5th INTERNATIONAL ACADEMIC CONFERENCE ON PLACES AND TECHNOLOGIES

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PLACES AND TECHNOLOGIES 2018

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DATA COLLECTION METHODS FOR ASSESSMENT OF PUBLIC BUILDING STOCK REFURBISHMENT POTENTIAL

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ABSTRACT

Improving the energy characteristics of public buildings in Serbia is a current topic investigated in two parallel projects carried out by the same research team from University of Belgrade Faculty of Architecture, which are both distinct in the formation and structuring of databases and the definition of their methodologies. The first project,*Energy Efficiency in Public Buildings*, is supportedbythe GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) and the Ministry of Mining and Energy of the Republic of Serbia, and focuses on schools and preschool facilities; the second project, *Empower public authorities to establish long-term strategies of renovation of public buildings* (EmBuild), is part of the Horizon 2020Project. The starting point for both projects is creating a quality and target-oriented database of energy characteristics of public buildings. The present paper will analyze the methodological approaches in formation of databases and compare their ultimate goals and results.

Keywords: Data collection, Building typology, Renewal strategies

Introduction

On the establishment of the Energy Community of South East Europe in 2006, the Republic of Serbia accepted the obligation to implement measures to increase energy efficiency and to form a national legislative framework in accordance with EU norms. Taking into account that buildings account for 40% of total energy consumption, increasing energy efficiency in this sector is an important segment of energy policy, with the aim of achieving energy savings, encouraging the use of renewable energy sources, and reducing CO_2 emissions. The Energy Efficiency Directive 2012/27/EU stipulates that the public sector of each member state should be the leader in the process of improving energy efficiency and that buildings used by state authorities should serve as an example illustrating the application of energy and environmental measures. The state itself, as the driver of energy policy, is then the representative of the implementation of the principles of energy efficiency.

In 2010-2014, University of Belgrade Faculty of Architecture, with the support of the GIZ, worked on a comprehensive project on the energy renovation of residential buildings according to the Tabula project methodology, the results of which were published in three books summarizing the complete work on the project. Residential buildings constitute the largest part of the building stock, followed by an extensive group of public buildings,which are being analyzed through two ongoing projects carried out by the same team from the Faculty of Architecture.

1 Corresponding author

The first project,*Energy efficiency in public buildings*, is conducted under the auspices of the GIZ and the Ministry of Mining and Energy of the Republic of Serbia, and focuses on the buildings of schools and preschool institutions. The research is based on the Tabula project methodology, in which the typology of buildings is the starting point for further research; however, such analysis has been done so far only for residential buildings. As public buildings represent a category of functionally, spatially, and structurally distinct facilitiesto which a general, comprehensive typology is inapplicable, this project is focused on educational and childcare institutions at preschool and school level. A precondition for the formation of the typology of such buildings was a highly adequate database; as itdid not exist as such, the strategy for data collection and database formation was defined for the needs of this project. Inthe absence of any well-established modalities according to which to structure the project and of any known state-formed national typology of public buildings, the project has a research character and represents a significant contribution toboth localand internationalexpert audiences involved in this issue.

The second project, *Empower public authorities to establish long-term strategies for the renovation of public buildings* (EmBuild) within the Horizon 2020, provides support to the public sector in the countries of South-East Europe in the preparation of a long-term strategy to encourage investment in the renovation and improvement of energy efficiency of the building stock. The project is targeted at local self-governments with the goal to encourage them to produce strategies for the renovation of their ownbuildings. The GIZ is the project coordinator while the project partners are from nine European countries including Serbia. Partner organizations are scientific institutions (universities, institutes) or energy efficiency agencies. Unlike the first project mentioned above, which has been developing its own research methodology, this project uses already fully defined methodology that should be implemented at local, national levels.

Although both projects have the same goal of increasing energy efficiency in the public sector and improving comfort in public buildings, theapproach to the problem is different. The purpose of this paper is to present the different approaches in the methodology of the projects concerning the collection and processing of data, in which the identification of the information required is one of the key indicators of their basic orientation and targeting. The first project involves a meticulously detailed review of all the data about abuilding in order to obtain a high quality database for exploring the distribution patterns of individual parameters, while the other project is oriented towards the formation of methods for rapid and effective identification of the buildings to be renovated.

