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DB Model Design for Efficient Project Management & Cost Automation

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Abstract:
Two of the most essential factors for efficient execution of construction projects are construction schedules and cost management. The former is managed using a process network and the latter by a cost estimation system. Generally these construction schedules and cost management are handled independently during all construction projects. So, the costs that arise from delayed projects schedule cannot be either foreseen or calculated exactly. To interlock these two processes together, we first proposed efficient bridge construction breakdown structure based on SfB Classification system and then change them efficient DB structure which can be used from the initial stage to the final stages of the construction period. All construction projects management will be accomplished efficiently through interlocking of process network and cost estimation by o process level

Keywords: *the Elderly Living Alone, Daily Stress, Satisfaction of Life, Satisfaction on the Physical Domain*

I. INTRODUCTION

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 aforementioned 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 to 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.

1.1. RESEARCH TRENDS AND METHODOLOGY

The fundamental purpose of an efficient project management system is to eliminate discomfort while providing a conversational closeness with the construction site. 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 in use for a while, including UCI (Uniform Construction Index) and SfB (Semaebets Kommitten for Byggnadsfrager). UCI only categorizes 16 construction sub-categories without factoring in other off-site construction information[Cann.J]. The 16 categories are grouped into 4 classes with 5 whole integers. Swedish Construction Dispute Mediation Committee suggests the SfB Classification System, which is based on

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design drawing, and oversees facility, functional elements, construction operations, and materials classifications for the operating division system[Jorgensen.K]. CI/SfB is the Construction Index/ Samarbetskommitten for Byggnadsfragor, a Scandinavian classification system for libraries set up in 1959 and intended for the construction industry. The first Swedish classification system, developed in the 1950s, was called SfB (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[Anupam Manori et al]. 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'[S.H,Baek][Long Cai et al]

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 [Jae-Woo LEE][K.Praveenkumar]. 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 aforementioned management systems[D.H Kim] However, the costs that arise from delayed projects cannot be either foreseen or calculated[Seung-Wan Ju et al].

To improve this inefficient system, this experiment was designed to 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

II. Concept of work breakdown system to interlock cost estimation and process management based on the SfB Classification System

This paper attempts to design a constructive division of labor based on the SfB 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. SFB CLASSIFICATION SYSTEM & PMA MODEL

To build the system, example of work breakdown system to unify cost estimation and process management based on the SfB Classification System is shown 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

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management. This classification method was based on contracts between an employer and contractor that were sub divided into facility, functional elements, construction operations, and materials classifications. These were later mutually combined to express the actual construction work. 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 SfB are correspond to milestone network & cost analysis, skeleton network & cost analysis(sub network & cost analysis), frag network & cost analysis and cost estimating each. This system have 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[H.T. Park et al]

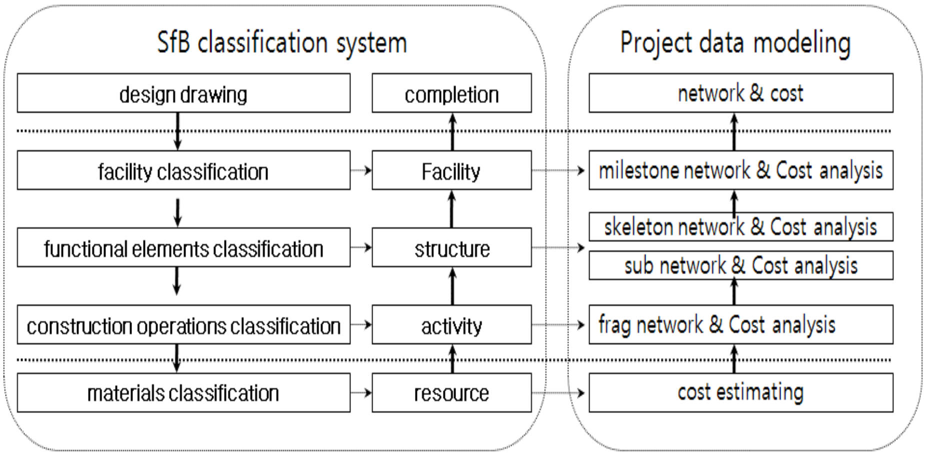

Fig. 1 Example of SFB Classification System(Left) & PMA Model(Right)

