Database Program for Managing Management Resources: General Contractor's Perspectives

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ABSTRACT: General contractors' overhead costs are increasing relative to direct costs. However, it is difficult to apply the traditional activity-based costing directly to the construction site overhead costing because the resource consumption rate per each activity is varied depending on the attributes of activities. The research develops a methodology of hybrid cost allocation system when resources are assigned to cost objects unlike the traditional activity-based costing. The study also develops a database program and demonstrates how it can be applied to the construction projects using a case study.

Keywords: Overhead cost control; Activity-based Costing; Subcontractor control

1. INTRODUCTION

The trend is for construction projects to involve an increasing number of specialty contractors [1]. As a result, projects are becoming more complicated and fragmented. Such fragmented management environments changed a role of general contractor to coordinate multiple subcontractors. Usually, general constructors sublet to subcontractors due to the need for specialized expertise and shortage in resources [2].

These trends have surfaced strongly as shown in the Table 1. Mochtar and Arditi (2000) explained the cause of these trends as due to increases of responsibilities of general contractors to perform additional tasks including "construction supervision, job coordination and perhaps basic site services" [3].

A general contractor usually wants to make a contract with a subcontractor requiring minimum contract amount to obtain the lowest price possible for each service. The way commercial contracts are made causes subcontractor to minimize management staffs to manage the project, thereby increasing a general contractor's burden on coordinating subcontractors. In such changed environments, general contractors' overhead costs are increasing relative to direct costs [4].

	1979	1993
the number of respondents subcontracting less than 50% of the work	59%	40%
the number of contractors that subcontracted 75~100% of the work	18%	36%

Table 1 Survey Results (Mochtar and Arditi 2000)

In addition to the increase of volume, activities contributed to overhead costs play an important role in coordinating different participants that include different specialty contractors and client [1].

However, the construction industry has not changed the method of controlling overhead costs in construction projects. The current method of overhead costing would result in the problems such as 1) cost distortion and 2) little management attention to processes of overhead labor resources [5]. Kim and Ballard (2005) analyzed overhead costs of general contractor by using activity-based [1]. However, Kim (2002) found that it is difficult to apply the traditional activity-based costing directly to the construction site overhead costing because the resource consumption rate per each activity is varied depending on the attributes of activities [5].

The objective of this research is 1) to develop a methodology to trace and manage overhead management resource, 2) to develop a database program (PPA+) so that the contractor can easily trace and manage its site management resources and 3) to demonstrate the usefulness of the PPA+ by a case study.

2. METHODOLOGY TO TRACE AND MANAGE MANAGEMENT RESOURCE

2.1. Profit Point

This study assumes that contracts between a client and a general contractor, and between a general contractor and specialty contractors are fixed cost contracts. Suppose there is a general contractor who is using 100% outsourcing in performing a project. Given this situation the profit can be calculated as follows (Kim and Ballard 2005):

Profit = (1) Total contract amount (Revenue) – (2) Total of outsourcing amount (Direct cost) – (3) Project management costs – (4) Sustaining costs ***Equation 1***

Project management costs refer to costs associated with managing projects. Sustaining costs refer to overhead costs except project management costs. Examples in the category of sustaining costs are project office rent and insurance. Project management costs in Equation 1 depend largely on how to manage different specialty contractors, each of which performs one or a few work divisions.

Kim and Ballard (2005) defined "profit points" imaginary points where a general contractor and specialty contractors interface. However, the flow of profit is not visible to general contractors because cost data comes not from profit points, but from accounting data which combines costs, concealing their origin [6].

2.2. Profit Point Analysis and Multi-Cost Objects

The profit point analysis [1] is a method for analyzing overhead costs determines costs and profits at each profit point where a company and subcontractors are interfaced, thereby revealing the flow of costs and profits.

In the model, management areas, work divisions/participants, and facilities are regarded as cost objects. Figure 1 shows three-dimensional cost objects on a project. Cost information on multiple objects can give a company insight into its relationship with specialty contractors because management areas such as coordination are the hubs of a company's business activities in a project. In contrast, current accounting systems put all cost information into cost accounts which combine profit points.

