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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 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).

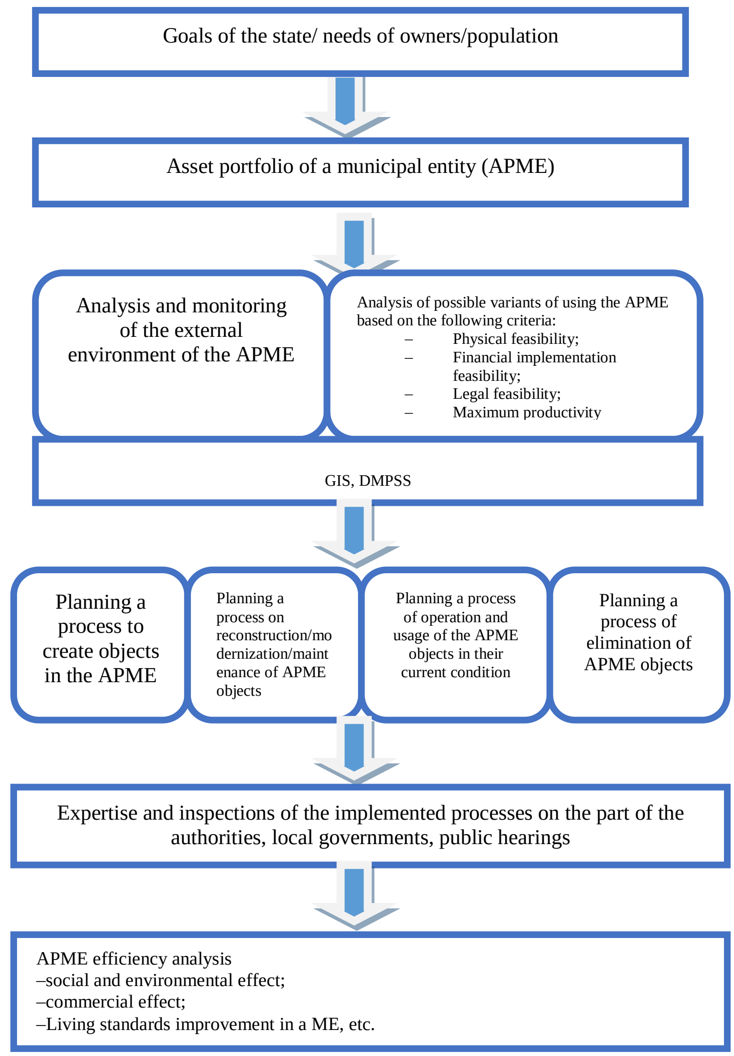

Fig. 1. APME management model.

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].

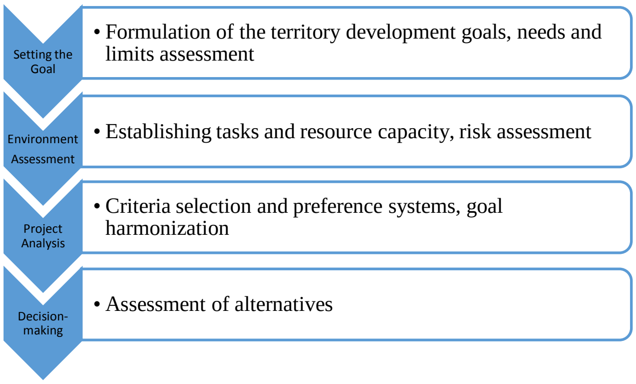

Fig. 2. Decision-making process support for managing the APME.

III. Example of Solving the Problem of Selecting a Territory Development Project

Selecting a solution is a choice of the most attractive project among many alternatives. As a rule, at the initial stage the decision maker or the manager (developer) analyses the situation and predetermines the long-term consequences of the future selection. This task is particularly relevant when it comes to promoting the APME development as it has a clear goal and a given object (territory). This is why it is important to examine thoroughly the various criteria of a project's impact on the APME when analyzing the available options. The developed criteria must both identify the advantages and disadvantages of the presented projects from different points of view and reflect the existing preference system of the intended user, be in line with current and strategic objectives specified by the Government of the Russian Federation. Taking into account the set task, the present article considers the analysis of the APME development (territories, land and property complex) illustrating it with three examples of investment projects that can be implemented.

In practice the manager (or the developer) does not have an opportunity to collect all the necessary information to predict the consequences of the implementation of a project, so we assumed that the initial conditions of the project implementation are uncertain.

Decision-making models under the conditions of uncertainty widely employ the Bellman-Zadeh principle [5] that is used in conjunction with Saaty hierarchy method [5] that allows identifying the degree of fuzzy set elements connection with a paired comparison procedure.