In a construction, for example a bridge construction, facilty means a bridge, and for a facility, many structures are needed and for a structure, many activities are required. A activity which is the lowest level should be accomplished using resources Each process in SFB 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 consist of milestone network &cost analysis, skeleton network/sub network &cost analysis, and frag network &cost analysis. Each process in SFB Classification system correspond to each process in PMA model. The PMA model have advantage that can interlock process network and cost accumulation by process.

2.2. CONCEPT FOR CALCULATING CONSTRUCTION EXPENSES

Appropriating the expenses of a construction project is a crucial part of any construction planning. By standardizing budgeting and cost control it can provide information on, and impact the viability of, the physical, economic and financial state of the project. Expenses estimation is performed using the WBS-Work Breakdown Structure 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.

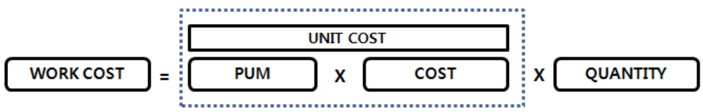

Fig. 2 Resource-based cost estimating (unit cost price) method

A cost estimation system, or construction cost computation, is composed of construction classification system information, resource classification system information, breakdown cost information, and yield statement of construction information. All of this information is 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[2]. 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 [4][5].

III. Project Modeling by proposed Model in Bridge Construction

Table 1 shows the classifications of a work breakdown structure for bridge construction based on the SfB Classification System in Fig. 1. Level 2 is categorized as facility. Different facilities will be combined to become a milestone network. Levels 3 and 4 are part of the functional elements class that becomes the skeleton network and sub-network. Level 5 is the construction operations class used on site, which becomes part of the frag network. It is important to note that level 5's construction operations class, which is part of the frag network, is crucial because its cost appropriation must be completed to build the automated construction cost D/B for bridge construction. The data needed for the calculation requires factors such as government official unit price, market price, and various price information. Such information will allow a D/B to be built for cost per material, equipment, and labor. This paper systematized the material unit price D/B into [L] labor unit cost, [M] material unit cost, and [E] equipment unit cost using codes

IV. DB Structure for Cost Estimation by Process in Bridge Construction

4.1. BUILDING BRIDGE CONSTRUCTION FRAG NETWORK ACTIVITY D/B AND CALCULATING UNIT COST

The second part of automating the construction cost D/B per network in bridge construction is building the unit cost D/B, which is part of the construction operation's frag network configuration in the work breakdown structure, as seen in Table 1. All of the activities that are part of network construction in level 5's 3.3.4.1, 3.3.4.2, 3.3.4.3, 3.3.4.4, and 3.3.4.5 are part of the standard item scheme, linking unit cost and material code. Material codes in Table 2 calculate labor expenses per material unit as seen in 3.3.4.1, where material cost is pulled from the table and is multiplied by unit cost to calculate 3.3.4.1, wooden cast installation.

The calculation above can be used for the unit costs of level 5's 3.3.4.1 wooden cast installation, 3.3.4.2 rebar installation, 3.3.4.3 concrete deposition, 3.3.4.4 curing, and 3.3.4.5 wooden cast production. These unit costs will be multiplied by the cost of the material code to calculate total unit cost, which will then allow for the calculation of material, labor, and other expenses. For example, the unit cost of wooden cast installation 3.3.4.1 is a product of the Con10 unit cost, with a quantity between 1000, 1500, 0.89M2, 0.500M2, 1.500, and the material codes L001, L003, M002, M003, E004 where the costs of the material codes are 70,000, 55,000, 25,000, 33,000, and 6500 Won, respectively. The products will list the unit costs of materials, labor, and other expenses, as seen in Table 4.