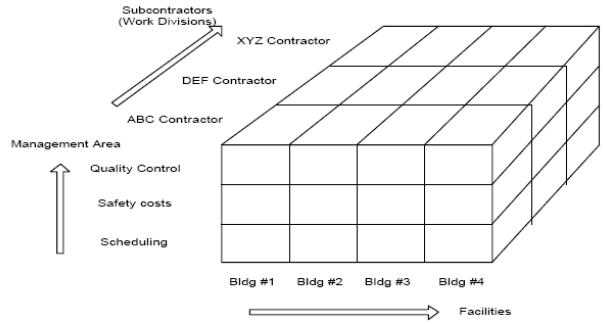

Figure 1. Multi-Cost Objects

2.3. Two-Staged Costing

The profit point analysis (PPA), as compared with traditional overhead costing, adopts the mechanics of the activity-based costing [7.8,9], which uses two-stage costing. Under PPA, the cost of activities and multi-cost objects cost is determined based on the primary principle that activities consume resources (costs). Cost objects, in turn, consume the activities. This principle is completely different from the traditional cost accounting system whose premise is that cost objects consume resources directly, and process (activity) costs are not calculated at all.

2.3. Hybrid Allocation System

Kim (2002) argued that many management activities in construction sites consume resources with high variance [5], which prevents the traditional activity-based costing from working. The model presented in this paper uses hybrid allocation method which uses two-staged costing [7] on activities that consume resources with little variances as well as one-staged costing on activities that consume resources with high variances. The model allows the user to select the allocation method based on the attributes of each activity (Table 2).

Table2. Hybrid Allocation System

Consistency of Resource Consumption by an Activity	
High	Low
Can Use Activity Driver Separately	Need to Use Resource Driver

3. DATABASE PROGRAM PPA+

This software application aims to control several project works at combined environment with head office by introducing activity-based costing into construction industry. Such access method prevents the cost distortion which occurred at existing system through analysis based on activity and enables addition of more exact cost.

In addition, this quantitatively controls the results of the several subcontractors related to the project and the mangers controlling the subcontractors by endowing the existing activity with the detailed attributes and analyzing the flow of cost through Analysis Services® provided by Microsoft company, and provides a basis to recommend the optimized subcontractors and managers for the relevant project using the data mining technique.

The database program, PPA+ can be used to help the user in evaluating the subcontractor. PPA+ can also be used to calculating rapidly and efficiently the labor time used on each activity executed by the project controllers attached to the contractor or by the indirect labors, and also analyzing the trend of activities on the construction site through data mining.

3.1 Scope of Development

This application aims to develop the Definition tool which allots exact cost on the cost object using ABC and the analysis tool which can perform analysis suitably for the characteristics of construction industry by introducing the profit point analysis theory.

3.1.1 Definition Tool

Definition tool performs model creation, period setup, currency and exchange rate setup, resource / activity / cost object definition, driver (resource driver & activity driver) setup, quantity input and calculation. In order to enhance work convenience and readability of user, entities are easily defined by dragging & dropping the icon of tool bar.

3.1.2 Analysis Tool

Analysis tool made it possible to show its respective detailed information and the account information connected by itself and driver as list and chart in terms of model / period / cost object / activity based on the data created and calculated by Definition tool.

Table 2. Development Tool and Language

Item		Development Tool or Language
Definition tool	DB Design	SQL Server 2000
	Definition Module	Visual C++ .NET
	Main User Interface and Dialog	Visual C++ .NET, STL, Skin Magic Lib.
	Data Synchronization	Visual C++ .NET, SQL Server 2000, OLE DB
	DBMS	SQL Server 2000/Analysis Services, Visual C++ .NET
	Calculate Tool	Visual C++ .NET
	Data Mining Architecture Design	SQL Server 2000/Analysis Services
Analysis Tool	Mining Package	Analysis Services
	Main User Interface	Visual C++ .NET, Prof-UIS
	Project Result View Design	SQL Server 2000, OLE DB, Visual C++ .NET, Chart FX
	Data Mining View Design	
	Reporting View Design	
	Project Result chart module	
	Data Mining chart module	MFC, STL
	Visual framework(multi views)	
	Report file processing	PlatformSDK, C++
	Printing reports	

3.2 System Description

This application consists of two parts: Definition tool and Analysis Tool.

