A CASE STUDY OF COST OVERRUNS IN A THAI CONDOMINIUM PROJECT

A Dissertation

by

KWANCHAI ROACHANAKANAN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2005

Major Subject: Architecture

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ABSTRACT

A Case Study of Cost Overruns in a Thai Condominium Project.

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Construction managers confront many problems. Still, this industry plays a vital role in the healthy growth of the economy of many countries throughout the developed and developing world. Effective management of construction projects has been a major research subject in the last century due to the importance of this industry and the amount of money it attracts. One critical problem facing construction managers is inefficient cost control procedures, particularly in developing regions of the world.

Since the end of the Second World War, the use of sophisticated cost control procedures in managing and controlling project costs have been accepted and applied widely in many parts of the world such as the United States and the United Kingdom. These procedures are important in a growing economy to ensure delivery of projects on time and within budget, but they are equally important during an economic recession when project viability becomes marginal.

In the early 1990s, the construction industry in Thailand played a critical role during a period of strong economic growth. Construction cost control was not a major concern as

developers rushed to capitalize on the booming market. In the late 1990s, the economy of Southeast Asia sank into recession. Project cost control became a critical issue for the developers as well as the construction companies in managing construction projects. A significant number of projects in Thailand in the late 1990s had significant cost overruns.

Cost overruns had been a problem during the high growth period in the early 1990s, but demand overcame the problems created by poor cost control. The use of good project cost control procedures has become a concern of project investors and construction companies in Thailand since the recession of the late 1990s. Project managers and developers are now aware that the failure of a cost control system or use of a poor system can lead to project failure. Project cost control methods need to be improved in Thailand to ensure that owners and contractors manage construction costs and meet project goals on time and within budget.

In this study, project cost controls in the United States and Thailand will be examined. These procedures will be analyzed to identify their similarities and differences. The causes and solutions for cost overruns in the two countries will also be examined. The results from the study will illustrate how the project cost control procedures used in the United States can be applied to the construction industry in Thailand to improve the procedures used by Thai contractors.

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CHAPTER I

INTRODUCTION

Problem Statement

In many large projects, construction management consultants play a critical role in estimating construction costs, scheduling construction activities, and implementing various techniques to complete the projects. The Thai construction industry suffers from many problems, including excessive cost overruns on major projects. Residential buildings in Thailand cost more than would be expected in an internationally competitive market, which became a critical concern to developers and banks during the Southeast Asian recession of the late 1990s (Phasiphol, 2000).

Montri (2003) states that the cost of construction tends to overrun the budget. This is one of the major problems to be addressed by construction management consultants during construction (Montri, 2003). Jarutat (2003) points out that cost overrun is a critical problem in Thai construction projects, especially in the case of condominium buildings which have had significant problems with inaccurate budget estimates.

Recent Thai construction problems highlight the fact that Thai consultants need to improve their ability to deal with project cost control and to develop the skills to minimize cost overruns. This fundamental change is required to bring Thai practices in line with internationally accepted practice such as US cost control procedures. An application of theory dealing with cost control and cost overruns is needed to be applied to solve the

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This dissertation follows the style and format of the *Journal of Construction Education*.

problem of cost overruns in the Thai construction industry after the recession of the late 1990s.

This research will identify and explain the differences and similarities between project cost control procedures and cost overrun theories for the American and Thai Construction industries. The study will identify the key components of cost overruns for typical condominium projects in Thailand to show how the Thai construction industry can become more efficient and respond better to meeting the national need for construction at an international accepted cost level.

Research Goal

The goal of this research is to identify solutions to reduce or mitigate cost overruns occurring in condominium projects in the Thai construction industry.

Research Questions

- What are the project cost control procedures currently used in the Thai construction industry?
- What are causes of cost overruns based on theory from the American construction industry?
- What are causes of cost overruns based on theory from the Thai construction industry?

- What are the similarities and differences between both theories and how can both theories be compared?

- Why do condominium projects in Thailand have significant cost overruns?

- How do construction management consultants in Thailand respond to cost overruns?

- Can construction cost models from the United States be added to solve the problems that result from poor cost control and cost overruns?

Background

The construction industry in Thailand plays a major economic role in periods of sustained economic growth. The Thai construction industry generated 7.6 percent of Thailand's GDP in 1995 which decreased to 3 percent in 2000 after the 1997 Southeast Asian economic crisis (Bank of Thailand, 2002). This economic crisis had a significant impact on the Thai economy. The construction industry has an interdependent relationship with many other industries, especially the real estate sector with the high demand for housing in Bangkok. Before the onset of the Asian economic crisis in 1997, the growth rate of the construction industry in Thailand was over 13 percent per year(Karasudhi, Tachopiyagoon, &Tang, 1990).

The collapse of the real estate market in 1997 as a result of the SE Asian economic crisis affected many industries including the construction industry (Merrill Lynch Phatra Securities, 2001). Some Thai design firms and contractors have been seeking new markets in other countries since the crisis (Ngamnetr, 2003).

However, some of these construction firms have serious problems with quality and budget control, which can be critical for working on international projects. Project management, which includes cost control, is an area of weakness for Thai companies that want to expand into the international construction market.

As a result of the late 1990's economic recession, the construction industry became stagnant, essentially because of the decline in real estate development and sales (Bank of Thailand, 1998). Condominium projects occupy a significant portion of the Thai real estate development market, (Jaruthat, 2003; Sansiri, 2003), see Table 1, and as a result of insufficient capital, most developers stopped construction of their condominium projects, resulting in uncompleted buildings in Bangkok.

