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Hybrid agents implementation for the control of the construction company

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Abstract

Planning the project duration together with separate works is an essential element of managing the construction. The final duration depends on multiple factors, including the funds, customer requests, and capabilities of the construction company. In order to avoid additional costs in penalties or additional expenses, the management needs to estimate the real construction duration in advance, before the contract is signed. Further on, these terms need to be monitored both in whole and for the specific jobs in order to be able to edit further stages with regard of the remaining time, resources and used resources ratio. The development of a decision support system for the construction company is a pressing problem due to the growing demand in decision making persons' labor automation in planning and monitoring the construction processes. The paper presents the model and the application experience for such a system.

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Keywords: Control; construction; planning; multi-agent simulation; decision support; subcontract

1. Introduction

The construction management processes are formalized in a model of multi-agent resource conversion processes (MRCP) [3] which allows evaluating the dynamics of process implementation and cost indicators (implementation

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time, the presence of duplicate functions, the process cost, staff salaries expenditure, etc.), as well as evaluating the process efficiency indicators (cost-effectiveness, working time and waiting time ratio, and the actual execution time and the planned execution time ratio). The application of multi-agent modelling allows formalizing, by means of the agents' knowledge base, the decision-making model and the accumulated scenarios for solving problems in the field of construction management.

The use of MRCP hybrid agents' technology to formalize the construction work management processes allows automating the decision-makers' functions of generating alternative solutions for various tasks: searching for investors and materials suppliers, selecting subcontractors, detecting and eliminating "bottlenecks" in planning. The use of hybrid agent technology involves describing the subject area with the aid of software products of varying functionality, integrated into a single decision-making support system: dynamic situations modeling system BPsim.MAS system and the system for technical engineering and commercial design BPsim.MSN [4]. The BPsim.MSN system implements the technology of intelligent agents (IA) providing the user with a tool to develop intelligent systems. The IA technology allows automating the decision-makers' work of analyzing and synthesizing business systems, such as business process reengineering [5], project management, construction management.

The basis for the dynamic model of design and construction processes implemented in BPsim.MAS is the MRCP model which provides support for work planning and for evaluating various projects of independent property development. The search for solutions model implemented in BPsim.MSN underlies the search for effective solutions for multi-criteria construction management tasks. As a result of integrating the proposed models, complex automation of decision-makers' work in the sphere of construction management is achieved.

2. Developing models for «Wan Bao» construction holding

As a result of examining the subject area the following construction work management steps were identified: drawing up a business plan reflecting the expected economic performance indicators of the holding's activities under certain initial conditions; obtaining a loan for construction; participating in the tender for the construction; planning design and construction work; carrying out design and construction work; selling/renting the constructed objects.

The BPsim.MSN tool was applied to describe the main classes that reflect the holding's database information on materials suppliers, on land characteristics, on subcontractors, on the holding structure, on credit institutions, etc. On the basis of the developed class diagram the business planning agent was designed, providing an automated way to generate alternative business-plans for construction work. The decision maker evaluates the proposed plans and selects a more economically advantageous one.

The initial conditions of the selected business-plan are input in the developed BPsim.MAS MRCP simulation model of design and construction. The model is designed to evaluate the effect of management decisions on the dynamic characteristics of the processes in «Wan Bao» holding. These include: the actual cost of the processes, reallocating resources between processes, downtime, individual processes overload, identified processes that require subcontracting resources, the actual total amount of labor and materials, and the actual duration of the processes. The characteristics evaluation is performed by the model agents.

Let us consider the description of the knowledge base (KB) of the following agents: operations agent *AOp* responsible for identifying operations that require subcontracting; distribution agent *AD* implementing the capture of the application for the operation and the distribution of holding *Rhold* resources and subcontracting resources when performing operation *Op*. The attributes of application *z* to perform operations described above are presented in Table 1.

Table 1. Defining attributes of application *z* to perform operation *Op*

Symbol	Description
z_p	The required labor to perform operation *Op*
z_s	The subcontracted labor required to perform operation *Op*
z_time	The remaining time of operation *Op* performance
z_pr	The mark of subcontracting operation *Op*: 0 – no subcontracting used; 1 – subcontracting used
z_owner	Owner-node of application *z* (agent *AOp* or *AD*, operation *Op*, next model node *NextNode*)
z_d	The date of operation *Op* start
z_m	The month of operation *Op* start