CONFERENCES PROCEEDINGS

3RD INTERNATIONAL ACADEMIC CONFERENCE ON PLACES AND TECHNOLOGIES

EDITORS
EVA VANIŠTA LAZAREVIĆ
MILENA VUKMIROVIĆ
ALEKSANDRA KRSTIĆ-FURUNDŽIĆ
AND ALEKSANDRA DUKIĆ
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3rd International Academic Conference on Places and Technologies

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EVA VANIŠTA LAZAREVIĆ
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PLACES AND TECHNOLOGIES 2016
CONFERENCE PROCEEDINGS OF THE 3RD INTERNATIONAL ACADEMIC CONFERENCE ON PLACES AND TECHNOLOGIES

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Eva Vaništa Lazarević, Milena Vukmirović, Aleksandra Krstić Furundžić, Aleksandra Đukić

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KEEPING UP WITH TECHNOLOGIES TO CREATE COGNITIVE CITY
BY HIGHLIGHTING ITS SAFETY, SUSTAINABILITY, EFFICIENCY,
IMAGEABILITY AND LIVEABILITY

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ABSTRACT

Focus on structuring and evaluation of existing building stock, its characteristics and improvement potential represents the first step towards its refurbishment. After development of National residential building typology, further steps include its application for planning activities both on national and local level. As a result of adoption of recent regulatory acts in the field of energy efficiency improvement, local governments have an obligation in formulating Local Energy Action Plans (LEAPs) with estimations of savings potentials and related costs. These action plans need to address building stock energy efficiency, where residential buildings have a significant impact on the overall energy performance. In order to properly assess energy savings and investment costs the actual residential building stock characteristics and energy performance levels need to be investigated. Although National typology of residential buildings represents the basis for estimation of local building stock and formulation of local building typology, different approaches for its application on local level are possible.

Two different approaches have been tested through a case study in municipality of Vršac: a top-down and a bottom-up method. Main characteristic of the top-down approach is that it mostly relies of data gathered for the purpose of National typology, while in the bottom-up method a local survey is conducted providing some new data which are then used in adjusting National typology to local conditions. While both methods result in a relevant local typology, their applicability and accuracy of final results depend on municipality characteristics. Results of energy performance calculations are derived and compared for both methods and application guidelines for both methods are defined, which will enable local authorities to properly address this issue in the process of preparation of local energy action plans and support decision making related to investment cost and generated savings.

Keywords: building typology, energy performance, energy efficiency, decision making, local energy action plans

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INTRODUCTION

It is impossible to introduce a sustainable strategy for energy efficiency, regardless of the level of the plan, without adequate treatment of building stock. At the same time, every strategic decision must be based on assessment of relevant information on the actual characteristics of the building stock, its specific characteristics and modalities of improvement that include elements of thermal envelope and the systems installed in the building itself. This is why focus on structuring and evaluation of existing building stock, its characteristics and improvement potential represents the first step in its refurbishment. First steps towards this action are being taken through several research activities.

After formulating National residential building typology [Jovanović Popović et al., 2013] according to TABULA project principles, Serbia has joined its follow up project, EPISCOPE, as an associated partner. TABULA project methodology has been widely acclaimed as valid for assessing refurbishment potential of residential buildings stock. Use of building typologies in assessing refurbishment potential has been [Ballarini et al., 2014; Dascalaki et al., 2011]. Following the development of residential building typology, further steps include its application for planning activities both on national and local level. As a result of adoption of recent regulatory acts [Law on efficient use of energy, 2013] in the field of energy efficiency improvement, local governments have an obligation in formulating Local Energy Action Plans (LEAPs) with estimations of savings potentials and related costs. These action plans need to address building stock energy efficiency, where residential buildings have a significant impact on the overall energy performance. In order to properly assess energy savings and investment costs the actual residential building stock characteristics and energy performance levels need to be investigated. Although National typology of residential buildings represents the basis for estimation of local building stock and formulation of local building typology, different approaches for its application on local level are possible.

In order to investigate possibility of application of National typology for this purpose, Serbian pilot action in EPISCOPE project has focused on local level, namely, municipality of Vršac in Vojvodina region. Two options for local typology application have been envisioned: a top-down approach, which mostly relies of data gathered in the process of development of National typology, and a bottom-up method, which is based on data gathered through a local survey. Both approaches were tested in the conducted pilot project, and their results were analysed and compared. From the conclusions of these analyses a common methodology for development of local building typologies for the purpose of Local Action Plans definition has been established.

Top-down approach was the first tested method. Local sample for the analysis of building characteristics was derived from the sample based on which National typology was developed. However, in order to formulate benchmarks for energy reduction, and compare results and targets of refurbishment actions in the future, some parameters such as relevant local renovation rates had to be defined. These could be properly determined on a local level, but only by new detail inquiry of the building stock, as part of the new local survey. These actions are conducted as part of the bottom-up method, for which purpose a new survey was designed, with a new, modified questionnaire for building inquiry.