Table 1

Types of Developed Projects from 2002 to 2003, Trirat Jaruthat

Codes	Function	2002		2003	
		Number	Percent	Number	Percent
1	Residential Building	441	86.81	240	65.93
2	Commercial-Office Building	53	10.43	97	26.65
3	Parking Building	3	0.59	11	3.02
4	Others	11	2.17	16	4.40
	Total	508	100.00	364	100.00

This study will focus on the cost overrun problem observed in a Thai condominium construction project during the 1990-97 period high growth, since condominiums play a significant role in meeting the demand for residential housing in Thailand. The aim is to apply the lessons gained from this case study of an important period in the development of the Thai construction industry and to apply these lessons to future construction. There is a dearth of these types of studies for periods of high growth in Thailand.

CHAPTER II

LITERATURE REVIEW

There are many causes for cost overruns (Halpin, 1985; Kaming, Olomolaiye, Holt, &Harris, 1997; Kerzner, 1995; Killingsworth, 1988). Yet, there are many ways that cost overruns can be avoided on major construction project. The United States construction industry follows generally accepted international practices in the field of cost controls for construction. A report on the Thai construction industry found that poorly applied project cost controls and cost overruns were a critical problem (Tungsanga, 2003). However, there has been no significant research on how these cost control procedures can be improved and how cost overruns can be avoided in Thailand given the peculiarities and development stage of the construction industry in Thailand.

This literature review of cost control procedures consists of three major parts. The first part deals with the definitions of construction and project cost control procedures as applied in the construction industry and the concepts of cost overruns. The second and third parts discuss project cost control procedures and the concept of cost overruns found in the American construction industry and the terms used in Thailand's construction industry. This review illustrates the impacts of project cost control procedures and cost overruns on construction projects in the United States and Thailand.

The following topics will be discussed in the first part:

- Construction Industry

- Construction Costs
- Project Scheduling
- Project Cost Estimates
- Concepts of Cost Overruns
- Causes and Impacts of Cost Overruns
- Cost Overrun Prevention

Construction Industry

The construction industry has a great impact on the economy of all countries (Leibing, 2001). In the American economy, the construction industry is often used as an economic indicator (Gould, 2002). Construction has a higher risk than companies manufacturing a stable product such as toilets since project costs must be estimated before construction begins and each project is unique (Ahuja, 1994). Following are some definitions of the construction industry (Leibing, 2001):

- Massive: in the terms of the money that projects can cost – the worldwide total is virtually uncountable
- Dominant: construction is a major factor in the national economy and contributes to the growth of geographic areas and employs a huge workforce

- Flexible: the construction industry can adapt rapidly to any climate, situation, or need
- Active: due to its continuous movement toward better quality, higher/newer technology, safer structures, and better services
- Structured: involves every feature of a project from financing to management to regulatory controls, to the actual construction design and execution

Leibing (2001) notes that the construction business is one of the largest industries in the world. The structure of the industry is shaped by three main factors (International Bank for Reconstruction and Development, 1984):

- Nature of the work to be done
- The choice of technology
- Social and economic environment

Construction Costs

Generally, the cost of a contract project bid in Thailand covers only the cost of construction (Leibing, 2001). However, this construction cost analysis will include the design and documentation of the project: the production of documents and information that directs the construction.

The initial cost of a construction project is the estimated total amount that will be paid for project planning and construction until project completion (Mann, 1992). This cost is obtained from a project estimate which is calculated from primary data available during the conceptual design phase (Killingsworth, 1988). This estimate is sometimes called the conceptual estimate, which will be usually less accurate than the estimate that is completed in the later phases of design and bidding (Bent & Humphreys, 1996). In the case of the United States, labor costs are much higher than in Thailand.

As mentioned previously, initial cost is an important component of construction costs. It can be used as the base line to compare with actual cost in order to examine deviations. Construction projects in both the United States and Thailand place emphasis on the initial costs. Certain factors need to be concerned because of their impact on the initial costs – time especially is a significant factor, particularly the time that needed for project delivery and construction. The impact of time can result in inflation or delays in the design process or material delivery. In addition, inflation rates also increase the cost of borrowing money.

The Urban Land Institute points out that time is critical for project development and construction, time delays due to design changes or environmental problems can directly affect the construction period (Urban Land Institute, 1989).

Changes in design can impact other steps before and after construction begins. In developing condominium projects in Thailand, interior design tends to be changed during construction to attract more tenants. In many cases, these design changes can cause significant delays in reaching practical or substantial completion of the building. As a direct consequence of this delay in interior work inflation and interest payments were the major problems in Thai projects during the late 1990s.

Impact of Time and Delay

As discussed previously, design changes resulting in construction delays can cause critical problems for the developer and the contractor who may incur higher expenses in the costs of materials or because of delays in material deliveries. As a result, all alternatives proposed by the architect or developer should be evaluated and estimated separately from other construction items (Urban Land Institute, 1989).

In many cases, it is difficult to complete the design before the construction begins. During the high economic growth of the early 1990s in Thailand, many development companies required the architects to prepare preliminary designs within a short period of time which were then used for awarding contracts. This decision provided incomplete drawings to the contractor and consequently inaccurate project estimates for the developer and the bank. The clear lesson for Thai project owners and architects is to work together to complete the design drawings before project estimates are prepared or contracts are awarded.

