes the effects on the quality of life. At the same time, the further development of the methodology in the future should treat the possibilities of life quality improvements in a more direct way. Furthermore, the future strategic platform for achieving energy efficiency in urban planning should also develop and deepen the criteria referring to the new construction/new housing complexes.

The priorities for achieving the goals in the planning process are very much influenced by the general economic and social circumstances, therefore the proposed methodology has

a time-defined framework. This means that once a hierarchy of urban planning activities has been established, it cannot be permanent and is prone to revision, which is fully in line with the nature of a planning process.

It is expected that the methodology can and would be applied in the urban planning practice, specifically in every urban plan dealing with existing multi-family housing complexes that lack energy efficiency at an urban planning level. In the case of ex-socialist countries like Serbia, such multi-family housing prevails and takes more than approximately 60% of the housing stock [73]. Bearing this situation in mind, the application of the methodology is mostly seen in the context of Serbia, but it could be adapted to a similar context elsewhere. In accordance with most international agendas referring to sustainable development, it is widely and globally accepted that it is necessary to create locally specific, tailor-made guides, manuals, and methodological tools for urban planning. On the other hand, it is also well known that the transferability and applicability of the methodological tools, guides and similar from one context to another, are very limited.

As it was emphasized earlier, the application of the methodology is most appropriate in the parts of the urban plan that refer to the measures and instruments of implementation. However, it is also possible to integrate the methodology in the section for energy efficiency measures at the urban planning level (according to the obliged contents of the urban plan defined by the Law on Planning and Construction) [27]. Although the obliged Energy efficiency measures at the urban planning level were introduced in 2014 by the then current Law on Planning and Construction, their implementation and concretization have not progressed much since then, so the integration of the proposed methodology could help to develop this important part of every urban plan in Serbia [27]. The proposed methodological tools can help all the actors included in the planning process, such as planning practitioners, city administration and political bodies in charge of the evaluation and approval of the plan, planning commissions, and above all, the citizens. The obligation to apply the methodology would be ensured by its incorporation into regulations, whether they would be on a local or state level. The process of introducing the necessary changes into regulations must be transparent and inclusive in terms of the participation of the formal city/government sector, civil sector and citizens, therefore the subjectivity of the planning practitioners or city administrators would be excluded.

Apart from the application of the methodology, it goes without saying it is necessary to work on other activities, which will contribute to the success of the whole concept of improving the energy efficiency in multi-housing urban areas. One of such activities should be the education and raising awareness of all actors involved in the process in terms of understanding the causal relationship between energy efficiency concept and the quality of life. This could be done through different workshops, promotion and facilitation process. The precondition of the full success of the methodology is a higher level of awareness of the public interest and betterment for all.

Although it might seem that the integration of the proposed methodology would be more time and money consuming, the greater benefits of its final implementation would prevail. The funding can rely on local or state budgets, but also non-government organizations. For example, in the past, foreign/international organizations such as US AID has already taken part in funding and improving the process of issuing building permits, and GIZ has funded a project regarding energy efficiency in public buildings [74,75].

Finally, it is important to remark that it is quite possible to empirically make decisions about which activity to carry out—currently, this is the everyday practice of planning professionals. However, the possibility of errors is not insignificant, so the suggested methodology provides the chance to reduce the errors and failures to a minimum, if not to completely avoid them.

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