Data collection procedure in the **Energy efficiency in public buildings** project

Considering the fact that neither a database for public buildings noreven a general list of institutions had existed, the work on the project started with determining the strategy for its formation. The research was carried out in several phases: the categorization of public buildings, the study of the available data, the field survey data collection, the analysis of the collected data, the definition of the typological approach, the formation of the typology, the definition of the modesand levels of renovation, and the calculation of energy consumption and savings achieved. The structure and the phases of the project are illustrated in Figure 1.

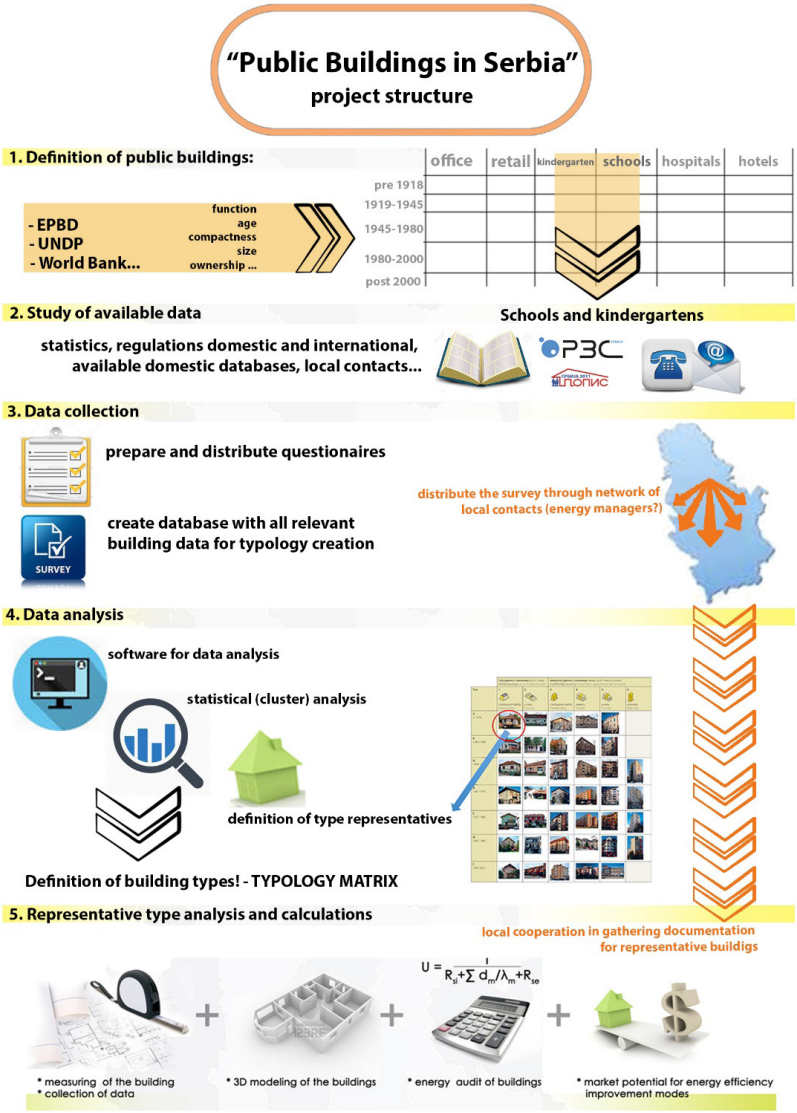

Figure 1: Structure of the **Energy efficiency in public buildings** project

The first step in the process of data collection was to define a questionnaire that would include all the data relevant to further analysis. For this purpose, experts from three key areas were engaged: architectural design and construction, mechanical engineering, and electrical engineering. Since the project is focused on a more detailed analysis of school and preschool buildings, three levels of the questionnaire were defined to separate the tiers of information relevant to a particular category of buildings.The first level of the questionnaire refers to all public buildings and it contains general information about the institution (category of the institution, address,