Cost in Real Estate Application

The real estate sectors in Thailand and the US are concerned about project costs since they need to be accurately estimated before beginning the project if an acceptable return is to be expected on the investment. In the real estate business, the following factors can affect the cost of construction (Featherston, 1986):

- Building design or type of use
- Construction classification
- Quality of project
- Building size, shape and height
- Specific equipment used in the construction
- Site improvement

Featherston (1986) mentions the major types of costs applied in the real estate business. These include direct and indirect costs, which are categorized in the same manner as the costs mentioned in the construction industry. Direct costs are composed of 1) labor cost, 2) material and equipment costs, 3) design and engineering costs, 4) subcontractors' fee. The following are categorized as indirect costs (Featherston, 1986):

- Legal fees, appraisal fees, and building permits and licenses
- Interest and fees for construction financing
- Construction liability and casualty insurance
- Property taxes during construction
- Construction administration and management
- Interest on investment and loss of rental income

- Builder's and entrepreneurial profit
- Selling costs

In the real estate business, which is highly related to the construction industry, the construction loan is another component that needs to be considered. The steps in developing projects in the United States and Thailand are similar in terms of the sequences and sources of funds to be invested in constructing properties. Most construction projects have to deal with a construction loan which is paid by the borrower in progressive payments based on the work performed during the construction period. The amount of principal that is paid out each month will be accumulated (Featherston, 1986).

Many factors can have an impact on construction costs because each project is unique in terms of management system, design and environment. However, project costs do not correlate to differences in facility size (Civil and Environmental Engineering, 2004). Factors affecting construction costs include the following (Hinze, 2001):

- Geographical conditions of project site
- Sources of materials, construction labor, and construction management
- Cost of building permits
- Costs of bond, worker compensation, and liability insurance
- Environmental protection

Besides the factors mentioned previously, construction costs can be identified in different detail, because of different kinds of projects and functions (Featherston, 1986). In real estate development, cost estimating is a significant element of doing business because it one of the major factors for making a decision to invest in a project (Featherston, 1986).

In case of adaptation project, which may need special concern for project cost, the building type and the proposed use of the building can directly affect construction costs (Douglas, 2002).

In real estate development, the cost estimates used in property appraisal are defined as generalized economic costs (Featherston, 1986). These costs can be obtained from following estimate methods:

- The comparative square-foot method
- The unit-in-place method
- The index method
- The quantity survey method

In construction, cost estimate at the design stage can be referred to as the feasibility cost estimate (Killingsworth, 1988). This estimates is completed after the entire project requirements are identified (Killingsworth, 1988), thus, the accuracy of project costs derived from this estimate is better due to the improved knowledge about the project.

Featherston (1986) states that design factors can affect the cost of construction project. As discussed in their book, these design factors are as follows:

- Building design or function
- Classification of construction
- Quality of construction
- Size of building
- Shape of building
- Height of building
- Site improvement

Project Scheduling

One of the purposes of planning and scheduling a project is to translate the work schedule into a cost schedule or budget (Neil, 1982). Because cost and schedule control need to be coordinated, no review of cost control would be complete without some brief reference to scheduling and the most common scheduling technique (American Society of Civil Engineers, 1985). Due to the time-value of money, a contractor could lose money to interest charges, if material is delivered today to be used it in next 4 or 5 months unless the contractor is paid for the material at the time it is delivered. Project scheduling ensures that the timely operation of construction ensures an on-time, on-budget, and profitable contract for the contractor, which is indirectly a significant concern for the developer.

As indicated in the report by the American Society of Civil Engineers (1985), the project schedule is a significant element in developing an estimate by identifying the sequence of activities and illustrating the interrelationship of all activities needed to complete the construction. It also shows the availability of project personnel, weather conditions, project resources, and the owner's requirements.

Gould (2002) states that the schedule is the primary control tool. However, the quality of materials specified by the architect can be modified and updated during the construction to prevent delays in material delivery.

The American Society of Civil Engineers (ASCE) (1985) states that project cost control is conducted based on the estimate and budget, while project schedule control is conducted based on the project schedule. They further point out that the network is the plan which becomes the schedule after time durations are assigned to the network activities.

Ritz (1994) states that the fundamental objective of the construction team is to complete the project as indicated in the contract, on schedule and within the proposed budget, thus project scheduling can have an impact on other project components such as estimating or budgeting. The plan will need to be updated to achieve the project's target which is to keep costs within budget and keep the schedule on track. (Gould, 2002). Management needs to modify the project schedule and estimates because of changes or discrepancies that may occur during the construction period (Civil and Environmental Engineering, 2004).

Ritz (1994) also points out that one-time completion can help owners achieve their requirements and schedules, and reduce high costs due to added interest and start-up costs. The owner may lose the advantage of cost control if the project schedule needs to be extended (Ritz, 1994).

Time and cost are critical to the project because of their complex interrelationship. As the project proceeds, the cost and budget can be influenced by delays and can lead to the adjustment of the activity schedule (Civil and Environmental Engineering, 2004). Bent and Humphreys (1996) mention that timely evaluation of potential and schedule risk and the presentation of recommended solutions to project management are required to achieve effective project control.

It is difficult to have effective project control processes that cover both time and schedule. As a result, the project manager needs to be concerned with the interrelationship between time and cost. As can be found in many construction projects, the contractors use different applications to record and report project costs and schedule. This can cause the project manager to have some difficulties in performing tasks related to different sets of applications (Civil and Environmental Engineering, 2004).

Bent and Humphreys (1996) claim that detailed scheduling of the overall project program is costly and time consuming. They recommend developing an entire summary schedule for the total program and preparing detailed short-term schedules.

An effective construction scheduling operation consists of the following:

- Construction preplanning which should be performed during the early engineering stage
- Program of constructability prepared during the early engineering stage
- Field budget based on quantity
- Detailed weekly work program
- Measurement of physical system based on quantities
- Measurement of productivity
- Effective schedule levels: overall summary and short-term details
- Adequate personnel resources

The schedule is an important component of the cost estimate. As a result, the schedule should be made prior to estimating the project costs based on construction techniques (Oberlender & Peurifoy, 2002). The construction period of each phase of the project and of the project as a whole affect the direct and indirect costs (Oberlender & Peurifoy, 2002). In some case, the schedule needs to incorporate and be compatible with decisions made in the detailed cost estimate (Oberlender & Peurifoy, 2002).