3.2.1 Definition Tool

Definition tool is a part which creates Model, Period, Resource, Activity, Cost Object and Driver and performs cost accounting work, and the information on the work of creation/correction/ modification of each object is reflected on database in real time.

When performing calculation after defining each object, creation of data translation service (DTS) package for doing the mining work is simultaneously performed with respect to the entire data including the data currently worked. If calculation and DTS package are completed, analysis tool performs inquiry and analysis for the relevant information.

3.2.2 Analysis Tool

Analysis tool consists of three parts: 1)the project view to inquire about the information on the cost calculated by ABC and the detail composition of each element, 2) the analysis view able to refer to subcontractor and manager analyzed by decision tree using the two methods of compare/optimized decision, and 3) the reporting view in charge of storing the result having been inquired and analyzed in the previous two views and outputting the report.

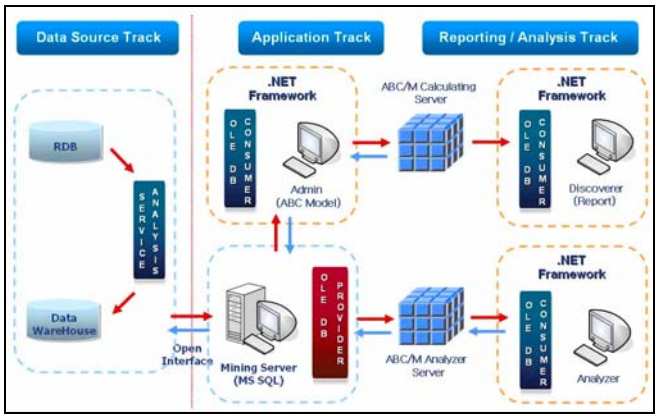

Figure 2 System Configuration

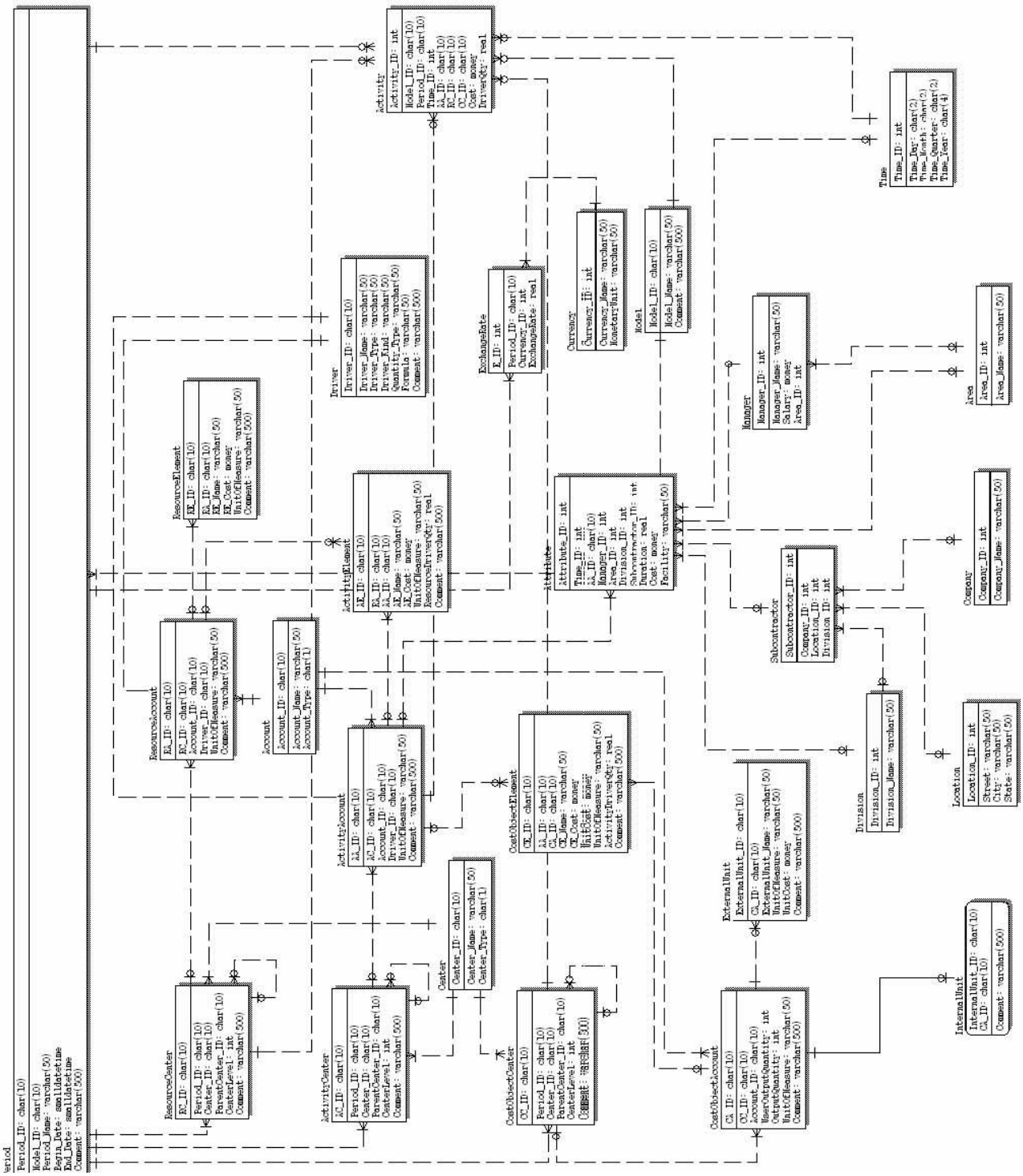

Figure 3. Database Relationship Diagram

2.2.3 Database Configuration Diagram

Creation/modification/deletion of database is performed by Definition tool which is basic application. Creating model at Definition tool and selecting period checks existence of existing equal data and then performs addition or modification work. In order to enable inquiry for each period about one model, the period table was made to have the primary key of model table included in foreign key.

each present model and period; and in order to enable reuse, center and account were made to refer to this table by adding the table containing actual information. Reuse for element table was not added because the account directly connected to itself was referred to instead of referring to the additional table at DB as all the /activity element for resource account and the cost object element for activity account as shown in the Figure 3 when definition tool sets up driver.

4. CASE STUDY

We applied a new database program to one commercial project (Kim 2002). The purpose of this case study has two folds: (1) to test feasibility of PPA+ and (2) to demonstrate the usability of results generated by PPA+.