contact, funding sources, and the number of buildings). The second level of the questionnaire refers to all state-owned educational (school and preschool) and administrative institutions (excluding the police and the military). In addition to general data (type of building, cadastral parcel, year of construction), it contains questions about the energy passport of the building and whether any subsequent interventionshave been undertaken on the building and if yes, of which kind. The third, most detailed level of the questionnaire refers only to educational institutions (primary and secondary schools and preschool institutions) that are state-owned and occupy an independent building (i.e. they are not part of a residential building).The questions can be classified in three areas: architectural design and construction, mechanical installations, and electrical installations. In the architectural and construction segment, the questions relate to the materialization of all elements of the thermal envelope (walls, windows, blinds, the roof, the basement), with a special emphasis on the existence of thermal insulation materials. In addition, the spatial characteristics of the building are defined: the number of floors, net and gross floor area, floor and net height, floor plan compactness, window-to-wall ratio, theroof type, etc.The next group of questions refers to the mechanical systems in the building: the installations for heating, ventilation, air conditioning (HVAC) and domestic hot water preparation (DHW). The greatest attention in structuring the questions was dedicated to the heating system because the energy required for heating is the key for subsequent calculations,upon which the energy class of the building will be determined according to the current energy regulations. The type and age of the heating system, whether there is a possibility of regulating consumption, the type and consumption of energy, and the assessment of the quality of the heating system are all defined. The part related to the electric power systems provides information on electricity consumption in the building, the presence and capacity of air conditioners, the modes of DHWpreparation, and the internal and external types of lighting. In addition, it is noted whether there are automatic lighting control systemsor photovoltaic systems for power generation within the facility. The third level of the questionnaire contains all the data necessary for structuring the typology of the buildings as well as for the energy calculations that are to follow in the further research.

The data collection was conducted through local self-government bodies as important agents in the process of energy renewal, with the aim of their involvement in the project and becoming acquainted with all the phases of its development and implementation. The GIZ, as the coordinator of the project, engaged local coordinators tomanage the data collection andthe municipal authorities to distribute the questionnaires to all public buildings on their territory, and to collect the completed forms. Simultaneously with the distribution of the questionnaire, a software package was created that enabled the direct upload of the questionnaire data on a web platform in order to speed up the entire process of database creation. The problems in this phase of the work arose from the incompetence of the respondents to the questionnaire, misunderstood questions or incorrect answers, which significantly affected the quality of the received data. In the previous project, which analyzedresidential buildings, the field survey was conducted by a professional organization that provided basic training of the enumerators;although this did not fully eliminate the possibility of error and misinterpretation, the results were of higher quality and usefulness.

Upon the collection and entry of the data, the samples were analyzed statistically according to the most important criteria defining the spatial and structural characteristics of the type: period of construction, floor area, number of floors, compactness, window-to-wall ratio, and roof type. In the data processing and type formation, a cluster analysis was used to group similar objects into the same class to reducethe differences within each cluster.

The results of the statistical analysis of the sample were used to create the national typology of school and preschool buildingsasthe prerequisite for further calculations of energy consumption and the formation of improvement strategies.

Data collection procedure in the *EmBuild* project

The EmBuild project was designed to establish direct cooperation with the public administration sector of cities and regions.For this purpose, 20 municipalities on the territory of Serbia were selected to undertake the entire process from datacollection on public buildings, to the selection method for the buildings to be refurbished, to the formation of the renewal strategy for the buildings in their possession (Figure 2). The EmBuild project advocates the bottom-up approach, which implies that the national renewal strategy should result from local initiatives. Thus, their inclusion in all phases of the project implementation is crucial to stimulating the activities at the local level, with the aim that other municipalities and cities in the region follow their example. The project anticipates two levels of renovation: low and no-cost measures with 5% savings, and deep refurbishment with over 60% savings.

