International Journal of ICT-aided Architecture and Civil Engineering
Vol.6, No.1 (2019), pp.19-24
http://dx.doi.org/10.21742/ijiace.2019.6.1.04

Design of Efficient Construction Process Interlock Cost Estimation and Project Management in Bridge Construction

Hong- Tae Park[1] and Boo-Hyung Lee[2]

[1]Department of Civil Engineering, Kongju National University, 275 Budae-dong, Seobuk-gu, Cheonan-si, Chungnam 331-717, Republic of Korea
[2]Department of Computer Science & Engineering, Kongju National University, 275 Budae-dong, Seobuk-gu, Cheonan-si, Chungnam 331-717, Republic of Korea
[1]pdxetm2011@gmail.com ,[2]htpark@ kongju.ac.kr

Abstract

In this study, we proposed the efficient DB construction process to interlock cost estimation and process management in bridge construction. In the proposed system, construction process is divided into five hierarchical levels that are milestone network & cost analysis, skeleton network & cost analysis (sub network & cost analysis), frag network & cost analysis and cost estimating. Milestone network & cost analysis level is the highest level and cost estimating level is the lowest level. Each level is designed as DB structure so that cost calculation by level is easy and project management is efficient.

Keywords: *DB construction process, Five hierarchical level, Cost estimation, Project management*

1. Introduction

A cost estimation system using a scientific approach to provide construction cost estimation has to be consistent. For the system to have maximum effect, a systematic work information classification system and computer system have to be set up as priorities. However, in existing cost estimation systems, the operators have to classify and input work information one by one, followed by the analysis process, so cost estimation system operators need to be sufficiently knowledgeable for the system to be useful

The fundamental purpose of an efficient project management system is to eliminate discomfort while providing a conversational closeness with the construction site. A few project management systems have been used including UCI (Uniform Construction Index) and Swedish System. UCI only categorizes 16 construction sub-categories without factoring in other off-site construction information [1]. The 16 categories are grouped into 4 classes with 5 whole integers. Swedish Construction Dispute Mediation Committee suggests the Swedish Classification System, which is based on design drawing, and oversees facility, functional elements, construction operations, and materials classifications for the operating division system [2]. CI/ Swedish system is the Construction Index/ Samarbetskommitten for Byggnadsfragor, a Scandinavian classification system for libraries set up in 1959 and intended for the construction industry.

Article history:
Received (April 29, 2019), Review Result (June 18, 2019), Accepted (October 24, 2019)

Print ISSN: 2205-8516, eISSN: 2207-5216 IJIACE

The first Swedish classification system, developed in the 1950s, was called Swedish System (Samarbetskommittén för Byggnadsfrågor, Co-ordination Committee for the Construction Industry). The limitations of this system in addressing new developments in the industry led to the introduction of the BSAB (Byggandets Samordning AB, Construction Co-ordination Limited) system in 1972. The Swedish Building Centre (SBC) released the latest revision of the BSAB96 system in 1999. The Swedish national building specification, the AMA, which uses the BSAB96

Classification system, was revised and republished by the SBC in 2001. AMA is the abbreviation (in Swedish) for 'General Material and Workmanship Specifications'

The most recent construction information classification system to be implemented in the UK is Uniclass (Unified Classification for the Construction Industry) driven by developments in ICT and international standards for classification systems. The first edition of Uniclass was published in 1997. Uniclass is a faceted system designed within the parameters of ISO TR 14177 [3]. A number of pre-existing classification systems, used for specific purposes, were also incorporated into its 15 Tables; for example:

Two of the most essential factors for efficient construction projects are construction schedules and cost management. The former is managed using a process network and the latter by a cost estimation system. All construction orders are made by the state and independently controlled using the above management systems. However, the costs that arise from delayed projects cannot be either foreseen or calculated

To improve this inefficient system, this experiment was designed so that unify the divided construction planning and cost management steps to produce a singular set of data that can be used from the initial stage to the final stages of the construction period. Furthermore, this unified approach can be synchronized to auto-calculate the cost of projects every step of the way, including frag network, sub-network, skeleton network, and milestone network. Finally, automated DB modeling was attempted

2. Design efficient construction process to interlock cost estimation and project management based on the Swedish Classification System

This paper attempts to design a constructive division of labor based on the Swedish Classification system, which includes facility, functional elements, construction operations, and materials classifications and simultaneously syncs construction expenses and processing network, using code categorization to individually calculate expenses. Furthermore, the processing network will aid in developing an automated project management DB.