Project Cost Estimates

Ahuja (1994) states that estimating is a primary part of the construction industry. The accuracy of estimates from conceptual design through detailed or bid estimates can affect the success or failure of a construction project (Ahuja, 1994). He also states that many failures are the result of inaccurate estimates.

Killingsworth (1988) states that cost estimates can be categorized based on conceptual design and design development. In this step, a check estimate is calculated and analyzed to confirm that the design schemes are known at this point. During this stage, the estimates are needed to compare the costs of the initial schemes and to verify the cost of the final design scheme. However, the actual details of systems and materials are not complete. According to Killingsworth (1988), the next stage is design development in which the final alternatives for materials, methods, and systems and detailed plans and specification for construction are identified. In this stage, the check estimates will be implemented to monitor the cost of developing the design. He recommends that the estimates be calculated when the project documents are approximately fifty percent complete, seventy-five percent complete, ninety percent complete, and when the documents are ready for bid or negotiation. Although some details are available for estimating, bid conditions and inflation are the factors that can affect the accuracy of cost estimates (Killingsworth, 1988).

Featherson (1986) states that the cost estimates used in project appraisal can be defined as generalized economic costs which are used to study the feasibility of the project. Ritz (1994) points out that an approach for conducting a feasibility estimate is to plot the size of the current project versus the actual data from a previous construction project with similar features or specifications (Ritz, 1994).

Ritz (1994) states that the construction cost estimate provides the primary specific indication of the total project cost. It is necessary to collect all the project costs to prepare an estimate for entire project (Oberlender & Peurifoy, 2002). The estimate of total project cost provides critical information to the owner, the project architect, and the construction contractor (Ritz, 1994).

Theoretically, the price will begin with an estimate cost that is agreed to by the owner and contractor. This estimate will become contract price and is converted to the project control budget that will be used to control the project costs. It is very important to establish a well-organized cost estimate based on the appropriate accounting codes so the project management can convert the project estimate to the project budget (Ritz, 1994).

Types of Estimates

The Construction Industry Institute (1986) divides the estimate into three major types. The first is order-of-magnitude and is a basic component of a feasibility study. This initial estimate will generate cost/capacity curves or other approaches that relate to output and can vary as much as plus or minus 50 percent (Construction Industry Institute, 1986). During construction, a number of cost estimates need to be developed to show the updated costs to the project management (Construction Industry Institute, 1986).

The second estimate is the factored estimate which assumes that cost, quantity, and dimensional relationships can be found between this element and other project cost components (Construction Industry Institute, 1986).

The third level of estimate is the control estimate which is prepared after the piping and instrumentation diagrams and civil control drawings are complete. As a result, the budget estimates cannot be categorized as the control estimate (Construction Industry Institute, 1986).

There are two major types of cost estimates (Kerzner, 1995). The first type of estimate is an order-of-magnitude analysis which is made without any detailed data. The accuracy of this analysis is approximately plus or minus 35 percent. The second type is the approximate estimate or top-down estimate, which is also made without detailed engineering data. Its accuracy is about plus or minus 15 percent.

Oberlender and Peurifoy (2002) mention that cost estimates can be categorized into two different types based on their intended purposes and the amount of information available when the estimates are prepared. He also states that several organizations classify cost estimates as flowing (Oberlender & Peurifoy, 2002):

1. Approximate Estimates

The project architect needs to price a variety of design alternatives to meet an economical design that does not exceed the owner's budget (Oberlender & Peurifoy, 2002).

Extensive experience and decision are needed to develop a reasonable approximate estimate for the project cost, since the estimator has to modify the unit costs for quantities of materials, labor, location, and construction contingencies.

Approximate estimates are accurate enough for evaluating design alternatives or presenting preliminary construction estimates to the owner, but they are not sufficient for the bid process. Most contractors estimate an initial cost for the construction project based on preliminary quantities of work.

2. Detailed Estimates

A detailed estimate can be prepared by identifying the costs of materials, labor, equipment, subcontract work, overhead costs, and profit (Oberlender & Peurifoy, 2002).

Basically, the detailed estimate will be prepared by a systematic procedure developed by contractors to meet their unique operations (Oberlender & Peurifoy, 2002). The highly detailed costs can be developed from a well-organized checklist of all construction activities necessary to construct the project (Oberlender & Peurifoy, 2002). The base estimate can be obtained from the sum of direct and indirect costs.

The following activities need to be coordinated and integrated in order to prepare a complete detailed estimate (Oberlender & Peurifoy, 2002):

- Development of construction techniques
- Construction schedule preparation
- Quantity of materials
- Cost estimate

- Risk assessment for project contingency

Besides the types of estimates mentioned previously, cost estimates can be categorized into four types based on the purpose of the estimate during the project's life cycle (Ritz, 1994):

- Feasibility
- Appropriation
- Capital cost or budget
- Definitive

Accurate Estimates

Ritz (1994) states that it is fundamental to have an accurate project cost estimate that can appropriately anticipate the cost of executing the work. He also points out that the construction cost estimate should be neither optimistic nor pessimistic--, it should reflect a reasonable cost.

Although the cost estimate is a predicted value, it is calculated based on some primary factors existing at the time of estimation (Ritz, 1994). These factors include the following:

- Project definition
- Contracting plan
- Construction schedule

- Construction techniques
- Productivity of labor
- Estimate techniques

The level of project definition can have an impact on the accuracy of any estimate (Ritz, 1994). Improvement in the project definition and pricing data can increase the accuracy of project cost estimate. If available data are still to be revised during the schematic design, this can be a major risk factor in the accuracy of estimate (Ritz, 1994).