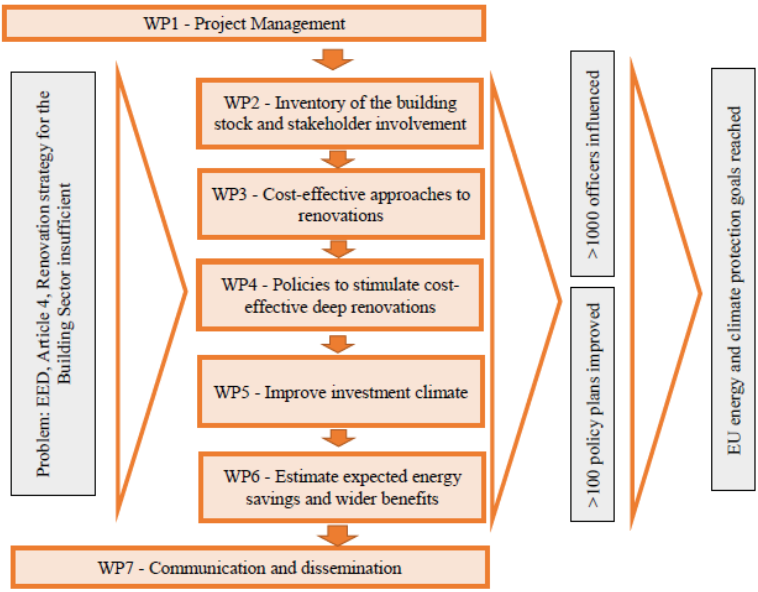

Figure 2: Objectives of the EmBuild project

In order to adopt a building renewal strategy, it is necessary to define the stages of refurbishment and to plan savings for each stage at the level of the building stock. This in turn requires a thorough review of the characteristics of the building stock. Thus, the first phase of the project is to collect basic data on the buildings such asthe floor area, the heating system, the type of energy source, and theconnection to the district heating system. Next, the energy consumption in buildings is analyzed (Figure 3), wherein it is necessary to determine the annual energy consumption for heating and electricity. To obtain comparative data, the consumption per square meter of the floor area is calculated, the data are compared with the reference values andany deviation isnoted, expressed as percentages. In each country, there should be reference values established for particular types of buildingsaccording to which the deviations for each individual case can be determined. Although the reference values can be setuponeither the average consumption valuesor the target values,for the given type of analysis, the target values should be used. If no reference valuesfor particular building categories are available, the legislative framework can serve as a basis for comparison; in most countries, the quality criteria

for newly builtstructures are defined as energy class A.

The comparison between energy consumption and the floor area of the buildings will identify the largest energy consumers to prioritize in the analysis. For this purpose, a diagrammatic representation is used in which the size of the circle denotes the area of the building, while the position in the coordinate system is determined by the deviations from the reference values for the annual heat and electricity consumption. The most disadvantaged position is in the upper right quadrant, which indicates high consumption of heat and electricity, and immediately signals the priorities for analysis.

After determining the level of urgency, a visit to the facilities in this group is planned to make an inventory of all elements that affect the energy performance of the building (thermal envelope, heating system, lighting, etc.). For this purpose, a traffic light rating system is used for a "simple and easy" preliminary analysis of the buildings. The condition of the building is rated as follows: Red—deteriorated, interventionis necessary; Amber—no urgent intervention is necessary; or-Green—satisfactory.

After the preliminary analysis, recommendations are given for a staged implementation of rehabilitation measures: urgent, less urgent, or potential in the later stages of renovation. The advantages of the preliminary analysis are that a simple and immediate method is used to estimate the condition of the facility and define low-cost renovation measures (quick repairs, calibrations, user behavior modifications, etc.). The disadvantages of the preliminary analysis are that it is not possible to estimate with certaintythe savings from the proposed measures or the exact value of the investment, which is vital for strategic planning. The selected building may be a unique case, and it may not be possible to apply the same set of measures to other buildings from the given inventory.

On the other hand, a detailed analysis of energy efficiency in buildings requires detailed data on the building stock, such as the size, form, architectural characteristics, materialization, and HVAC, DHWand lighting systems. At this stage, both presented projects have a common denominator, namely, the typology of buildings. The typology is a tool recognized by the European Union and their directive recommends that the TABULA methodology be used to assess the condition of the buildings and the investments in energy efficiency. The typology of public buildings is such a complex endeavor that a comprehensive, all-inclusive classification has yet to be developed.