4.1 Project Description

Sun Microsystems, provider of "industrial-strength hardware" and "services that power the network" intended to build tree office and laboratory buildings in Newark, CA.

Client intends to minimize construction durations by applying design-build method for 1) MEP (Mechanical, Electrical, and Plumbing) part responsible for DPR, Inc and 2) civil work part managed by KMD. Change order occurs more frequently in the altered environment than traditional design-bid-build environment. After all, general contractor put more efforts to manage subcontractors.

However, with a traditional costing system, experience obtained from current project can not be managed in a quantitative way. Precisely, if current costing system is continuously used, trial and error occurred in the DPR Inc.'s project and experienced by general contractor will be repeated identically. Ultimately, these vicious cycles will be act as causes of productivity decrease.

In this context, existing cost data [5] are collected and analyzed again by using PPA+ program from perspectives of DPR Inc. who performed and managed MEP construction. After this process, several reports are prepared to assist selecting subcontractors for similar projects possible to occur in the future.

4.1 Data Input by Using Definition Tool

4.1.1 Resource

In the Activity-Based Costing, resource is a subject who consumes activity. Salary paid to employees, utility costs and facility-maintaining costs are included in this category. In this analysis, only salary was taken into consideration.

4.1.2 Activity, Attribute, and Cost Objects

Previous PPA literature [1, 5] included 1) Activity list, 2) Management Area List, 3) Work Division List and 4) With Whom List in the frame of Cost object. They assumed that cost objects consume resources directly.

However, this calculation method appears to use multiple-one-staged-allocation which conflicts with two-staged-allocation of standard ABC structure suggested by CAM-I [1].

Therefore, PPA+ was designed based on the hybrid allocation system in which the a user can define and select the allocation system (i.e., one-stage or two-stage) based on the attributes of the activity (Table 2).