Most construction cost estimates are based on completed floor plans and specifications since the data from project design is usually completed or well defined (Ritz, 1994). For an accurate estimate, the estimator needs to have access to comprehensive historic data and be able to select and apply the appropriate methods plus have the experience to make reasonable judgments about the level of potential risk (Smith, 1995). The information for the direct-cost portion can be obtained from the drawings and specifications indicated in the contract documents (American Society of Civil Engineers, 1985). The direct cost can be estimated after the quantity takeoff is completed and then, the indirect costs can be completed (Oberlender & Peurifoy, 2002).

Oberlender and Peurifoy (2002) point out that omissions in the estimate, miscommunication of project information, or unreliable assumption can cause inaccurate project estimates. The following procedures can improve estimate documentation to reduce inaccuracies (Oberlender & Peurifoy, 2002):

- Improvement of communications among all parties involved with the project
- Establishment of a system to monitor the estimate
- Establishment of an effective principle for project control

Killingsworth (1988) points out that the degree of estimate accuracy can be influenced by type of construction, the applicability of the cost data, and the experience of the estimators. Project management personnel can increase estimate accuracy by improving and maintaining their performance and by constantly checking estimate assumptions, cost data, forecasts, and estimate quantities and prices against actual project conditions (Killingsworth, 1988).

According to "Experience learning in cost estimating," Lowe and Skitmore (1994) state that the experience of the estimator can affect the accuracy of estimated project costs. Other factors that can influence the cost estimate are the length of experience of an estimator and the type of buildings or projects (Lowe & Skitmore, 1994).

Estimating Techniques

Since the cost estimates are important for construction, the selection of the appropriate techniques can have an impact on uncertain items, specific contingencies, and general estimating allowances (Smith, 1995).

The procedures of cost estimates begin with developing the project costs during the estimating phase and transferring this data to the job cost system. Cost estimating is closely linked to cost control, and one builds upon the other (Halpin, 1985). This job cost system represents target values against the field costs and performance which can be measured (Halpin, 1985). The field data will be collected, distributed, and recorded in appropriate job cost accounts after the construction begins. Halpin (1985) mentions that the design, implementation, and maintenance of a project cost control system can be considered a multiple step process.

While estimating project costs, the contractor needs to consider inflation because when preparing an estimate, the estimator calculates the project costs as if it will be built today. Halpin (1985) recommends that the estimator project current costs to the time that they occur on the schedule using an inflation rate based on his best judgment to provide more accurate cost estimates. Another concern for the estimator is depreciation, especially when estimating costs regarding equipment (Halpin, 1985). The expense of depreciation reflects a piece of equipment or a structure that loses its value with time according to a combination of use and obsolescence.

Different stages of the project can have a different scope of work and different information regarding design and construction materials. Complete project scope and design information are required for accurate estimating (Killingsworth, 1988). However, estimates for feasibility studies and for project budgets are conducted before the entire project requirements are known or completed.

The results of the project estimate can be improved by conducting estimate documentation through the following procedures (Oberlender & Peurifoy, 2002):

- Distributing information
- Identifying the items that need to be classified
- Assisting the estimator to obtain and manage sufficient data
- Reducing confusion in the estimate
- Providing appropriate information for future uses
- Maximizing the reliability of the estimate

There are some advantages from documenting an estimate including improving communication between the estimating team and management, establishing a system for estimate evaluations, and developing the fundamentals for initial project cost control (Oberlender & Peurifoy, 2002).

Poor communication within the construction process can cause problems with quantity estimation and control (Construction Industry Institute, 1986). These difficulties can be increased when the engineering work and construction are managed separately by different parties (Construction Industry Institute, 1986).

Basically, the cost plan is prepared based on the cost estimate and its scaling to the project schedule (Halpin, 1985). An accurate cost estimate is a primary component during the need analysis phase; studies should be conducted to identify project and site needs and limitations (Killingsworth, 1988).

Brandon and Ferry (1984) mention that most cost planning and cost control procedures are dependent on prices obtained from bills of quantities or other sources. Neil (1982) claims that resource quantities and costs are the products of estimating. One characteristic of all cost planning and control procedures is the budget and the subsequent budgetary control which is analyzed to ensure that project costs will not be over budget. Factors which could affect the estimates of the project costs include land values, grants, subsidies, and taxation concessions (Brandon & Ferry, 1984).

There are certain systems used to effectively manage cost estimates. One standard system is cost accounting, which is widely used by construction companies. Accounts of individual job costs indicate the basic units for cost control and can identify the expenditures of some particular project (Civil and Environmental Engineering, 2004). Specific cost accounts can identify the expenditures of particular projects and indicate the expenditures resulting from specific events that occurred during construction.

Contingencies

The treatment of contingency amounts can be one of the routine problems in establishing a project budget in terms of cost accounts (Civil and Environmental Engineering, 2004). Practically, the budget for contingency allowance should also be included in the final cost with a provision for inflation (Civil and Environmental Engineering, 2004).

In order to identify an appropriate contingency to be added to the base estimate, a risk analysis of uncertainties needs to be performed (Oberlender & Peurifoy, 2002). Oberlender and Peurifoy (2002) state that project management can determine the contingencies by identifying categories of work items which can be obtained from the project's written specifications based on the Construction Specification Institute. Work breakdown structure can also be used to identify work items by their location on the project. The inability of estimators to anticipate the direction of design development is one factor contributing to insufficient conceptual estimates (Construction Industry Institute, 1986).