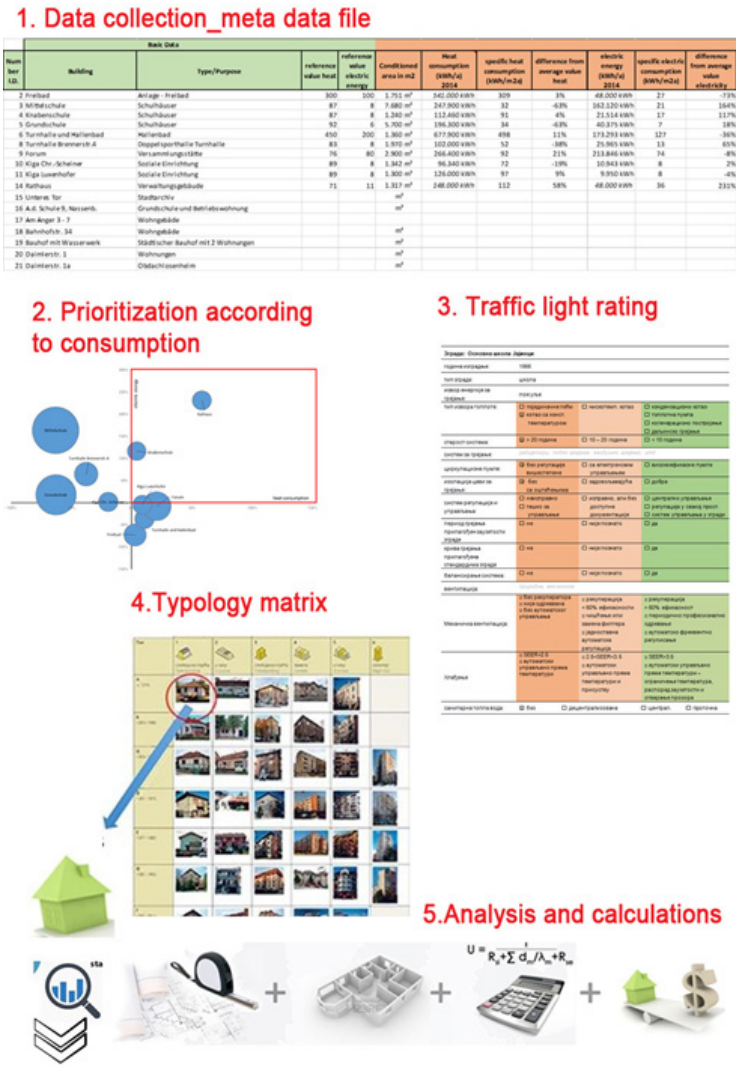

Figure 3: Structure of the EmBuild project

CONCLUSIONS

The two current projects that are focused on energy efficiency in public buildings may have different approaches to the subject, but certain segments of both methodologies are identical. Namely, the Embuild project concentrates on local self-governments entrusted with the governance of public buildings, for which they should formulate and implement their own renewal

strategies. To facilitate this, the Embuild project actively involves the representatives of model municipalities in all phases of the project in order that they be informed, trained and ready to implement the planned procedures. The complete methodology of the project is directed towards the organization, management and implementation of the strategies for energy renovation of public buildings so that the representatives of the local self-government are not presented with a finished product that only needs to be executed, but rather that they should master the tools and the procedures to create their own strategy independently. For this purpose, the method for rapid assessment of the condition of the building was developed in order to provide simple and easy (i.e. without professional assistance) identification of the key problems in the facility and, if possible, application of renovation measures that do not require large investments.

Similarly, the Energy Efficiency in Public Buildings project also recognizes the importance of local self-government in the process of energy renovation, in the way that they are actively involved in data collection for the establishment of a public buildings database. However, given the nature of the project, they are not included in the research stage that requires expert professional knowledge. The methodology of this project requires a detailed analysis of the buildings and depends on the typology of buildings as the starting point for further analysis. This is another common feature with the EmBuild project, in which detailed analyses are based on the typology of buildings recognized by the European Union as a harmonized method in structuring the building stock.

Apart from methodological differences and similarities, the two projects share the same goals: the improvement of energy efficiency in the public sector, the reduction of negative environmental impacts, the improvement of the occupancy quality in public buildings, and the economic and social benefits of energy renovation.

REFERENCES

"Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency". Official Journal of the European Union, vol.55, 14.11.2012, 1-57.

Jovanović Popović, Milica et. all. 2013. National typology of residential buildings in Serbia. Belgrade: Faculty of Architecture University of Belgrade and GIZ.

The Rulebook on the Energy Efficiency in Buildings. Official Gazette of RS, No. 61/2011.

The Rulebook on the conditions, content and way of issuing Energy performance certificate of buildings. Official Gazette of RS, No. 61/2011

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