4.2 Results

4.2.1. Generic Summary Cost Reports

Figure 4 shows an example of summary cost report to manage ACCO. As seen in Figure 4, a general contractor' management costs on each activity to manage a specific subcontractor is analyzed.

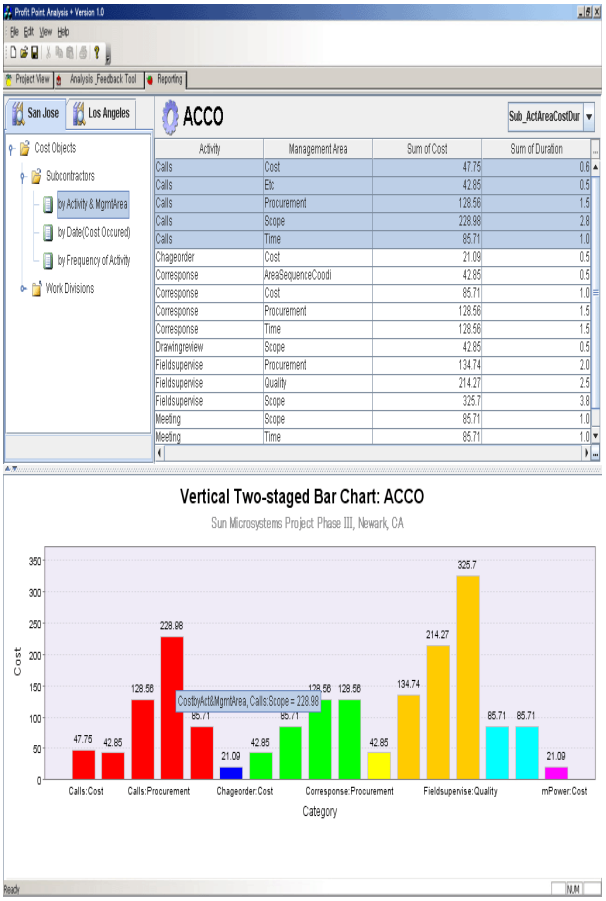

Figure 4 Generic Cost Summary Report

4.2.2. Subcontractor Comparison Reports

A "Summary Costs Report" of subcontractor can be further used to compare two or more subcontractors who performed similar projects. This report can be used during subcontractor selection process in the future.

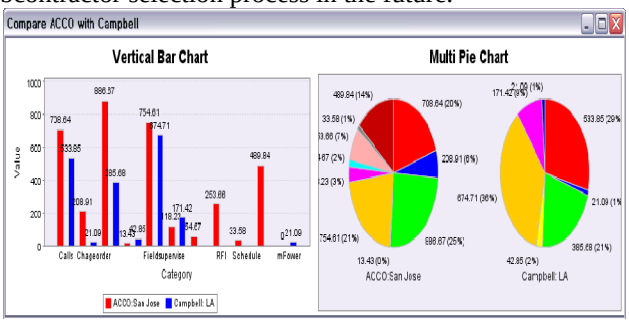

Figure 5 Subcontractor Comparison Reports

Figure 5 shows analysis of monthly activity report for ACCO and Campbell in similar environment.

4.2.3. Other Reports

PPA+ provides various other cost reports. Among them, two cost reports are shown in this part as exemplary cases.

4.2.3.1 Cost Report Using Pareto Chart

This report shows accumulated management costs for each subcontractor by daily bases.

Figure 6 shows monthly management costs of DPR Inc to manage ACCO from 17th of January to 15th of February. Red colored bars indicate daily costs generated and overlaid blue line in shape of Pareto chart displays accumulated costs.