The Work Breakdown Structure is a method that allows all steps of a construction process to be broken down to the very base unit, and have it rearranged in a hierarchical way that allows for networking. This is the basic approach for appropriating costs and processing all construction classifications during networking. For cost appropriation and construction administration to be synchronized, all these processes must be configured into a single system.

2.1 Swedish classification system & PMA model

To build the system, example of construction process to unify cost estimation and process management based on the Swedish classification system is represented in Figure 1. Both cost appropriation and construction administration processes were synchronized and unified as a single operation division system which in turn, became the basis of an automated network system model for project management

This classification method produced based on contracts between an employer and contractor that were sub divided into facility, functional elements, construction operations, and materials classifications. They are combined to express the actual construction work later. Material costs were combined with labor to calculate labor expenses, while structure and facility were built in that order on top of labor classification to complete a given construction work. In the proposed system, facility, functional element, construction operations and materials classification in Swedish system are correspond to milestone network & cost analysis, skeleton network & cost analysis (sub network & cost analysis), frag network & cost analysis and cost estimating each

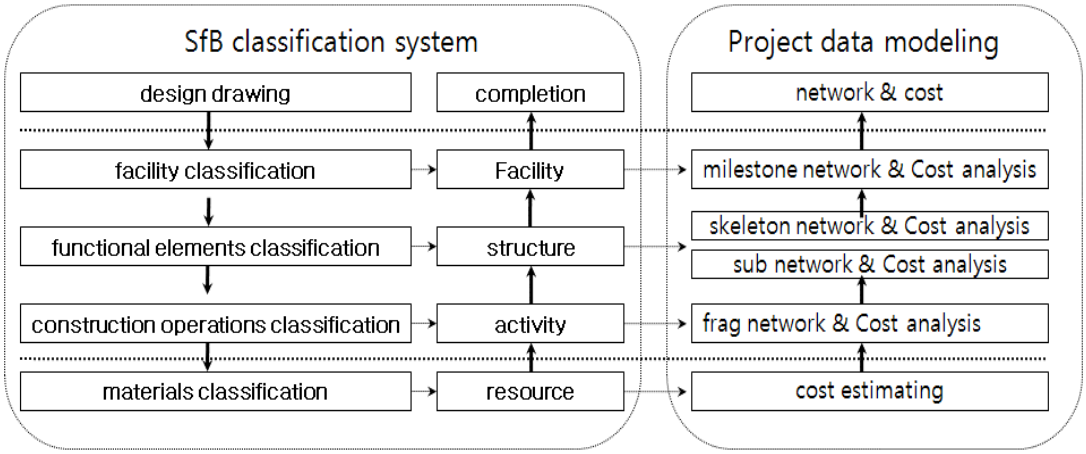

Figure 1. Example of construction process to interlock cost estimation and project management based on the Swedish Classification System

This system has been used in Sweden and according to the system, work breakdown system is divided into facility, functional element, construction operation and material classification these correspond to each facility, structure, activity and resource

In a construction, for example, a bridge construction, facility means a bridge, and for a facility, many structures are required and for a structure, many activities are required. An activity which is the lowest level should be accomplished using resources Each process in Swedish Classification system correspond to each process in our Project management automation DB model (frag network, sub network/skeleton network, milestone network) our model (PMA) can interlock process network and cost accumulation by process

PMA model consists of milestone network &cost analysis, skeleton network/sub network &cost analysis, and frag network &cost analysis. Each process in Swedish Classification system corresponds to each process in PMA model. The PMA model has advantage that can interlock process network and cost accumulation by process.

2.2 Method for calculating construction cost

Appropriating the expenses of a construction project is a crucial part of any construction planning. By standardizing cost control, it can provide information and viability of, the physical, economic and financial state of the project. Expense estimation is calculated by using construction process where different parts of the construction project are itemized. There are two approaches to calculating cost: resource- based and performance- based. While both methods are in use today, the trend is moving towards performance- based calculation. Figure 2 shows the resource-based calculation method.