Let us assume that there is a set of n alternative projects:

$$X = \{X_1;X_2;...X_K\} \quad (1)$$

The set of quantitative and qualitative criteria that can be used in the comparative analysis of the presented projects is identified.

$$G = \{G_1;G_2;...G_n\} \quad (2)$$

Then we can consider a fuzzy set for criteria G:

$$G = \left[\frac{\mu G_{1(X_1)}}{X_1}, \frac{\mu G_{2(X_2)}}{X_2}, \ldots, \frac{\mu G_{i(X_k)}}{X_k}\right] \quad (3)$$

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: $G_1;G_2;...G_n$, then the best one is the alternative that satisfies the criteria G_1 and, G_2 and, …, and G_i

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

$$D = G_1 \cap G_2 \cap, \ldots, \cap G_n \quad (4)$$

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

$$\mu(X_j) = \min_{i=1,n} \mu G_i(X_j) \quad (5)$$

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

$$\mu(X^*) = \max_{j=1,k} \mu G_i(X_j) \quad (6)$$

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 X_1

Indicator	Dimension	Number
Total area of the house	m2	22 972,88
Living space	m2	8 354,1
Total area of the included non-residential space	m2	1750,71
Construction volume of the building	m3	85 617,42
Total area of the land plot	m2	3 617,00
Development footprint	m2	1 752,20
Number of floors	floor	22
Number of sections	pieces	2

TABLE II. TECHNICAL AND ECONOMIC PARAMETERS OF X_2

Indicator	Dimension	Number
Total area of the building	m2	6994,12
Commercial capacity of the building	m2	2289,84
Commercial and exhibition capacity of the building	m2	3737,14
Consrtuction volume	m3	45320,94
Total area of the land plot	m2	4017,00
Development footprint	m2	2933,62
Number of floors	floor	3

TABLE III. TECHNICAL AND ECONOMIC PARAMETERS OF X_3

Indicator	Dimension	Number
Total area of the building	m2	3768,50
Construction volume of the building	m3	35769,80
Total area of the land plot	m2	4471,00
Development footprint	m2	3608,00
Number of floors	floor	2
Capacity	person	2400

The analysis shows that the X_3 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.

$$A(G1) = \begin{array}{cc} & \begin{array}{ccc} x1 & x2 & x3 \end{array} \\ \begin{array}{c} x1 \\ x2 \\ x3 \end{array} & \begin{bmatrix} 1 & 0.33 & 0.33 \\ 2 & 1 & 0.5 \\ 3 & 2 & 1 \end{bmatrix} \end{array} \quad A(G2) = \begin{array}{cc} & \begin{array}{ccc} x1 & x2 & x3 \end{array} \\ \begin{array}{c} x1 \\ x2 \\ x3 \end{array} & \begin{bmatrix} 1 & 0.33 & 0.13 \\ 3 & 1 & 0.14 \\ 8 & 7 & 1 \end{bmatrix} \end{array} \quad A(G3) = \begin{array}{cc} & \begin{array}{ccc} x1 & x2 & x3 \end{array} \\ \begin{array}{c} x1 \\ x2 \\ x3 \end{array} & \begin{bmatrix} 1 & 0.33 & 0.17 \\ 3 & 1 & 3 \\ 6 & 0.33 & 1 \end{bmatrix} \end{array}$$

$$A(G4) = \begin{array}{cc} & \begin{array}{ccc} x1 & x2 & x3 \end{array} \\ \begin{array}{c} x1 \\ x2 \\ x3 \end{array} & \begin{bmatrix} 1 & 0.33 & 0.14 \\ 3 & 1 & 0.2 \\ 7 & 5 & 1 \end{bmatrix} \end{array} \quad A(G5) = \begin{array}{cc} & \begin{array}{ccc} x1 & x2 & x3 \end{array} \\ \begin{array}{c} x1 \\ x2 \\ x3 \end{array} & \begin{bmatrix} 1 & 0.33 & 0.25 \\ 3 & 1 & 4 \\ 4 & 0.25 & 1 \end{bmatrix} \end{array} \quad A(G6) = \begin{array}{cc} & \begin{array}{ccc} x1 & x2 & x3 \end{array} \\ \begin{array}{c} x1 \\ x2 \\ x3 \end{array} & \begin{bmatrix} 1 & 6 & 6 \\ 0.17 & 1 & 1 \\ 0.17 & 1 & 1 \end{bmatrix} \end{array}$$

$$G_1 = \left\{\frac{0.15}{x_1}, \frac{0.31}{x_2}, \frac{0.54}{x_3}\right\} G_2 = \left\{\frac{0.07}{x_1}, \frac{0.19}{x_2}, \frac{0.74}{x_3}\right\} G_3 = \left\{\frac{0.09}{x_1}, \frac{0.44}{x_2}, \frac{0.46}{x_3}\right\}$$

$$G_4 = \left\{\frac{0.08}{x_1}, \frac{0.22}{x_2}, \frac{0.7}{x_3}\right\} G_5 = \left\{\frac{0.11}{x_1}, \frac{0.54}{x_2}, \frac{0.35}{x_3}\right\} G_6 = \left\{\frac{0.75}{x_1}, \frac{0.13}{x_2}, \frac{0.13}{x_3}\right\}$$

Fig. 3. Priority vectors and matrix harmonization.

$$D=\left\{\frac{0,21}{X_1}, \frac{0,31}{X_2}, \frac{0,49}{X_3}\right\}$$

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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