Decision-Making Support for Municipal Property Management

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Abstract—The paper considers an approach to the decision-making support in managing the asset portfolio of a municipal entity. A management model based on complex information analysis was proposed. Management efficiency assessment criteria were considered. The need for factoring in the uncertainty of goals, limits in solution selection in managing the development of an asset portfolio of a municipal entity was proved. The example of the selection of an area usage option was considered.

Keywords—asset portfolio management, efficiency assessment of asset portfolio management, decision-making methods under conditions of uncertainty

I. INTRODUCTION

Managing an asset portfolio of a municipal entity (APME) is a complex task aimed at ensuring sustainable development of communities, building their resource capacity and increasing local budget revenues. The solution to the problem requires constant monitoring of big data sets and responsive analysis of data related to the development of an asset portfolio, real estate market status, changes in the regulatory framework, etc. Wrong decisions in managing the APME cause risks of inefficient area usage, investment activity decrease, etc.

An asset portfolio of a municipal entity is a resource that when managed efficiently allows generating profit and benefits for a community as a subject of the competitive environment. On the other hand, urban areas and municipal property form the basis of existence and functioning of an urban community. Meeting the needs of urban residents in quality housing, social infrastructure, recreation areas, transport and utilities infrastructure and other life-support systems is the main objective of the operation of a city. The management of the APME must take into consideration both financial indicators and physical, geographical, engineering, environmental ones. Moreover, any urban project can be successfully implemented only after it has been considered and approved by the urban community. As a result there is a need for new approaches to criteria system development that helps to select efficient solutions and to choice support methods that provide for a high level of goal uncertainty and challenge limits.

II. CHALLENGES IN MANAGING AN ASSET PORTFOLIO OF A MUNICIPAL ENTITY

Managing the APME is a complex of efficient activities carried out by the property owner (or the manager) aimed at maintaining basic qualities of the property or its expansion; targeted impact on the property and subjects of its usage for the benefit of the ME related to introducing rules, conditions for the usage of municipal property and the achievement of established goals taking into account public values [1].

In a broad sense, managing the APME can be seen as a decision-making process that helps to select the object management form. Managing the APME must be oriented towards the achievement of goals that face a municipal entity: increasing revenues to the local budget coming from the its property turnover, stimulating social and economic area development with a view to solve the local problems fully and quickly under the changing conditions of the internal and external environment.

The major challenges in the APME management process:

- Establishing main goals and tasks for the development of the APME.
- Collection of data on the APME operation (establishing the data sources, creating collection and initial processing mechanisms, storage and quick access, ensuring data security).
- Setting criteria to assess the efficiency of the APME management.
- Formulating the APME development plan.
- Reorganizing the APME management processes.
- Efficiency assessment of the APME management.

The processes of an asset portfolio management on the local self-government level in Russia are different from the corresponding rights and responsibilities of legal entities. The alienation of municipal property and its leasing are the main ways to manage the APME. If we consider each of the aforementioned management types from the economic point of view, we can come to the following conclusion: alienation of

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property is a one-time opportunity of a municipality to raise revenues to the budget. The most rational way to manage assets is to lease objects as it guarantees long-term revenue stream.

The main leasing forms are the following: auction, commercial tender, short-term leasing and intended use property transfer. Every of the forms has its own specific features but also one goal, namely to increase the efficiency of the management of the property that have been given to the local self-government bodies.

Public-private partnership is a form of managing municipal property in many countries and a priority that is represented by an organizational and institutional alliance between the public authorities and private sector with a view to implement socially relevant projects in various activity areas. Relations between the state, local self-government and businesses is based on concessional agreements. This type of a partnership is one of the most effective tools to coordinate decisions on planning the social and economic development of territories.

Ambiguous approaches to the efficiency assessment of the APME management are one of the main problems associated with the APME usage. Today there is no single analysis methodology for the APME management efficiency. Maximum possible revenue flow from managing the given asset portfolio is taken as an efficiency indicator in the majority of cases. Nevertheless, cost assessment does not always show the relevance of the decisions associated with the management type of an object. First of all, it is essential to take into account the benefit of the public, historical and environmental aspects of an area Fig. 1.

