The method of iterative use of the ABC-XYZ analysis in the construction industry

Alexander Konikov[1,*]

[1]Moscow State University of Civil Engineering, 26, Yaroslavskoye shosse, Moscow, 129337, Russia

Abstract. The issue of marketing in the construction industry has always remained relevant. Indeed, it is not easy to design objects so that they bring high and stable income. The paper studies a solution to the problem, based on the use of the iteration method, the ABC - XYZ analysis, and digital filtering. It is based on the well-known principle of the study of complex systems: the sequential division of a complex task into a number of simpler ones. We would like to note that the "classic" ABC - XYZ analysis gives only general results about the profits from construction projects and does not study the reasons due to which these profits are received. In contrast, the proposed tooling allows taking into account the main technical, geographical and other factors typical for profitable construction projects. One of the advantages of the considered approach is that the conventional computer tools - a spreadsheet MS Excel, is used in solution. The paper discusses the advantages and disadvantages of the proposed approach, specifies in which cases it is advisable to use this approach and where to use more powerful and expensive tools - Big Data technology. For better visualization and clarity, the elements of set theory are used in the paper. This methodology is universal, and its use in the energy industry is possible when selecting more profitable types of products.

1 Introduction

The role of marketing research in the construction industry is continuously increasing. This paper proposes an approach to determine the objects whose sale brings the highest and most stable income. Setting the task is quite simple, but the solution is a very difficult task - you should analyze the results of sales of a large number of objects, each of which has many parameters (technical, geographical, etc.). At first glance, this is a typical case when you should use Big Data technology. The author is one of the proponents of this approach (the advantages of using Big Data technology in construction are discussed in publications [1-7]), but in this paper, the author alternatively proposes a different approach based on the iterative use of the ABC - XYZ analysis. The basis of the approach is a well-known method for solving complex problems - the division of a complex task into a number of simpler ones.

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[*] Corresponding author: a.konikov@gmail.com

2 Materials and Methods

The setting of the task is as follows. It is required to analyze the sales results during a certain time interval for a large number of apartment buildings, townhouses, etc. As a result, to identify objects, the sale of which brings the most high and stable income. The object may be a particular townhouse or apartment of a specific type (for example, a two-story one), for which at least one economic indicator is known - income from the sale.

Let's represent all the objects that entered the marketing research in the form of a set $W\{w_1, w_2, \ldots, w_r\}$ (Figure 1).
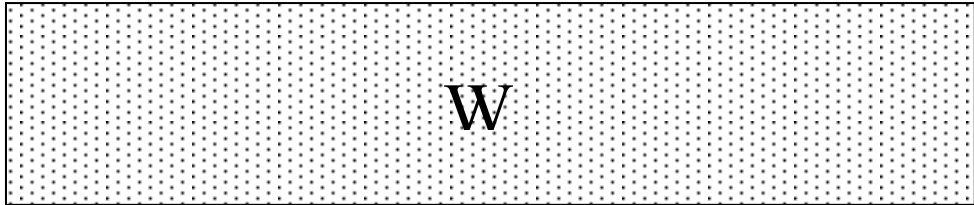

Fig.1 The set of objects $W\{w_1, w_2, \ldots, w_r\}$ included in the marketing research.

The number of elements in the set $W\{\}$ can be quite large, of the order of 1000. It is very difficult to intelligently examine the patterns in such a number of elements. (We point out that the proposed research apparatus does not imply a huge number of elements of the set $\gg 1000$). We divide the set $W\{\}$ into subsets - so that the number of subsets $n \ll r$. When combining objects into subsets, you can follow different strategies - based on the specific situation. For example, one subset for multi-room business class apartments, the other - duplex apartments, etc.