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Table I. Bridge Construction Work Breakdown Structure

Level 1	Level 2	Level 3	Level 4	Level 5
Facility category		Functional element category		Construction operation category
	milestone network	**skeleton network**	**sub network**	**frag network**
B Bridge construction	1. Temporary construction			
	2. Site formation			
	3. Bridge column			
		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			

Table II. Resource Classification D/B

code	labor unit cost	code	materials unit cost	code	equipment unit cost
L001	70,000	M001	10,000	E001	2,300
L002	80,000	M002	25,000	E002	6,000
L003	55,000	M003	33,000	E003	2,500
L004	60,000	M004	28,900	E004	6,500
L005	90,000	M005	5,870	E005	3,300
L006	45,000	M006	22,000	E006	7,800
L007	75,000	M007	67,000	E007	3,100
L008	66,000	M008	21,000	E008	5,000

Table III. DB structure of Bridge Construction Frag Network by Activity

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Level 5	Activity Name	Item Code	Quantity per unit	Resource code
3.3.4.1	Wooden cast installation	Con 010 Wooden cast installation	1.000	L001
		Con 010 Wooden cast installation	1.500	L003
		Con 010 Wooden cast installation	0.890	M002
		Con 010 Wooden cast installation	0.500	M003
		Con 010 Wooden cast installation	1.500	E002
3.3.4.2	Rebar installation	Con 011 Rebar installation	2.000	L002
		Con 011 Rebar installation	3.000	L004
		Con 011 Rebar installation	2.000	M003
		Con 011 Rebar installation	3.500	M004
		Con 011 Rebar installation	1.400	E003
3.3.4.3	Concrete deposition	Con 012 Concrete deposition	2.200	L003
		Con 012 Concrete deposition	1.400	L005
		Con 012 Concrete deposition	1.000	M005
		Con 012 Concrete deposition	2.310	M006
		Con 012 Concrete deposition	1.500	E004
3.3.4.4	Curing	Con 013 Curing	2.000	L007
		Con 013 Curing	2.500	L008
		Con 013 Curing	1.700	M007
		Con 013 Curing	1.800	E005
3.3.4.5	Wooden cast manufacturing	Con 014 Wooden cast manufacturing	3.700	L001
		Con 014 Wooden cast manufacturing	4.000	L003
		Con 014 Wooden cast manufacturing	3.564	M002
		Con 014 Wooden cast manufacturing	4.650	M003

4.2. PROCESS OF AUTOMATING CONSTRUCTION EXPENSES BY NETWORK IN BRIDGE COMPOSITION

The three step of building an automated construction cost D/B for bridge construction is calculating the budgeted cost of work performed (BCWS). This is done by multiplying the unit costs from Table 4 by the estimated quantity (EQ) and actual quantity (AQ) for the 3.3.4.1 wooden cast installation, 3.3.4.2 rebar installation, 3.3.4.3 concrete deposition, 3.3.4.4 curing, and 3.3.4.5 wooden cast production activities. This algorithm can further auto-calculate the cost of wooden cast production, rebar installation, curing, and wooden cast removal, which are frag network level 5, a sub-network of level 3.3.4 activity. Table 6 shows the specific 3.3.4 auto-calculated values for BCWS and BCWP based on the total costs shown in Table 5, of 101,036,500 Won (BCWS) and 70,725,550 Won (BCWP). The remaining specific values for 3.3.1 earthwork, 3.3.2 well installation, 3.3.3 foundation, and 3.3.5 bridge bearing are found using the same algorithm. The expected costs for 3.3.1, 3.3.2, 3.3.3, and 3.3.5 were made up for this experiment. This algorithm can further auto-calculate the cost of earthwork, well installation, foundation, frame construction, and bridge bearing, which are sub-network level 4, part of the skeleton network level 3.3 bridge activity of column A.

