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Allocating Safety Cost using in Construction Site

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Abstract: Environments, Health, and Safety (EHS) activities are strongly linked to the concept of sustainability in the current construction industry and consequently absorb more financial and managerial attention. One of major obstacles in EHS costing is that most EHS costs are buried in general overhead costs. Therefore, EHS costs lacks transparency, making it hard to allocate EHS costs to relevant construction projects. This paper present a recent study in which a method of activity-based costing (ABC) has been applied to safety costs at a contractor's home office. The list of safety activities, their cost drivers as well as their cost information on one of Korean general contractor is provided. The authors expect that the application of ABC will improve transparency in costing EHS costs as well as allocating EHS costs to projects.

Keywords: budget; safety accident; safety management; safety law

1 INTRODUCTION

Environments, Health, and Safety (EHS) activities are strongly linked to the concept of sustainability in the current construction industry and consequently absorb more financial and managerial attention. EHS activities can be carried out for a variety of purposes, from activities related to preventing safety accidents to administrative activities responding to an accident when it occurs. EHS activities are perceived critical activities that affects sustainability for the next generation. However, it is challenging to quantify the costs of EHS activities.

One of major obstacles in EHS costing is that most EHS costs are buried in general overhead costs, but none of them directly attempt to capture the full scope of measures taken to meet/exceed environmental, health, or safety standards. Therefore, EHS costs lacks transparency, making it hard to allocate EHS costs to relevant construction projects.

For the most part, the job is entirely performed by subcontractors. So general contractor (GC) don't see line items for EHS cost, such as "safety costs" or "fall prevention costs". For example, the framer's contract will have just a few schedule of value (SOV) line items, and when they bill GC the SOV will list a % complete for framing on levels 1, 2, 3, or 4. Some costs are more obvious to capture. And another example is that GC had to hire a third party testing agency to perform an air barrier test to conform to the design specification. These costs were considered soft costs though, so those billings were routed through the ownership entity accounting rather than the GC's accounting.

If GC really wanted to track this closer, GC would include separate line items in every contract that forced the subcontractor to bill GC for EHS work done. The problem is that makes the billings too complicated, which consumes a lot of our time on the back end correcting billing statements before GC send it to the lender to get funded. And few publications exist on methodology for tracking the overhead costs associated with environmental, health and safety initiatives on projects.

Generally a general contractor estimate EHS costs by assigning a certain percentage of total construction costs since it is challenging to accurately estimate the EHS costs. However, such practice remains potential financial risks since a general contractor does not know accurate EHS costs. In this paper, we chose safety costs in general overhead costs for the case study. Given that contractors pay more safety costs than before, it is important for contractors to accurately measure safety costs on each project. While project safety costs can be easily tracked, it is hard to measure how much safety costs of general overhead costs is spent on each project.

The purpose of this research paper is to show how allocating safety overhead costs to construction projects can be distorted using traditional volume-based allocation method, and propose adopting activity-based costing which allows for accurate allocation of safety overhead costs. We also addressed the potential benefits along with the case study.

2 SAFETY COSTS

Safety cost could be defined as "the cost of the resources, goods and services employed in order to improve working conditions and to reduce the accident rate". Safety costs can be grouped into prevention costs and evaluation and monitoring costs [1]. The guideline to calculate safety costs in Korea is in contract regulation by the Ministry of Strategy and Finance [2]. The cost of safety on each project is calculated by a percentage of project direct cost. The standard of safety cost is stipulated by the Occupation Safety and Health Act by the Ministry of Employment and Labor [3].

Table 1 Safety cost based on construction type and cost (Unit: $) [4]

Type	Cost			
	Under 0.5 mil (X)	Over 0.5 mi l to Under 5mil		Over 5 mil (X)
		Percentage (X)	Basis amount (C)	
General (1)	2.93%	1.86%	5,349	1.97%
General (2): Lift, cable car etc.	3.09%	1.99%	5,499	2.10%
Heavy civil	3.43%	2.35%	5,400	2.44%
Rail and track	2.45%	1.57%	4,411	1.66%
Unique and etc.	1.85%	1.20%	3,250	1.27%
Safety cost	Direct cost × X	Direct × X + C		Direct cost × X

Details on the method of calculating safety costs are presented in above Tab. 1. As seen in Tab. 1, different

percentage of project types is applied [4]. In general, a general contractor determines safety costs by multiplying construction costs by a certain percentage as seen in Tab. 1.

However, a research team note that many general contractors deliberately underestimate construction project costs overall in order to win bids, therefore, they underestimate safety and environmental costs the most [5].

Though the guideline differentiates the project types, it does not reflect the project context that each project has. Some project needs more resources in managing safety while some do not. Without accurately measuring safety costs of each project, contractors have difficulty in improving processes associated with safety management.