Any plan is bound to fail, if appropriate financial, human or energy resources necessary to implement the project are not allocated. This is why it is particularly important to formulate city development plans and analyze the ways of their implementation based on decision evaluation mechanism that can help to forecast the future urban environment that forms the life support system. Decisions are made both on the strategic level in the process of formulating management principles and on the operational level when area management modes are selected, funds are allocated and management conditions are changed, etc. [2].

Major stages of decision-making process support for urban area development planning can be defined in the following way Fig. 2.

It is essential to use a mechanism that allows making a balanced assessment of solutions when managing the APME. The selected solution allows evaluating the produced social and economic effect on the given APME area. The key role in processing the initial data set is played by decision-making process support systems (DMPSS). As for today there is no single classification of DMPSS and no reference system fit for all kind of tasks, but effective methods were developed that allow making an evidence-based executive decision. These methods are based on the analysis of the available information on the object of the research, its external social and economic setting, rather than on subjective and intuitive personal opinion (of an employee, manager, or expert).

Goals of the state/ needs of owners/population

Asset portfolio of a municipal entity (APME)

Analysis and monitoring of the external environment of the APME

Planning a process to create objects in the APME

Planning a process on reconstruction/renovation/maintenance of APME objects

Planning a process of operation and usage of the APME objects in their current condition

Planning a process of elimination of APME objects

Expertise and inspections of the implemented processes on the part of the authorities, local governments, public hearings

APME efficiency analysis

–social and environmental effect;
–commercial effect;
–Living standards improvement in a ME, etc.

Fig. 1. APME management model.

The most widely used technologies supporting executive decision-making processes are the following: fuzzy set theory, hierarchy analysis technique, neural networks, genetic algorithms, neuro-fuzzy systems [3].

Every aforementioned tool has its advantages and disadvantages, but they share a common basis, namely the mathematical apparatus with AI elements that helps to make the best relevant decision taking into account established goals and limits.

Today fuzzy set theory methods (FST) are increasingly used to accomplish long-term and short-term objectives in economy and management development.

FST allows abandoning classical complex system creation algorithms that require a clear step-by-step process to achieve a result, complete and consistent initial data and to process the precise characteristic of object/objects of the research. FST supports the decision-making process under the conditions of uncertainty.
When the initial information on the characteristics of the studied system and its operation efficiency evaluation criteria indicators are not clear, it is feasible to use the approach based on fuzzy set and possibility theory [4].

Then we can consider a fuzzy set for criteria G:

\[ G = \left[ \frac{\mu G_1(X_1)}{X_1}, \frac{\mu G_2(X_2)}{X_2}, \ldots, \frac{\mu G_k(X_k)}{X_k} \right] \]  

where \( \mu G_i(X_j) \in [0, 1] \) – is the assessment of the alternative project \( X_j \) on the criteria \( G_i \) that characterizes the degree of the membership of the alternative in the notion described by criteria \( G \).

If there are \( n \) criteria: \( G_1; G_2; \ldots; G_n \), then the best one is the alternative that satisfies the criteria \( G_1 \) and, \( G_2 \) and, \( \ldots \), and \( G_l \).

Then the rule for the selection of the best alternative can be written down as an overlap of two corresponding fuzzy sets:

\[ D = G_1 \cap G_2 \cap \ldots \cap G_n \]  

The operation of fuzzy set overlap corresponds to operation min that done with their membership functions:

\[ \mu(X_j) = \min_{i=1,n} \mu G_i(X_j) \]  

The most efficient project must have \( X^* \) the highest value of the membership function:

\[ \mu(X^*) = \max_{j=1,k} \mu G_i(X_j) \]  

Let us consider three variants of the implementation of an APME development investment project on the basis of comparison of technical and economic parameters. The input data on the projects gives an idea of the final impact that is achieved when an object is constructed.

\( X_1 \) is an investment project on the construction of an apartment building (Table I). \( X_2 \) is an investment project on the construction of a shopping mall (Table II). \( X_3 \) is an investment project on the construction of a Sports and Recreation Center with swimming pool (Table III).

As a rule, the currently used methodologies do not allow fully taking into account the uncertainty of many factors that define the quality of a project. The quality assessment of decisions must be carried out on the basis of economic, social, technical and environmental indicators allowing for the complex nature of their correlations on the basis of existing Russian national standards and norms.