Cost Estimates in Thailand

The main objective of cost estimation is to identify the costs of individual activities and the cost of projects at every stage of construction. Basically, the work is categorized into two major parts; building and civil works. In order to estimate the cost of the project, the following factors need to be considered (Supphasri, 2003):

- Price of major items; materials, equipment and labor
- Operating expense; insurance, bank fees, bonds as indicated in the contracts
- Monthly expenditures
- Miscellaneous expenses

The principles of cost estimates are as follows (Supphasri, 2003):

- Quantity Takeoff
- Pricing of Unit Rate
- Final Pricing

The cost estimate is not only the estimation, but is also an overview that illustrates engineering discipline, project management and project planning which are the bases of engineering (Supphasri, 2003). Accurate costs estimate play a vital role in successful in bidding and the survival of a construction company (Supphasri, 2003).

The accuracy of cost estimates depends on the following factors (Supphasri, 2003):

- Original resources
- Working environment
- Transportation and procurement system
- Project characteristics
- Contracts
- Construction planning
- Construction techniques
- Cost estimation method

The estimation method depends on the details of an individual construction project. The critical issue to be considered is the unit price of individual items based on the types of activities and projects (Supphasri, 2003).

Supphasri (2003) states that the heart of a detailed estimate is to identify an accurate unit rate to conform to the type of activity and project. One of the best sources of unit rate comes from the construction company's archives or data base which can be obtained from a previous project cost or historical data base (Supphasri, 2003).

Types of estimates applied in the Thai construction industry can be categorized based on the purposes and project requirements (Supphasri, 2003). First, estimates based on purposes can be divided into four types (Supphasri, 2003):

- Feasibility study
- Functional unit price estimate
- Detailed estimate
- Budget estimate

Second, estimates based on requirements consists of two types (Supphasri, 2003):

- Rough estimate
- Detailed estimate

Supphasri (2003) outlines the steps for estimating as follows:

- Bidding
- Negotiation

- Contracts
- Construction
- Completion

Factors that can affect unit prices in Thailand include (Supphasri, 2003):

- Type of Construction
- Quantity of Work
- Physical Condition of Construction Site
- Material Delivery System
- Quality of Work

For all practical purposes, the procedures for cost estimating used in Thailand are similar to those in the United States (Supphasri, 2003). The data needed for cost estimating include:

- Labor Productivity
- Labor Rate: cost per hour/day/week
- Labor Unit Price
- Material Unit
- Material Conversion

- Material Unit Price
- Waste Percentage
- Equipment Productivity
- Equipment Rate
- Equipment Unit Price

The Engineering Institute of Thailand (1999) recommends that design firms and construction companies use the CSI standard format (Construction Specification Institute's) for project cost estimates. However, there is one additional division in the CSI system used in Thailand, which is Item 17 Painting Work while the CSI standard format used in the United States has 16 divisions.

In the book "Guideline for Quantity Takeoff for Structural and Architectural Works" by the Engineering Institute of Thailand (2002), there are nine standard categories of cost estimates which differ from those discussed in the book "The Guideline for Information Management for Construction Evaluation and Management." Basically, most standard divisions identified by the Engineering Institute of Thailand are similar to the CSI standard format. These include subcategories such as levels 01 0100 general description or 03 0100 concrete work. However, estimating techniques are different for the units of materials and measurement of labor cost.

Concepts of Cost Overruns

As defined by the Asian Development Bank (2003), cost overrun refers to “the excess of the foreign exchange and/or local currency expenditures incurred or expected to be incurred by the borrower over and above the project cost estimates as originally approved by the board.”

Angelo and Reina (2002) state that the problem of cost overruns is critical and needs to be studied more to alleviate this issue in the future. They also point out that cost overruns are a major problem in both developing and developed countries (Angelo & Reina, 2002).

Causes and Impacts of Cost Overruns

Halpin (1985) points out that both project management and upper-level management must be concerned about the costs of all construction activities since cost overruns can increase project cost and reduce profits. Matthews (2002) states that many factors can cause cost overruns, including inaccuracy of project documents and estimates (Matthews, 2002). Other causes of overruns are underestimated costs, overestimated revenue, underestimate of environmental impacts and overvalued economic development (Flyvbjerg, 2003). Goodyear (2002) indicates that the requirements of project participants beyond projected requirements can result in cost overruns (Goodyear, 2002).

In 1996, Harris, Holt, Kaming, and Olomolaiye researched cost overruns in Indonesia and discussed some of the factors responsible which included unpredictable weather, inflationary material costs, inaccurate material estimates, project complexity, lack of information about the site geography, lack of contractor experience on certain type of projects, and unfamiliarity with local regulations (Kaming, Olomolaiye, Holt, &Harris, 1997). More details of each factor are also discussed in their research. According to their research, the critical causes of cost overruns are inaccuracy of quantity estimate, increased material cost due to inflation, and increased cost due to environmental restriction.

In addition, inappropriate design can cause project overruns, especially in large public construction projects. Even a small percentage in cost overruns can equal a large amount of money, especially in the case of large projects. In a construction project, many parties work together to execute the project in a timely manner and within budget. However, the responsibility of each party needs to be identified before the construction starts, so that they can work efficiently (Kormani, 2002). Since cost overruns can create a considerable risk, Komarni (2002) recommends that owners and contractors share this risk together.

Possible causes of overruns from the beginning of projects include omission of some items and out-of-date cost data (Killingsworth, 1988). The cost information such as local labor and equipment rates, labor productivity, and material costs used in estimating should be accurate. These data can be obtained from historical data, past projects, a proprietary database, or current local and material costs.

Besides the inaccuracy of cost data or failure of estimation, the type of contract can have an impact on cost deviation. Extensive documentation associated with any contract should illustrate both client and contractor objectives to protect their own interests. In addition, the contractor needs money to provide bonds, safety barriers, and to prepare schedules and reports which depend on direct labor, materials, equipment and project supervisory costs (Neil, 1982).