3 ACTIVITY-BASED COSTING

According to previous research [6], overhead cost management tool serves two roles: (1) it should offer precise quotation on cost objects; and (2) it should come up with decreasing total costs without losing its worth. Precise distribution of overall overhead costs to projects is vital for two reasons. First, exact distribution of the overall overhead costs offers the overall supplier with precise information on profits for each project. Second, exact cost information on each project allows the overall contractor to guess the costs on the forthcoming projects more correctly, putting him or her in a superior location in bidding for a future job.

Activity-based costing (ABC), a new accounting technique, has been created as a means of resolving the issues with traditional cost accounting, including (1) its failure to contribute to the reduction of overall costs and (2) cost distortion brought on by the incorrect allocation of overhead costs. A production system or organization's activities can be identified using the accounting methodology known as "activity-based costing" [7].

An ABC system has the following characteristics:

1) ABC uses two-stage costingUsing resource cost drivers, general ledger accounts (i.e., resource costing) are linked in the right proportion to different activities (e.g., time or area). Using activity cost drivers, activity costs are subsequently allocated to final cost objects [8].
2) ABC System Recognizes Different Types of Activities (Hierarchy): The product unit level, the cluster level, the product sustaining level, and the provision sustaining level are the four standard levels of operations in the ABC system used in manufacturing [9-11]. ABC systems are frequently used in the building industry to benefit from a cost hierarchy with many levels of activities, including work division level, project level, and organization level [6, 12].

4 CASE STUDY

4.1 Background

This research deals with the overall overhead costs of an overall contractor in Korea. The sample business had 2021 sales of more than $9 billion USD [13] and was listed among the top 30 builders in Engineering News-ranking Record's of the Top 250 International Contractors for 2021 [14]. The sample contractor, XYZ, has five business sections: infrastructure, power, plant, architecture, and miscellaneous department.

Company XYZ spends about 1% of its sales revenue on on-site safety management expenses; the same amount of 1% is spent on the headquarters team for on-site support. Therefore, about 2% of sales revenue is being spent as a safety cost. The study focuses only on safety costs out of general overhead costs.

4.2 System Objectives and Cost Objects

The ABC system has twelve projects, each of which is cost object. Twelve projects are categorized intro three business sectors: residential construction, commercial construction, and heavy civil construction. Therefore, we can use three business sectors by configuring overhead costs allocated to each project.

4.3 Data Collection Method

Interview and survey were employed for collection. The research team used open-ended questions for the interviews with key personnel of the safety department of XYZ. The questions included organizational structure, communication channels, and key activities of the department. Interview responses helped the research team develop a list of the activity centers and the activity. Once activities is identified, the research team used a time-effort way [15] in which a survey was used to identify every staff in the department to identify % of the staff's time consumed on each activity.

Table 2 Activity List

Activity Center	Activity ID	Activity
Safety Training	S-1-01	Plan Training
	S-1-02	Develop/Update Training Materials
	S-1-03	Execute Training
Safety Planning	S-2-01	Develop/Update Corporate Safety Manual
	S-2-02	Review/Approve Site Safety Plan
	S-2-03	Review/Approve Site Safety Budget
	S-2-04	Develop/Update Internal Safety Policy
Safety Auditing	S-3-01	Develop Auditing Plan
	S-3-02	Execute Site Safety Audits
	S-3-03	Document/Follow-up Auditing Results
Insurance/ Indemnification	S-4-01	Investigate Accidents
	S-4-02	Indemnify Safety Claims
	S-4-03	Process Worker's Compensation
	S-4-04	Renew Worker's Compensation Policy
	S-4-05	Renew Site Insurances

4.4 Activities

The research team used a series of interviews with each staff of safety department of XYZ's home office. Activities are grouped into activity centers. Through the interviews with staffs, 15 (fifteen) activities were identified and categorized into five activity centers. Each activity has its own activity ID number is presented in Tab. 2.

4.5 Costs of Activities using Time-Effort Method

Each employee in the department (in this case, the safety department) that will be polled must identify the typical proportion of time spent on each activity. The result of survey using time-effort method is shown in Tab. 3. The following formula can be used to quickly determine each activity's cost [13].

$$Activity\ Costs = \\ = \sum\left(Employee\ Salary \times Time-effort\ Percentage\right). \quad (1)$$

4.6 Cost Drivers

Any factor that changes the way other products, suppliers, or customers engage in an activity is referred to as a cost driver [12, 13]. In effect, the aspects that exhibits an equivalent connection with an activity cost is referred to be an activity cost driver [12, 15]. A factor whose volume rises as an activity cost does is known as a driver of activity cost. There are three types of cost drivers in construction ABC system: the budget cost driver, the duration cost driver, and the transactional cost driver [15]. The research team used two types of cost drivers: budget cost driver and transactional cost driver. The team determined a cost driver for each activity taking into account the behavior of each activity cost as well as the simplicity of tracking the capacity of each cost driver. The list of cost driver is shown in Tab. 4.