Let the set $W\{\}$ be divided into n subsets of $U_1\{\}$, $U_2\{\}$, …, $U\{\}_n$. For clarity, the dividing process is illustrated in Figure 2.
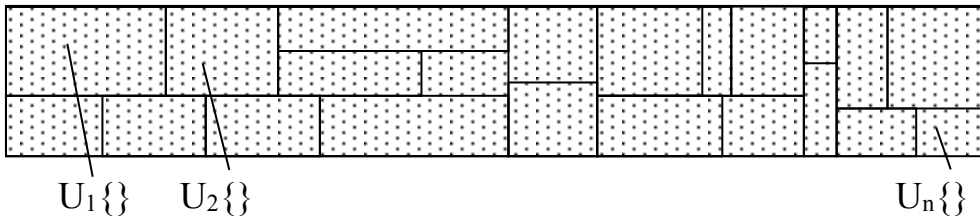

Fig.2 Dividing of the set $W\{\}$ into subsets

The set $W\{\}$ is the union of the sets $U_1\{\}$, $U_2\{\}$, …, $U\{\}_n$

$$W = U_1 \cup U_2 \cup, \ldots, \cup U_n \tag{1}$$

Denote the aggregate of sets $U_1\{\}$, $U_2\{\}$, …, $U\{\}_n$ as $m_1, m_2, \ldots m_n$ (such a designation is not entirely correct from the point of view of the "classical" theory of sets, however it allows making the consideration more clear). Then you can write the set $M\{m_1, m_2, \ldots, m_n\}$, each element of which is itself a set (hereinafter, for simplicity, we call $m_1, m_2, \ldots, m_n$ simply "elements"). Then for each element m_i, it is possible specify the figure characterizing the profitability of this type of object. For example, this figure may mean the income received from the sale of townhouses of a certain type.

Further, it follows that the elements $m_1, m_2, \ldots, m_n$ can be ranked depending on their profitability, i.e. conduct the ABC analysis.

ABC analysis divides all elements into 3 types - type "A" - brings up to 80% of the total income, type "C" - less than 5%, objects of type "B" hold some intermediate position. Specific figures for research purposes can be changed.

Next, we introduce the concept of the studied set I {} - this set includes objects for which a detailed analysis is carried out. In the simplest and most logical form, this set includes elements of category "A". When these elements are too small, elements of category "B" may be added to them. The set I {} is much smaller than the set M {}, which is illustrated in Figure 3.

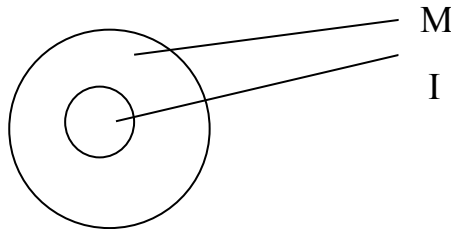**Fig.3** Sets M{} and I {}

The transition from the set M{} to the set I {} containing a much smaller number of elements is an important stage in the reduction of the dimension of the task.

Mathematically, this can be expressed as follows:

$$I \subset M \qquad (2)$$

$$\forall \varepsilon \in M \, \exists \, \varepsilon \notin I \qquad (3)$$

It was noted above that in most cases, the set I {} includes the objects that were in the group "A" during the ABC analysis of the elements of the set M{}. Then

$$I = A \qquad (4)$$

$$I = A \Leftrightarrow \forall \varepsilon: (\varepsilon \in I) \Leftrightarrow (\varepsilon \in A) \qquad (5)$$

Further, one can "expand" the set I {} by additionally including the "less profitable" subset B{}

$$I = A \cup B \qquad (6)$$

$$A \cup B = \{\varepsilon \mid (\varepsilon \in A) \lor (\varepsilon \in I)\} \qquad (7)$$

Sometimes it is better not to "connect" the subset B {} to the analysis, but to change the percentages in the ABC analysis, for example, suppose that the group "A" includes elements that bring not 80% of total income, as in the "classical" ABC analysis, but 65%.