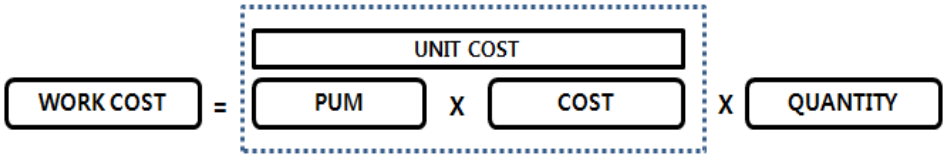

Figure 2. Resource-based cost estimating (unit cost price) method

A cost estimation system, or construction cost computation, are composed of construction classification system information, resource classification system information, breakdown cost information and yield statement of construction information [4][5][6]. All of this information are used comprehensively to calculate the final construction cost. From this information, the construction classification system is the uppermost information and the most important information. However, the existing cost estimation system requires the person in charge of the cost estimation to classify, input, and analyze the construction information. Such system requires the person in charge to have sufficient knowledge of the related cost estimating system. The process of linking the cost estimation system and the construction classification system modeled as a DB structure is necessary for accurate and systematic construction cost estimation[7][8]. In Figure2, facility, functional element, construction operations and materials classification in Swedish are correspond to milestone network & cost analysis, skeleton network & cost analysis (sub network & cost analysis), frag network & cost analysis and cost estimating in PMA (Project Management Automation) DB Model.

2.3 Construction process classified by Swedish em and our PMA system

[Table 1] shows a work breakdown structure for bridge construction based on the Swedish classification System and PMA model in Fig. 1. A construction process consists of 5 levels and each process in SFB and PMA model assigns to each level in [Table 1]. Level 2 corresponds to facility classification and milestone network in SFB and PMA. In this table, a bridge construction is divided as 5 levels. Level 1 is the highest level that means a final bridge. Level 5 is the lowest level that has many activities for a final bridge. In each level, Processes in Swedish and PMA are assigned.

For example, in level 5, is a construction operation classification of Swedish and frag network of PMA model are assigned, this level is the most basic level for a bridge construction and consists of 5-activities such as Wooden cast installation, Rebar installation, Concrete deposition, Wooden cast removal.

Table 1. Construction Process for Bridge Construction

Level 1	Level 2	Level 3	Level 4	Level 5
Completion Facility Classification		Functional element Classification		Construction operation Classification
Completion	milestone network	skeleton network	sub network	frag network
B Bridge construction	1. Temporary construction			
	2. Site formation			
	3. Bridge			
		3.1 Abutment A		

		3.2 Abutment B		
		3.3 Bridge column A		
			3.3.1 Earthwork	
			3.3.2 Well installation	
			3.3.3 Foundation	
			3.3.4 frame construction	
				3.3.4.2 Wooden cast installation
				3.3.4.1 Rebar installation
				3.3.4.3 Concrete deposition
				3.3.4.4 Curing
				3.3.4.5 Wooden cast removal
			3.3.5 Bridge bearing	
		3.4 Bridge column B		
		3.5 Bridge column C		
	4. Equipment work			

3. Conclusion

Two of the most essential factors for efficient construction projects are construction schedules and cost management. The former is controlled using a process network and the latter by a cost estimation system. All construction orders are made by the state and controlled using above management systems. However, the costs that arise from delayed projects cannot be either foreseen or calculated.

To improve this inefficient system, we proposed the work breakdown structure based on Swedish classification system to interlock cost estimation and process management in construction process. In the proposed system, facility, functional element, construction operations and materials classification in Swedish are correspond to milestone network & cost analysis, skeleton network & cost analysis (sub network & cost analysis), frag network & cost analysis and cost estimating each. The proposed structure makes interlocking of cost estimation and process management to automate project management easily.

References

[1] Can J., “Principles of classification,” NBS-UK, **(1997)**

[2] http://www.buildingsmart.org/standards/standards-library-tools-services/data-dictionary/

[3] Jorgensen K., “A Classification of building object types-misconceptions, challenges and opportunities,” Proceedings of CIB W78-W102 International,. Conference. Sophia Antipolis, France; 26-28 October, http://2011-cibw078-w102.cstb.fr/papers/Paper-24.pdf, **(2011)**

[4] J. H. Park, H. T. Park, and Y. B. Jeon, “The development of factor model based on actual work cost for golf courses,” Journal of The Korea Academia-Industrial Cooperation Society, February, pp.620-627, **(2010)**

[5] G. H. Kim, “Research on power plant construction cost forecasting model using the construction model of a similar work,” Chung-Ang University, December, pp.79-99, **(1988)**

[6] B. S. Kim, “The basic design Cost Estimation Model for RC rigid frame bridge steps,” Journal of Korea Construction Engineering and Management, March, pp.111-119, **(2009)**

[7] B. H. Lee, “Construction cost estimating for project control,” Gumi Publishers, November, pp.325-332, **(1992)**

[8] H.T Park and B.H Lee, “WBS-based hierarchical classification and its DB modeling of all construction information for apartment house,” International Journal of Smart Home, vol.9, no.2, pp.133-142, **(2015)** DOI: 10.14257/ijsh.2015.9.2.12