Common criteria for alternative projects that characterize the feasibility and efficiency of the implementation of these projects was identified despite the fact that every proposed project has its own specific features resulting from the construction and future operation requirements (lighting, object engineering system maintenance, green space, parking space requirements, etc.). Selection criteria:

- G1 – location of an object.
- G2 – investment appeal of the project.
- G3 – competitiveness among market players/market segment development trends.
- G4 – budgetary effectiveness.
- G5 – legal security.
- G6 – environmental level.
The alignment of priority vectors and matrices is shown in the Fig. 3. The solution to the multi-criteria problem is shown in the formula below the Fig. 3.

**TABLE I. TECHNICAL AND ECONOMIC PARAMETERS OF X₁**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Dimension</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area of the house</td>
<td>m²</td>
<td>22 972,88</td>
</tr>
<tr>
<td>Living space</td>
<td>m²</td>
<td>8 354,1</td>
</tr>
<tr>
<td>Total area of the included non-residential space</td>
<td>m²</td>
<td>1 750,71</td>
</tr>
<tr>
<td>Construction volume of the building</td>
<td>m³</td>
<td>85 617,42</td>
</tr>
<tr>
<td>Total area of the land plot</td>
<td>m²</td>
<td>3 617,00</td>
</tr>
<tr>
<td>Development footprint</td>
<td>m²</td>
<td>1 752,20</td>
</tr>
<tr>
<td>Number of floors</td>
<td>floor</td>
<td>22</td>
</tr>
<tr>
<td>Number of sections</td>
<td>pieces</td>
<td>2</td>
</tr>
</tbody>
</table>

**TABLE II. TECHNICAL AND ECONOMIC PARAMETERS OF X₂**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Dimension</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area of the building</td>
<td>m²</td>
<td>6994,12</td>
</tr>
<tr>
<td>Commercial capacity of the building</td>
<td>m²</td>
<td>22 898,4</td>
</tr>
<tr>
<td>Commercial and exhibition capacity of the building</td>
<td>m²</td>
<td>3731,14</td>
</tr>
<tr>
<td>Construction volume</td>
<td>m³</td>
<td>45320,94</td>
</tr>
<tr>
<td>Total area of the land plot</td>
<td>m²</td>
<td>4017,00</td>
</tr>
<tr>
<td>Development footprint</td>
<td>m²</td>
<td>2933,62</td>
</tr>
<tr>
<td>Number of floors</td>
<td>floor</td>
<td>3</td>
</tr>
</tbody>
</table>

**TABLE III. TECHNICAL AND ECONOMIC PARAMETERS OF X₃**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Dimension</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area of the building</td>
<td>m²</td>
<td>3768,50</td>
</tr>
<tr>
<td>Construction volume of the building</td>
<td>m³</td>
<td>35769,80</td>
</tr>
<tr>
<td>Total area of the land plot</td>
<td>m²</td>
<td>4471,00</td>
</tr>
<tr>
<td>Development footprint</td>
<td>m²</td>
<td>3608,00</td>
</tr>
<tr>
<td>Number of floors</td>
<td>floor</td>
<td>2</td>
</tr>
<tr>
<td>Capacity</td>
<td>person</td>
<td>2400</td>
</tr>
</tbody>
</table>

The analysis shows that the X₃ project is the most attractive and surpasses the others by 3 criteria out of 6.

**IV. CONCLUSION**

Growing requirements for the urban environment call for a change in the approaches to solving challenges in urban process management and infrastructure development. The ability to predict the needs of city residents and businesses and provide the conditions for stable functioning of all urban subsystems under varying conditions [7]. The development of urban territory and its radical redevelopment needs substantial investments. This is why executive decision-making process must be based on a deep analysis of the situation and assessment of the impact of a decision.

Fig. 3. Priority vectors and matrix harmonization.

\[ D = \begin{pmatrix} 0.21 & 0.31 & 0.49 \end{pmatrix} \]

The creation of an information and analysis system to support the relevant decision-making process is an essential task, in particular because of the need for a big data set analysis and high level of uncertainty.

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**REFERENCES**