Here we make an important remark: when choosing the number of elements l of the set I{} under study, one should proceed from common sense. It is important that l is not very big and not too small. We present some general guidelines for choosing. First of all, we once again recall that each element of the set I {} itself is a set of specific construction objects; we denote the total number of objects corresponding to the selected l through d. Each of the d objects has j technical, geographic, and other characteristics (the researcher himself indicates these characteristics). The general rule is that the aggregate amount of information should be such that it is possible to track the patterns of falling into the group of "revenue" objects. Thus, the number l should be such that it was possible to "track" d objects with j characteristics using the research apparatus considered below. This number

can be changed (for example, by changing the percentages in the ABC analysis), "adjusting" the research apparatus to the individual abilities of the researcher.

So, after the ABC analysis, we got a set of d specific objects that have good rates of return. For a number of objects that have time-dependent statistics on sales, it is possible to additionally conduct the XYZ analysis.

The XYZ analysis ranks the elements, depending on the stability of sales. Stability is proposed to measure by the value of v – the ratio of the standard deviation to the average value:

$$v = \frac{\bar{x}}{\sigma} *100\% \tag{8}$$

If the value of v does not exceed 10%, then the demand for this type of objects is stable, and they are referred to the category "X"; if the value of v exceeds 10% but not more than 25%, then the demand for this type of objects is less stable, and they are categorized as "Y"; if the value of v exceeds 25%, then the demand for objects is unstable in nature, and they are classified as "Z". The relationship between the objects included in the marketing research is illustrated in Figure 4.
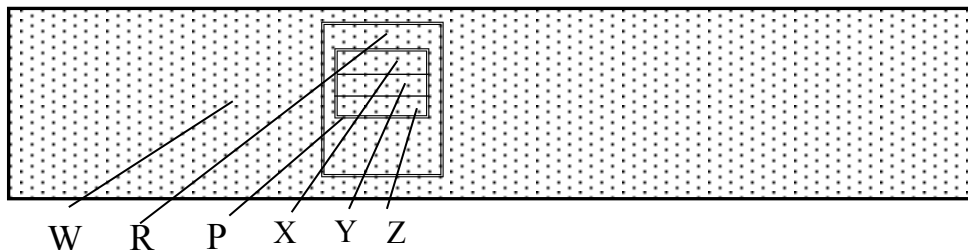

Fig.4 The set of all objects included in the marketing research.

Here W{} is the set of all objects included in the marketing research, R{} is a set of objects with good indicators on sales profitability, P{} - part of this set is objects for which there is time-dependent statistics, and it is possible to conduct the XYZ analysis. X{} - objects with good sales stability, Z{} - objects with low stability, Y {} - objects that hold an intermediate position.

Mathematically:

$$R \subset W \tag{9}$$

$$P \subset R \tag{10}$$

$$P = X \cup Y \cup Z \tag{11}$$

So, we have a list of specific construction objects that have good sales performance characteristics (elements of the set Q {}, see Figure 4).

Place the data on the objects of the set Q {} in a table using, for example, Excel.

Table 1. Table of parameters of objects that bring a good income.

Object type	Technical characteristics			Geographical characteristics		Other characteristics			XYZ analysis

The type of the object is entered in the first column according to the partition shown in Fig.2. Next are the columns with the technical characteristics of the foundation, walls, etc. The most important characteristics are indicated here, their number should not be large -

otherwise it is difficult to evaluate the results and find patterns. Then follow the columns conventionally called "geographical characteristics". For example, there may be a distance to the nearest metro. There should also not be many fields. In addition, the condition of homogeneity must be observed: there should be information of the same type for different types of objects in one column (for example, it cannot be assumed that in one case the distance is indicated in km, and in the other - in the number of stops). When entering data related to the XYZ - analysis, except for the symbols "X", "Y", and "Z", the symbol "N" is used, meaning that the analysis was not performed.