Cost Overrun Prevention

In addition to preventing cost overruns, a project has to be planned effectively and operated professionally to accomplish the objectives of time, cost and performance (Choudhury, 2001). Management must be vigilant to detect actual or potential cost overruns in field construction alleviate the possibility of cost overruns (Halpin, 1985).

Effective construction management can prevent cost overruns (Kaming, Olomolaiye, Holt, &Harris, 1997) with a well-established numbering or coding system to manage costs effectively (Civil and Environmental Engineering, 2004). Besides a numbering or coding system, a sensitive chart of cost accounts can provide evidence of cost deviation (Halpin, 1985). In addition, this chart should establish a detailed cost plan which is not too complex. This plan should be based on the cost estimate and its scaling to the time frame scheduled for the project

In the literature, several researchers discuss cost overrun concepts and provide guidelines on the prevention of this problem. Many causes of cost overruns were discussed, however, none of the previous research discusses how to implement cost overrun concepts in different business cultures.

As mentioned previously, cost estimates are performed at the beginning of a project. If the project team is established effectively, the response from all team members can prevent cost overruns. A design economist plays a critical role during the initial state of the project by providing information about the initial and future project costs to help the design team make decisions about cost allocations (Brandon & Ferry, 1984).

Material takeoffs and contingencies are fundamental to the control of estimates. Material takeoff is directly related to the amount of material specified by the architect and effective cost control of bulk materials is correlated to the direct involvement of design personnel (Construction Industry Institute, 1986). Basically, the design engineers are not needed to consider the quantities of bulk material that are required by their design (Construction Industry Institute, 1986). During the early design stages, a standard or parameter system can be established for bulk quantity estimation, while takeoff is appropriate for detailed design (Construction Industry Institute, 1986). The responsibility of the architects for the quantities they generate can provide some benefits to the project. According to immediate takeoff, the length of the cost blackout period between design and time it affects the cost can be shortened. During this period, if the overruns are found, design of the project can be modified (Construction Industry Institute, 1986).

Practically, the clients should require a full scope definition before the project begins. However, if the clients have time to do so, they should require management to include an analysis of risks of cost/schedule overruns to be part of the feasibility analysis of the project (Construction Industry Institute, 1986).

Besides the design economist, the architect influences the estimates (Brandon & Ferry, 1984) and should participate in the cost planning process. Besides the responsibility of the architect on cost overruns, the management also plays a vital role in controlling and preventing overruns during the construction period, by detecting the actual cost overruns in field construction at the beginning of the project and beginning remedial action to eliminate or reduce the impact of overruns (Halpin, 1985). Halpin (1985) states that project management and upper-level management should be aware of the costs of all project activities in order to decrease project costs and maximize project benefits (Halpin, 1985).

Ahuja (1994) states that contingency is an unknown legitimate and unpredictable cost, therefore, based on the bidding documents, the project manager must decide how much of an overrun could occur.

A well written construction contract can help management prevent or avoid cost overruns. Construction procedures and contracting processes sometimes fail to meet fair, competitive business practices. Contracts may indicate the rights of the owners and the obligations of the contractor but neglect to state the amount of compensation to the latter for default by the owner. These processes can cause delayed payments and failure to compensate for escalation in costs and delays in obtaining the work site (International Bank for Reconstruction and Development, 1984).

Difficulties in contract documents can create problems for the project. In many cases, the contract documents are too complicated for the project to be completed and sometimes inhibit participation in bidding by domestic construction companies. Inexperienced and redundant contract supervision can cause more serious problems (International Bank for Reconstruction and Development, 1984).

CHAPTER III

COST CONTROL PROCEDURES AND COST OVERRUNS IN THE UNITED STATES

No other country can match the United States in new construction developed every year or has a gross national product (GNP) that attributes one of every eight dollars to construction (Leibing, 2001). Leibing (2001) states that the construction industry is an important entity in all societies and is also a primary national economic factor. Approximately seventy percent of construction volume is new construction, while additions or alternations to existing facilities equal some twenty-one percent. Nine percent involves repair and maintenance work. The construction industry is a conservative business, whose expenditures are highest when the economy is growing. Further, it is the largest single production activity in the economy of the United States.

In recent years in the United States, construction has accounted for some 16 percent of the gross national product. The need for correct application of construction technology is universal (Leibing, 2001).

In the American construction industry, failure to maintain adequate cost control account for a loss of $15 billion a year, especially in rework expenses (Construction Industry Institute, 1989b); anecdotal evidence suggests that the level of waste in the construction industry is as high as forty percent.

Construction Management

All construction projects consist of three major parts-- management, engineering, and construction (Leibing, 2001). Each part influences all steps of construction and impacts the success or failure of the project. Pilcher (1994) notes a management system consists of all those parts of the system which come under the control and influence of a particular manager or management.

Project Cost Control

Cost control is a significant task for the construction management team (Bureau of Engineering, 2003a). The purpose of project cost control is to first maintain control of the final budget for a project and second, identify the existence and extent of problems that may cause cost overruns on a project (Civil and Environmental Engineering, 2004). Project control not only provides recommendations for cost savings; but also identifies the costs associated with deviations from the construction plan. Construction planning and cash flow projections support the effective management of the total project cost control. Analysis of cost estimates and change orders can identify the potential for cost overruns. Timely and accurate payments to contractors is a critical concern for successful cost control (Bureau of Engineering, 2003b).

Cost control is conducted to ensure that the project costs are monitored and kept with in the company's requirements and project objectives (Wilson, 1983). Bent and Humphreys (1996) claim that the outcomes of an effective project control procedure are accurate cost and schedule forecast. Wilson (1983) points out that information and action are the heart of cost control.

