

# Computer-Aided Modelling, Evaluation and Management of Construction Projects According to PLM Concept

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**Abstract.** The major problem for investors in construction area is to choose the financially effective construction alternative, most often associated with underestimated actual demand for resources. The lack of information feedback among all participants of the project and the uncertainty treats at the design and construction stages are presented in this paper. Solution is the theoretical 3D building information model, combined with resource demand calculations, comparison of alternatives and determination the duration of all construction project life stages. The software based on this aggregate 4D PLM model can be the mean of effective management of the construction project, embracing planning, design, economic calculations, construction, management, usage and maintenance of the completed building. The paper also describes multiple criteria evaluation software used to identify the most effective construction alternative with presented suggestions of implementation in practice.

**Keywords:** Project life cycle management, 3D and 4D modelling, computer-aided evaluation and management in construction.

## 1 Introduction

Investors such as governmental organizations, financial-insurance companies, banks, industrial companies and active owners at the local and foreign real-estate markets face the same problem – the rapid grow of prices for real-estate and qualified human working power. The same big and more smaller problems influence the construction industry. The construction process is affected by many factors, influencing all the parameters (such as development, infrastructure, duration, resource demand, financial stability). At the beginning of the construction project implementation, efforts are made to predict the influence of these factors with the help of various calculation means and data bases, relying on both statistical and expert-provided data. It is assumed that parts of the project under consideration or even the entire project are similar to accomplished earlier construction projects. However, these assumptions are not always correct and their bias degree is quite high in comparison to actual obtained parameters after the construction project implementation.

In order to determine theoretical values of the parameters as precisely as possible [1] and to reduce errors in the field of construction, the use of Product Lifecycle Management (PLM) [2], [3] or the so-called four-dimensional (4D) concept [4] is recommended. To achieve the effective management, fulfil the correct Enterprise Resource Planning (ERP) conditions with proper Supply Chain Management (SCM) and automated Material Requirements Planning (MRP), it is recommended first to create a 3D model of the construction project and to perform the simulation of its implementation. The fourth dimension – time, is employed for the analysis of simulation [5], [6], i.e. the project can be evaluated in terms of time (resistance to long-term effects, uniform durability of the project parts, saving power and other resources in implementing the project, analysis of the environmental pollution, etc.).

## 2 Objectives of the Research

The works devoted to the analysis of various aspects of construction projects' management [7], scheduling-planning and safety [8], design-planning-estimating procedure integration [9] analyze both structure and models used to evaluate the available alternatives [10], as well as major principles of their implementation [9]. Researchers offered possibilities of cost and time reduction for project documentation [11], schedule information, visualisation, communication [12], construction projects management and analysis using 4D project both with IT power. Most of them identified advantages [8], [9], [12] such as the same design interpretation among project members, understanding of construction sequences, certified amounts of construction works, design quality analysis and possibility of alternative evaluation.

However, the researchers tend to underestimate the influence of suitability and precision of the evaluation data as well as the reliability of methods and means of their application [13]. The present paper analyses the indicators of project efficiency as well as the methods of determining their values and precision of the technique used which will help to avoid further comparative analysis of inefficient project alternatives. The application of 4D concept model for the construction project management will also can be considered as the computer-aided financial and organizational means for company management and resource planning.

A traditional construction project can be described as a model covering all stages of its implementation [4], [9]: development and planning, design and economic assessment, tender and negotiations, construction and handover, maintenance and utilization. In these stages certain participants (Customer, customer's representative, department, designer, contractor, investor or owner) perform the appropriate actions. The information collected through earlier stages [6] is transferred to the next stages. However, the data collected in this way often are not suitable and should be changed in order to implement the most effective construction alternative.

The main problem is the lack of information exchange between the construction project developed-assessed by designers (architectural, technical and work design of the project, 3D models) [2] and the construction works performed by a contractor. For example, at the design stage, technical decisions are made without consulting with construction specialists, and, at the construction stage, the contractor often attempts to implement the vision of designers in the simplest way. The lack of information