3 Results

With such data presentation, the analysis toolkit turns out to be extremely simple - you can use the well-known Excel technique - "data filtering". Then, for example, to select two-storey apartments, the sale of which brings a good and stable income, it's enough to specify the option "two-storey apartments" in the corresponding column of technical characteristics and indicate "X" in the column "XYZ analysis". We deliberately took a simple example to explain the essence of the matter. For a more detailed analysis, you should specify options for a larger number of columns in the technical and geographic characteristics.

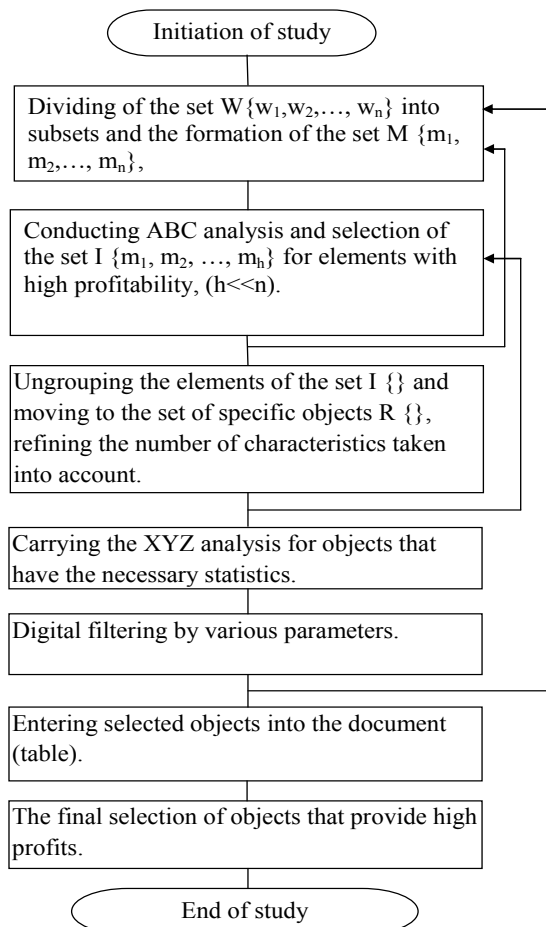The general algorithm for the study is shown in Figure 5:

Fig .5 Block diagram of the study

The research process is iterative in many ways:

First, after filling in the data in Table 1 and initial attempts to apply digital filtering, you can further specify a number of parameters: the number "n" when dividing the set of construction objects into subsets, the percentages in the ABC analysis, the type and number of technical and geographical characteristics.

Secondly, you can iteratively change the options for dividing the set of construction objects into subsets. For example, instead of dividing considered at the beginning of the work, you can use another - depending on the value of the object. Then you can place objects that worth less than 2.5 (in million rubles) in one subset, in the other - from 2.5 to 3.5, in the third - from 3.5 to 5, etc. Of course, specific figures can be (also iteratively) modified. In the process of research, it is necessary to record objects that meet the needs of the researcher and enter them into a separate document (for example, a table). From these objects, a marketing researcher selects the final list, taking into account practical experience and common sense. The process can be formalized: select objects that fall into the above document at various partitions.

4 Discussions

The paper considers an urgent task for the construction industry - designing objects in such a way that they bring a fairly high and stable income. This problem is associated with the processing of a large number of objects, and for each object, it is necessary to take into account a range of technical, geographical and other characteristics. The modern trend of research in this area is connected with the use of Big Data technology. Without denying the advantages of this technology, the author proposes an alternative approach based on the use of the iteration method, the ABC - XYZ analysis, and digital filtering. It is based on the well-known principle of the study of complex systems: the division of a complex task into a number of simpler ones.

5 Conclusion

With the introduction of a number of restrictions on the number of objects and the number of characteristics taken into account, it is possible to obtain results at relatively low implementation costs. The use of an iterative approach allows making the study more flexible, versatile, and adapted to a specific task and the possibilities of the researcher – marketing expert. The advantages of the method include visibility and "transparency" of the study, consistent purposeful progress towards the goal. The stages of the study are presented in the form of a specific algorithm, on the basis of which this method can be implemented in practice.

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