Local typology of building stock

Need for formulation of local typologies of building stock has been emphasized by obligations of local authorities in term of planning of activities and investments in energy efficiency, set by the legal framework. The Law on efficient use of energy defines the legal framework for the level of the Republic of Serbia, but also at the level of smaller spatial entities - local governments, ordering the formulation of the Local Energy Efficiency Plans. More specifically, Article 10 defines that each local government, as the organizer of local energy management, is required to bring their own energy efficiency in line with the Strategy and Action Plan adopted at the level of Serbia.
The content of the program includes a number of different activities: the need for a review and assessment of the annual energy needs of local government as a whole, including the assessment of the energy performance of buildings, as well as need to propose measures and activities which will ensure efficient use of energy in the overall energy sector. This law defines also the introduction of energy management services (Article 19) as obligatory for all municipalities with more than 20,000 inhabitants. The energy manager, among other, has an obligation to collect and analyse data on energy use, prepare appropriate programs and plans, proposes measures that contributes to efficient use of energy and to control their implementation. Construction of energy managers service, understood in this way, to a great extent depend on the possession of information on the structure of energy consumption in local government, its carriers, characteristics, as well as the principles and modalities of achieving a higher degree of efficiency.

Although National typology can be used as a mean of efficient planning tool on the level of whole Serbia, its application on local level needs to be analysed. Analysing the diversity of the structure of settlement in Serbia, their size, the spatial distribution of the building stock and forms of building it is obvious that it is necessary to develop a methodological approach for local application of typologies, and the principles by which it is possible to form local matrices. Any methodology developed for the local level, must primarily take into account the existence of specific local features: uneven development, different densities within a very small space frame and typological diversity. An example of the variety of different forms of building stock in the context of their spatial distribution can best be seen in Figure 1. Looking at the physical structure shown in the illustration, through the basic analysis of urban matrix, the diversity of forms can be determined, with the logic of spatial distribution that is extremely inconsistent and not related to the basic city zoning. Historically the development of cities in Serbia is largely characterized by different trends of development that manifest in varied scope, type, method and distribution of the construction process. The boundaries of planning zones are often extremely deterministic without ‘soft’ connections with the environment which often results in stark contrast to the built structure. The result of these activities is the phenomena of collective building blocks situated at the ends of the urban fabric surrounded by individual housing.
While working on the further implementation of the National methodology, observed characteristics have led to the development of two potential approaches for development of the matrix of local residential buildings. These two approaches are fundamentally different in the way of data collection that is forming a base and partly by way of data processing. Professionally, these approaches can be characterized as: **TOP-DOWN** (top to bottom) and **BOTTOM-UP** (bottom to top) method, and each has its own peculiarities, certain advantages and, of course, limits of the application, which will be further analysed and presented.

**Top-down method**

Top-down approach is characterized by the process of forming typology which is based on data from a broader spatial framework (National typology) as well as other data available for the analysis of the local level. The quality of the results depends largely on the availability of data. As a starting point, database established during the creation of the National typology of residential buildings, or other larger scale survey is used. In addition to these data, it is preferable to use and all other data that are available both at the national and local level:

- census of population and housing, data on the number of dwellings by municipalities, time periods, and the size of dwellings [Statistical Office of Republic of Serbia. 2013];
- statistics on buildings constructed by municipalities (Statistical yearbooks);
- statistics on housing built from 1994 to 2008 (Statistical yearbooks);
- or other data that may exist at the local level:
  - data from the cadastrale;
  - data from public companies for heat supply;
  - data from public companies for gas supply;
  - information from public companies for maintenance of residential buildings.

The development of methodology must represent teamwork with a defined manager of overall survey (local energy manager) and with the participation of a large number of professionals like statistical experts, experts on building typologies, local consultants with expertise in the field of construction and energy efficiency and researchers in the field (optional, but highly desirable).

The procedure of forming the typology starts similarly as the procedure used in formulating national typology in Serbia [Jovanović Popović, Radivojević, 2012]: analysis of the available data and implementation of the cluster analysis method applied to the local level. As the result, a new definition of representative types is possible and different, local typology formulated. In the process of forming the matrix, degree of relevance is very important, because experience has shown that adjusting the national matrix usually involves reduction (in some cases, drastically) of the number of types, thus determination of threshold (statistical representation of the type) is a basic generating parameter. By defining a new, statistically defined matrix, it is necessary to identify the material characteristic of buildings in order to access the identification of the model building and in the next step of real building as its representative. Representative buildings are identified in the field or in the available database. After formulation of local building typology, energy performance characteristics of new types are calculated according to national regulations and building sector energy characteristics on municipal level are summarized. Thus, matrix forming based on a top-down method is largely based on expert evaluation of existing data. In the example of the municipality of Vršac, which was used as a test case, there was an insufficient number of analysed buildings in the data base used in the process of forming of National typology, that served as a starting point, as well as the uneven distribution of the sample. The methodology of the national typology was carried out through two independent census cycles based on different statistical approaches. In Vršac municipality only 44 buildings of 6696 in the first and 176 of a total of 17,502 in the second survey are listed. This number of listed buildings does not represent valid statistical sample for municipality of Vršac.
Bottom-up method