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Table IV. Calculation of Unit Costs of Bridge Construction Frag Network Activity

Level 5	Activity Name	Material cost	Labor	Expenses	unit cost
3.3.4.1	Wooden cast installation	38,750	152,500	9,000	200,250
3.3.4.2	Rebar installation	167,150	180,000	3,500	350,650
3.3.4.3	Concrete deposition	56,690	247,000	9,750	313,440
3.3.4.4	Curing	113,900	315,000	5,940	434,840
3.3.4.5	Wooden cast removal	242,550	479,000	0	721,550

Table V. Total Cost of Bridge Construction Frag Network by Activity

Level 4	Sub Network	Level 5	Frag Network	unit cost	EQ	AQ	BCWS	BCWP
3.3.4	Frame Construction	3.3.4.1	Wooden cast removal installation	200,250	50	35	10,012,500	7,008,750
		3.3.4.2	Rebar installation	350,650	50	35	17,532,500	12,272,750
		3.3.4.3	Concrete deposition	313,440	50	35	15,672,000	10,970,400
		3.3.4.4	Curing	434,840	50	35	21,742,000	15,219,400
		3.3.4.5	Wooden cast removal	721,550	50	35	36,077,500	25,254,250
		total cost					101,036,500	70,725,550

4.3. FORMULATING A FRAG NETWORK D/B

An automated formulated frag network D/B consists of activity code [LEVEL 5], which in turn contains [pre-activity code] that shows pre-activity, [schedule delay] that can be affected by a TYPE of pre or post-activity.

Table VI. Total Cost of Bridge Construction Sub Network by Activity

Level 3	Skeleton Network	Level 4	Sub Network	BCWS	BCWP
3.3	Bridge column A	3.3.1	Earthwork	202,765,600	67,567,345
		3.3.2	Well installation	258,954,780	98,657,234
		3.3.3	Foundation	200,976,000	87,567,000
		3.3.4	Frame construction	101,036,500	70,725,550
		3.3.5	Bridge bearing	50,943,900	25,554,000
		total cost		814,676,780	350,071,129

[TYPE] that shows the relationship between pre and post-activities, and [LEVEL 4] of the upper level. As an example, activity 3.3.4.1 is preceded by activity 3.3.4.2 that is related to start to start (S) and finish to finish (F) where each S=50% (pre-activity air of 50%) and F=50% (post-activity air of 50%) shows

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the delayed time. The formulated frag network now completes the sub-network activity 3.3.4 of LEVEL 4. An automated formulated frag network D/B consists of activity code [LEVEL 5], which in turn contains [pre-activity code] that shows pre-activity, [schedule delay] that be affected by a TYPE of pre or post-activity, [TYPE] that shows the relationship between pre and post-activities, and [LEVEL 4] of the upper level. As an example, activity 3.3.4.1 is preceded by activity 3.3.4.2 that is related to start to start (S) and finish to finish (F) where each S=50% (pre-activity air of 50%) and F=50% (post-activity air of 50%) shows the delayed time. The formulated frag network now completes the sub-network activity 3.3.4 of LEVEL 4.

4.4. FORMULATING A SUB-NETWORK D/B

An automated formulated sub-network D/B consists of [LEVEL 4], [PRE-ACTIVITY CODE], [SCHEDULE DELAY], [TYPE], AND, and [LEVEL 3] of the upper level. As an example, activity 3.3.1 is preceded by activity 3.3.2 that is related to start to start (S) and finish to finish (F) where each S=50% (pre-activity air of 50%) and F=50% (post-activity air of 50%) shows the delayed time. The formulated sub-network now completes skeleton network activity ***3.3 of LEVEL 3***

4.5. FORMULATING A SKELETON NETWORK D/B

An automated formulated skeleton network D/B consists of [LEVEL 3], [PRE-ACTIVITY CODE], [SCHEDULE DELAY], [TYPE], AND, and [LEVEL 2] of the upper level. As an example, activity 3.1 is preceded by activity 3.1 that is related to start to start (S) and finish to finish (F) where each S=50% (pre-activity air of 50%) and F=50% (post-activity air of 50%) shows the delayed time. The formulated skeleton network now completes milestone network activity 3 of LEVEL 2

