Object oriented modelling of construction operations for schedule-cost integrated planning, based on BIM

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The study is aimed to develop a method to integrate time and schedule data of construction projects using object-oriented modeling. Although, many researchers have recognized the importance of data integration and have suggested methods to associate time- and cost-related data, the information models and methodologies developed are not being utilized widely in daily practices. The reason for this fact includes that current construction management information systems do not yet provide the functionality to efficiently deal with time and cost information to better support project managements. Therefore, the object-oriented modeling methodology based on BIM is suggested in this research, in which the time and cost data integration is achieved by parameterizing construction operations into objects. For observing applicability of the modeling method, a prototype has been developed using the JAVA that this paper presents a discussion about implementing of the integration model in the programming language as well.

In this research, the object-oriented modeling of construction operations is suggested as a modeling method to describe construction operations in detail, make a realistic construction simulation, and increase the utility of time-cost integrated analysis. Each construction operation object consists of *parameters* to represent a state and *functions* to represent rules. From the BIM building objects, objects which represent a lowest level in the construction project hierarchy, tasks, are created. Then those objects are collected to form another type of object to represent a higher level of project hierarchy, processes. Objects that are formed through this procedure are used as *blocks* to simulate construction operations.

The Construction Task Object(CTO) suggested in the research is designed to represent the lowest level of the hierarchy of construction, task, and Construction Process Object(CPO) is designed to represent the second lowest level, process. As mentioned above, the object-oriented modeling of construction operations in this research is based on building component objects modeled in BIM. CTOs and CPOs, which represent *how to build*, are generated from building component objects, formed in the BIM modeler, which represent *what to build*.

The relation between a BCO and CTOs is same as *Inheritance*. A CTO represent a task which is a kind of work to build the building component. Because there are lots of work to be done to complete a building component, necessarily a BCO should be connected to many CTOs, each of which represents a certain task. The CTOs, which have same target BCO, should share the data of BCO, so all the data of BCO is transmitted to relating CTOs through *inheritance*. CTOs are defined with receiving the inheritance from BCOs, so that all the parameters and functions in BCOs can be automatically transmitted to CTOs. For defining each class, the override and polymorphism of object-oriented
languages are utilized. These two capabilities increase the convenience and applicability of classes in parent-children relations. Using polymorphism and override in object-oriented programming languages, a variety of construction processes can be modeled in detail and simultaneously a number of various construction operation objects can be controlled in an unified way.

The discoveries in this research are mainly two:
- it is found that the object-oriented modeling method, which has been invented in software development areas to improve the functionality of programming language, can be adopted to the construction industry and used to model construction operations.
- Through parameterization, the object-oriented modeling method can contribute to improved time-cost integration practiced in construction management.

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References