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Decision Making with use of Building Information Modeling

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Abstract

The paper presents possibilities of Building Information Modeling (BIM) techniques and relevant software for decision making optimization in construction. Some relevant description of BIM elements needed for optimization in construction investment process. Authors presents chosen tools for decision making - point of reference method. Paper consist also practical example of suggested methodology use - choice of the best location of the office building.

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Keywords: Building Information Modeling; IFC; decision making; optimisation

1. Introduction

The present article is aimed at analysis of possible applications of Building Information Modeling (BIM) for decision-making in civil engineering. It discusses the basic aspects of decision support optimization. The authors have presented practical examples of use of the tools, described earlier, for solving of selected decision-making problems. The summary presents conclusions on the current possibilities of use of BIM in decision-making processes, as well as perspectives for further development of such software tools in the future.

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2. Decision making in construction

2.1. Decision making

Decision-making is necessary throughout the entire cycle of development of any investment project. The pre-investment phase requires decisions with regard to feasibility, location of the investment or selection of the design. In the construction phase, decisions are made to solve technical and transport-related problems, as well as to optimize use of the accessible construction site. In the operational phase, the decisions made are associated with possible restoration, renovation or extension. A situation, in which a given entity, or the decision-maker, is faced with the necessity to choose from at least two options, according to decision theory, is known as the decision-making problem [5].

Depending on the approach of the authors, various phases of the decision-making process are distinguished. Regardless of the approach, selected by the management, the decisions made should be rational, coherent and logical. For this purpose, it is necessary to have the current, reliable and full information on the problem and the decision-making situation. In construction, such comfortable situations are particularly rare. The multitude of entities involved in the construction undertaking leads to conflicts, which require decisions to be made, already at the stage of compiling of the documentation. Another issue is the human factor. For instance, subcontractors may attempt to hide the fact of falling behind the schedule, reporting progress of works in accordance with the plan. Meanwhile, for the decision-making process, awareness of the delay is of key importance for the decision-maker to make a good choice, adequate to the realistic circumstances.

It should be kept in mind that almost every decision brings both desirable and undesirable effects. For instance, when choosing the contractor on the basis of the lowest price criterion, the investor often decides to apply the variant, associated with the highest risk.

In many cases, the decision-making process is so complex that it requires construction of a simplified model of the decision problem. These models present, in a specific conventional manner (depending on the model type), a fragment of reality, which is significant from the perspective of the decision problem. Several types of models can be distinguished, such as verbal (including descriptive), analog (including physical), symbolic (including formal and mathematical models) [10].

The mathematical model, which allows for use of computer aided methods to choose the optimum solution, is particularly useful for decision-making problems. Construction of the model is of great importance, in particular, when it is not possible to conduct tests using the real object (system). In construction trade, such situations prevail. Testing of different variants in reality is associated with enormous financial expenditures, which are unacceptable for most investors.

Another important part of modeling of a decision problem is defining of the desirable end state, or the objective. For this purpose, it is necessary to recognize the relevant variables of this state and determine their end value. The term “target” is often applied, which is defined from the perspective of maximization or minimization of a specific state variable. Another type of objective is the membership objective. These can be divided into the following types: point, calculation, upper threshold, lower threshold and interval objectives. In most cases, point objectives are not expressed categorically, by elimination of all solutions, which fail to fulfill the objective, but as reference points. Unfortunately, if different definitions of distance from reference point are used, we can obtain different results, if the point we are searching for is not included in the set of attainable points. Therefore, another development of mathematical modeling of decision-making problems is often introduced, which is the fuzzy set theory. Application of the fuzzy set theory, or, to be more precise, the membership function, allows for unequivocal assessment of points close to the reference point. As a result, if a given point is not attainable, we will always obtain the same result, regardless of the function used.

Frequently, we are dealing with several functions describing various criteria. This leads to emergence of multidimensional assessment vectors. In order to be able to compare such assessments, we have to introduce the notion of preference. Three basic relations can be distinguished: [10]

$a \succeq b$ weak preference relation – meaning that a is not worse than b,

$a \succ b$ strict preference relation – meaning that a is visibly better than b,