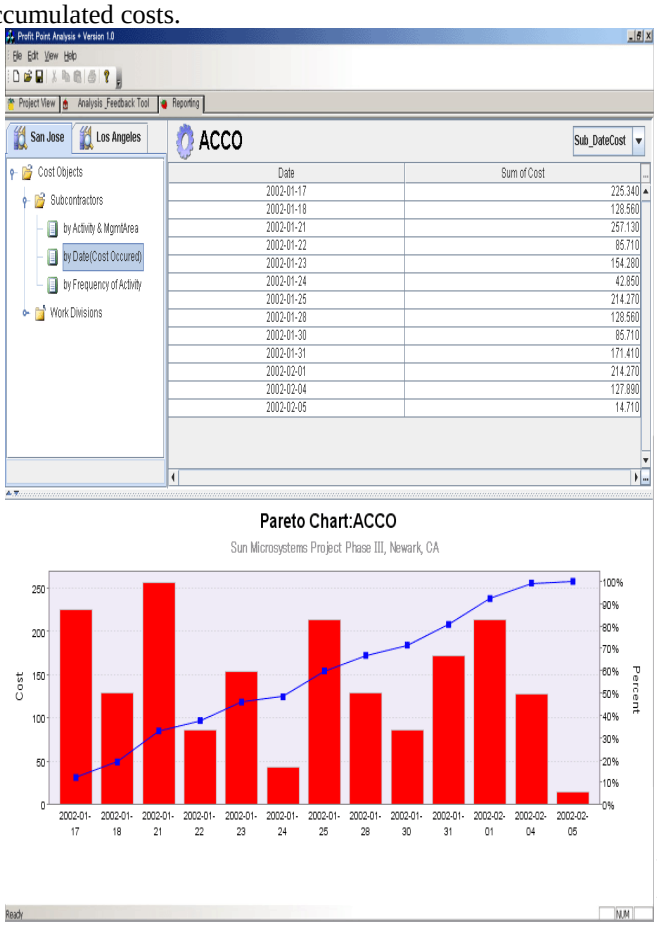

Figure 6 Monthly Mgt. Cost Report Using Pareto Chart

4.2.3.2 Event Frequency Chart

Event Frequency Chart shows report of daily management activities performed by general contractor, for example, DPR Inc. by subcontractors.

As shown in Figure 7, DPR Inc has performed "Fieldsupervise" Activity and "Corresponse" Activity at 1st of February to manage ACCO. Detailed information of each event can be obtained from table provided on top part of screen.

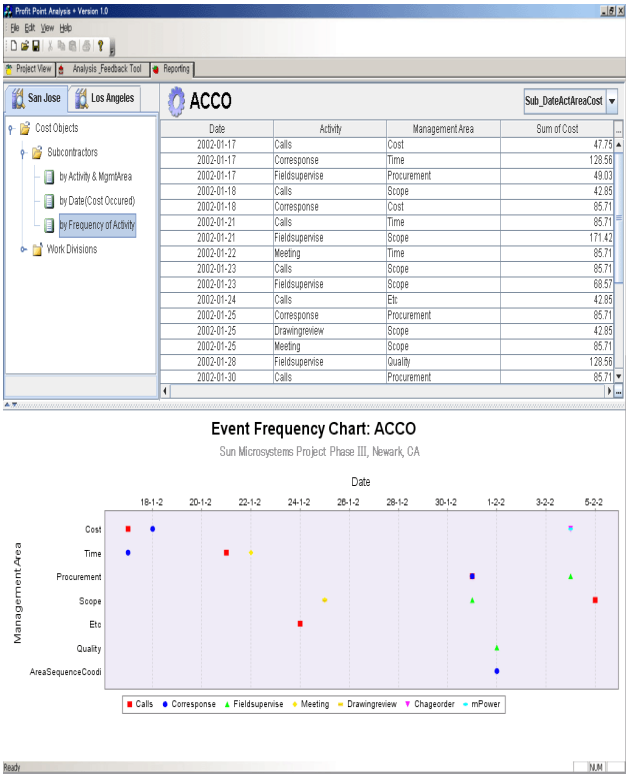

Figure 7 Event Frequency Report

5. CONCLUSIONS

It is difficult to apply the traditional activity-based costing directly to the construction site overhead costing because the resource consumption rate per each activity is varied depending on the attributes of activities. The research develops a methodology of hybrid cost allocation system when resources are assigned to cost objects unlike the traditional activity-based costing. The study also develops a database program and demonstrates how it can be applied to the construction projects using a case study.

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The part which needs improvements includes the information extraction function from source system using ETT (Extraction, Transformation, and Transportation), which was excluded in this study by considering size, realization period, etc. Adding this function will not only define more exact and useful resource, but will also remarkably reduce the work time required when defining activity.

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