4.6. FORMULATING A MILESTONE NETWORK D/B

An automated formulated milestone network D/B consists of [LEVEL 2], [PRE-ACTIVITY CODE], [SCHEDULE DELAY], [TYPE], AND, and [LEVEL 1] of the upper level. As an example, activity 1 is preceded by activity 2 that is related to start to start (S) and finish to finish (F) where each S=50% (pre-activity air of 50%) and F=50% (post-activity air of 50%) shows the delayed time. The formulated milestone network now completes the total bridge construction of LEVEL 1. Figure 3 represents a hierarchical procedure in which cost calculated in lowest level, frag network is applied to higher level, sub network and then cost calculated in sub network is applied to higher level, skeleton network and then cost calculated in skeleton network is applied to the highest level, milestone work. the efficient project management is accomplished because process management and cost management are interlocked by this work breakdown structure and cost analysis system. By this work breakdown structure, process for completion a construction are classified clearly and cost can be calculated easily by process

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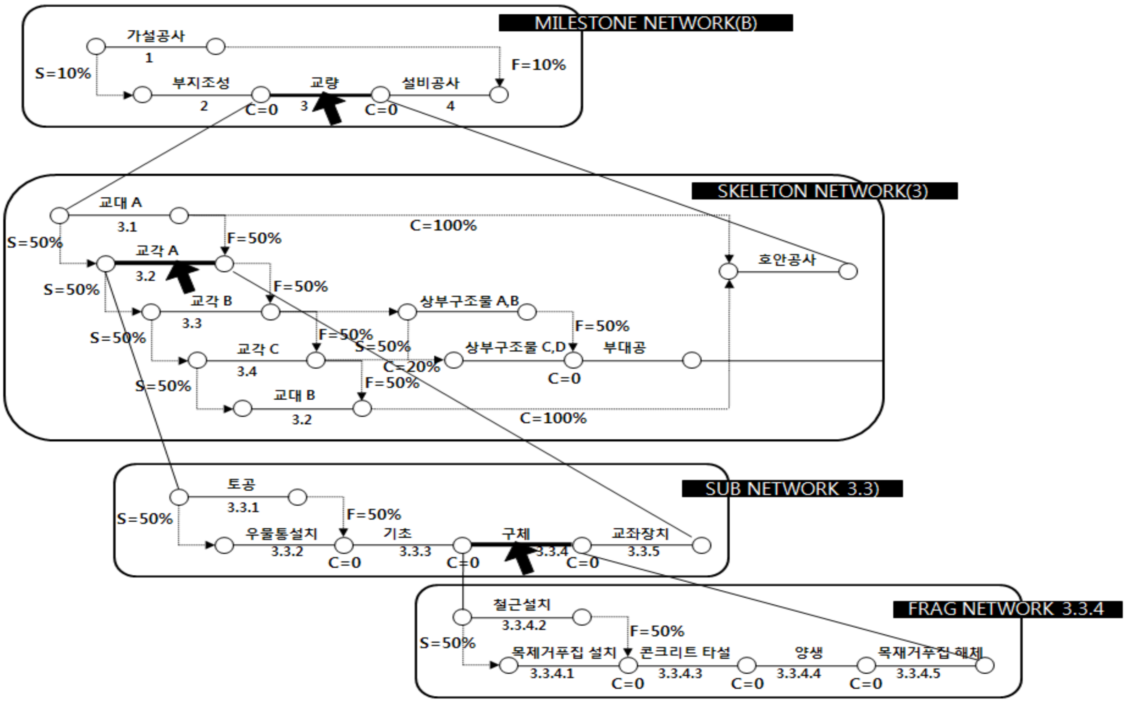

Fig. 3 A Hierarchical Procedure for Cost

V. Results

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 bimodally controlled using the aforementioned 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 to 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. Generally these construction schedules and cost management are handled independently during all construction projects. So, the costs that arise from delayed projects schedule cannot be either foreseen or calculated exactly. To interlock these two processes together, we first proposed efficient construction breakdown structure PMA model based on SfB Classification system.. In the proposed system, facility, functional element, construction operations and materials classification in SfB are correspond to milestone network & cost analysis, skeleton network & cost analysis(sub network & cost analysis), frag network & cost analysis and cost estimating each. All construction projects management will be accomplished efficiently through unification of process network and cost estimation arisen according to process level. The proposed system can unify process network and cost accumulation and automatically interlock cost calculated from lower process stage to higher stage in process network

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