Bottom-up methodology can be characterized as a method for forming typology based on the data collected in accordance with predefined statistical principles and according to the adopted questionnaires, through direct research in the field, or the process of surveying a particular, predefined sample. The quality of the results is directly dependent on the sample definition, its size and quality of the data collected. As in the top-down approach, but even more important is to engage team of experts with specialties in defined areas. Due to this methodological approach, the relevance of the results is directly dependent on the principles and the implementation of a local survey, and thus special attention must be paid to the definition of type and size of the survey, which determines the manner and scope of research that is directly proportional to the size of the analysed unit. Type of the survey defines whether it is only one or a two-stage survey, and the percentage of buildings to be analysed in the second round. For the town of Vršac sample size was defined with 1300 buildings plus 144 stratum (total fund) of multi-family buildings for a total of 1,444 buildings in the sample, partly on the basis of the defined principles but primarily due to the funding limitations. The creation of the sample is one of the most important steps in the implementation of this methodology. A methodology of forming a sample is developed by connecting statistical principles of numerical relevance with urban and architectural characteristics of the buildings. The method is based on the principle of zoning of the research area, on the macro and micro zones (Figure 2). Macro zones are parts of the territory (urban structure) with relatively homogenous characteristics according to the basic parameters (age, type of construction), while the micro-zones form their substructure. The number of macro zones can vary depending on the complexity of the physical structure of a specific urban territory. In the case of Vršac (Figure 5) the territory was divided in 18 macro zones. After the sampling the procedure of selection of building representatives through cluster analysis is same as in National Typology and top-down model, resulting in more accurate data on building types.
Comparison of two methodologies

The difference between the two approaches can be presented by direct comparison of the results, on a finalized local matrix, which is generated by overlapping national and developed matrixes for Vršac (Figure 3). Building types that have shown significant local relevance are shown in colour, while others are overtaken from National typology. Data for all the buildings are either calculated again (local reference buildings) or downloaded from the National typology (for all other buildings). In the case of Vršac, in the final matrix almost all buildings appear, which may not be the case in the smaller municipality. In that case, same fields can be empty and filled neither with local representatives nor types form national typology.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Family housing</th>
<th>Multi family housing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>detached</td>
<td>row house</td>
</tr>
<tr>
<td>A</td>
<td>8.45 %</td>
<td>3.67 %</td>
</tr>
<tr>
<td></td>
<td>6.30 %</td>
<td>3.62 %</td>
</tr>
<tr>
<td>B</td>
<td>10.05 %</td>
<td>4.21 %</td>
</tr>
<tr>
<td></td>
<td>6.61 %</td>
<td>3.85 %</td>
</tr>
<tr>
<td>C</td>
<td>13.08 %</td>
<td>5.35 %</td>
</tr>
<tr>
<td></td>
<td>9.08 %</td>
<td>5.31 %</td>
</tr>
<tr>
<td>D</td>
<td>18.44 %</td>
<td>15.94 %</td>
</tr>
<tr>
<td></td>
<td>13.80 %</td>
<td>10.57 %</td>
</tr>
<tr>
<td>E</td>
<td>19.55 %</td>
<td>10.94 %</td>
</tr>
<tr>
<td></td>
<td>17.50 %</td>
<td>21.07 %</td>
</tr>
<tr>
<td>F</td>
<td>17.36 %</td>
<td>16.69 %</td>
</tr>
</tbody>
</table>

Figure 1: Building typology matrix for the municipality of Vršac. (top – down data in white cells: left – percentage by number of buildings, right – percentage by area / bottom-up data in grey cells: left – percentage by number, right –percentage by area)
At first glance, the imprecision of top-down methods can be seen, and its dependence on the available data do not always provide a realistic picture of the situation on the ground. Some types that exist in the matrix, in this methodology, do not at all appear as relevant in the bottom-up approach (C4, D4, E4, F4, A3, B3). For those types, where a large sample is available, all the data are almost identical, which only confirms the methodological characteristics and accuracy of both approaches. On the other hand, some types are represented in a similar manner in both methodologies (C1, D1, E1). For these types, which have great both local and national representativeness, some more complex improvement scenarios should also be investigated, taking into account their more detailed characteristics.

CONCLUSIONS

In summary, it can be said, that in order to obtain more accurate results, which can be considered as a basis for strategic decision-making, more applicable is bottom-up methodology, while the top-down method can be used when a basic picture of the status of the building stock in a particular local government is needed.

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