Table 3 Time-Effort Survey Result (unit : %)

Activity Center	Activity	Staff 01	Staff 02	Staff 03	Staff 04	Staff 05	Staff 06	Staff 07
Safety Training	Plan Training	90	5					
	Develop/Update Training Materials	5	60					
	Execute Training	5	35					
Safety Planning	Update Corporate Safety Manual			60	30			
	Review/Approve Site Safety Plan			40	20			
	Review/Approve Site Safety Budget				30			
	Develop/Update Internal Safety Policy				20			
Safety Auditing	Develop Auditing Plan					20	40	
	Execute Site Safety Audits					30	40	
	Document/Follow-up Auditing Results					50	20	
Insurance/Indemnification	Investigate Accidents							20
	Indemnify Safety Claims							30
	Process Worker's Compensation							25
	Renew Worker's Compensation Policy							10
	Renew Site Insurances							15
Total		100	100	100	100	100	100	100

Table 4 Cost Driver List

Activity Center	Activity	Cost Driver	Type
Safety Training	Plan Training	The number of training	Transaction
	Develop/Update Training Materials	The number of training	Transaction
	Execute Training	The number of training	Transaction
Safety Planning	Update Corporate Safety Manual	Budget ratio	Budget
	Review/Approve Site Safety Plan	Budget ratio	Budget
	Review/Approve Site Safety Budget	Budget ratio	Budget
	Develop/Update Internal Safety Policy	Budget ratio	Budget
Safety Auditing	Develop Auditing Plan	The number of audits	Transaction
	Execute Site Safety Audits	The number of audits	Transaction
	Document/Follow-up Auditing Results	The number of failures	Transaction
Insurance/Indemnification	Investigate Accidents	The number of accidents	Transaction
	Indemnify Safety Claims	The number of accidents	Transaction
	Process Worker's Compensation	The number of accidents	Transaction
	Renew Worker's Compensation Policy	Budget ratio	Budget
	Renew Site Insurances	Budget ratio	Budget

4.7 Costs of Cost Objects

The unit rate of activity costs should be used to assign activity costs to cost items. The following definitions can be used to determine an activity cost's unit rate [15-17]:

$$Unit\ Rate\ of\ \ Activity\ Costs = \frac{Activity\ Costs}{Total\ Volume\ of\ \ a\ Cost\ Driver}. \quad (2)$$

The cost-allocation base was the unit rate of an activity's cost. This case study shows the research team measured two-month average of cost drivers' volume. The result of cost allocation using ABC can be seen in Tab. 5.

5 DISCUSSION AND CONCLUSION

While traditional cost accounting assigns overhead costs to numerous projects in proportion to each project's revenue

or contract amount, ABC does overhead costs on the consumption of cost drivers. Tab. 5 shows the result of overhead assignment using traditional method and its comparison with ABC.

Table 5 Overhead assignment between traditional method and ABC

Activity	P1	P2	P3	Note
Overhead allocated, Trad $	4,295.31	4,286.66	4,203.26	(1)
Overhead allocated, ABC $	3,718.06	4,819.59	1,200.93	(2)
Difference	577.24	–532.93	3,002.33	
Difference %	16%	–11%	250%	
Over of Under-charged	Over	Under	Over	
Activity	P4	P5	P6	
Overhead allocated, Trad $	2,337.49	3,655.94	4,234.37	(3)
Overhead allocated, ABC $	6,788.69	1,044.55	3,700.65	(4)
Difference	–4,451.20	2,611.38	533.72	
Difference %	–66&	250%	14%	
Over of Under-charged	Under	Over	Over	
Activity	P7	P8	P9	
Overhead allocated, Trad $	3,144.30	3,421.77	2,785.19	(5)
Overhead allocated, ABC $	3,665.21	926.22	6,640.60	(6)
Difference	–520.90	2,315.55	–3,555.41	
Difference %	–14%	250%	–58%	
Over of Under-charged	Under	Over	Under	
Activity	P10	P11	P12	
Overhead allocated, Trad $	3,073.12	3,589.45	3,150.14	(7)
Overhead allocated, ABC $	2,312.23	3,516.39	3,666.87	(8)
Difference	763.90	73.06	–516.74	
Difference %	33%	2%	–14%	
Over of Under-charged	Over	Over	Under	
(1)+(3)+(5)+(7) = 42,000.00				
(2)+(4)+(6)+(8) = 42,000.00				

As seen in Tab. 5, the projects that was overcharged or undercharged more than 30% under traditional costing system are as follows:

- Overcharged Projects: Project 3, Project 5, Project 8, and Project 10
- Undercharged Projects: Project 4 and Project 9.

Provided that accurate cost information on safety costs of the general overhead, a company is able to measure the costs of safety. As seen in the case, ABC helps to prevent cost distortion that may occur under traditional costing system. In this regard, contractors can make their bidding numbers more competitive when ABC is adopted.

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