In order to control the project effectively, the project manager must monitor the schedule to avoid construction delays and additional costs because the building cannot be occupied as planned (Civil and Environmental Engineering, 2004).

Project cost control data are important to project management in the company's estimating and planning departments to provide feedback information essential for effective estimates and bids on new projects (Halpin, 1985). The form and design of a cost control system depends upon the needs of the contractor and the effort that must be expended to implement and maintain the system.

According to results from research, the Construction Industry Institute (1989a) provides the following recommendations for project control and decreases the design changes by:

- Identifying the definitive project scope
- Conducting periodic reviews with all participants
- Implementing procedures that can reduce the scope of modifications
- Conducting a quality management program that commits to all levels in the company.
- Establishing the quality standard

- Establishing an effective database system to identify deviation costs and problems with quality

- Using the Quality Performance Management System to verify costs related to quality management and correcting deviations.

Project control can be accomplished by the application of cost engineering (Neil, 1982). Cost engineering covers the functions of planning, estimating, scheduling, and cost control in construction. Neil (1982) suggests that a cost-engineering system will provide effective project control from the time a contractor receives bid documents and until the project is closed and historical records are completed.

According to the American Society of Civil Engineers (1985), a cost-control system is based on determining the percentage of completion of an item of work. This is very important so the cost engineer can properly determine how much of the estimated cost of an item can be allowed for comparison to the actual cost incurred to date (American Society of Civil Engineers, 1985).

There are several tools that can help a project manager manage project costs. The first is the job cost system which is an effective management information system for gathering information to help the project manager (Halpin, 1985). Halpin (1985) states that collecting the data used as a basis for estimating future projects is another function of the job cost control. The second tool is the cost accounting system which provides two critical functions: first to monitor and control costs against target costs and values, and second to collect data for estimating future projects (Halpin, 1985).

An effective cost control system, then, consists of a series of estimates beginning with the need identification phase and continuing through need analysis, conceptual design, design development, and construction to the final cost of the project.

Kerzner (1995) states the requirements for an effective control system should include:

- Establishing plan of work to complete the project
- Accurate estimating of time, labor, and costs
- Effective communication of scope of required tasks
- Well controlled budget and authorization of expenditures
- Appropriate accounting of physical progress and cost expenditures
- Ongoing time and cost reestimation to finish remaining activities
- Regular continuous comparison of actual progress and expenditures to schedules and budgets during construction and at project completion

A well organized cost and control system should be arranged, developed, and implemented so that the management can receive immediate feedback (Kerzner, 1995).

Practically, all projects must be managed to control project costs and budgets, to provide adequate personnel, to schedule, to control and supervise, and to coordinate all parties to ensure a profitable outcome (Leibing, 2001). Halpin (1985) states that the first step in establishing a cost control system for a construction project is to define project-level cost centers.

The first step in the cost control cycle is the preparation of the cost plan (Halpin, 1985). Killingsworth (1988) claims that an effective cost control system must begin with project planning. He also states that construction scheduling and cost estimates should be performed together.

Halpin (1985) states that both project planning and cost control reporting system will generate the data that can identify the current project status, effectiveness of work progress, and payment requests. He also points out that cost management emphasizes monitoring and controlling the cash flowing into and through the project cost accounts. The primary purpose of the cost account section is to categorize the total project into smaller units of work that can be measured on the job site.

Cost Planning and Control Procedures consist of the following elements (Brandon & Ferry, 1984):

- Preliminary estimate based on the cost of total construction. This is an approximate estimate which may lack some information.
- Preliminary cost plan: Preparing the cost plan after the first design drawings provides an advantage for the project since the client can see whether the initial specifications are within project cost limits.

- Cost plan: This plan can be established from cost elements which will illustrate the unit prices of the construction and can be compared to project design alternatives.

Since the cost plan is vital to project cost control, the architect should design the building to conform to the cost plan and the design should be finished before the completion of drawings (Brandon & Ferry, 1984). Although the cost plan is an important component, it is not widely implemented by Thai construction companies.

In Thailand, most large projects that deal with a large amount of money tend to be more concerned with implementing cost planning during the design phase.

Variances are monitored between expected costs, as projected by the estimate and budget (time-scaled estimate), and the field production rates and charges. By examining the variances, the manager can detect which accounts are seriously deviating from planned progress and can take corrective action (Halpin, 1985).

Neil claims that work breakdown structure is a tool for managing project cost control (Neil, 1982). He points out that "the theory behind project control through work packaging is simple – to manage a whole operation, you manage and control its parts, these parts being work packages in the case of construction." He also states that by setting up a control system during construction which focuses on work packages, the contractor can directly compare actual expenditures of resources and money to that budgeted.

Cost Overruns

According to research done by the American Society of Civil Engineers (1985), the failure of estimates leading to cost overruns results from many factors, including the general state of the economy, government regulation, inadequate supervision, and poor plans and specifications (American Society of Civil Engineers, 1985).

A potential project overrun can be detected from the major deviation of actual and proposed costs (Bent & Humphreys, 1996). Practically, an inaccurate estimate will more likely lead to project overruns than a lack of control and poor site management (Bent & Humphreys, 1996). Components related to project costs usually cause overruns, e.g. project specification. Because the specifications can affect the entire cost of the project and budget, it is essential to construct the project to specifications to keep project costs budget (Ritz, 1994).

Evaluation of Causes and Impacts of Cost Overruns

Project cost overruns can cause a slower payout and reduce an early return on the client's investment (Ritz, 1994). Poor scope definition at the estimate (budget) stage and loss of control of project scope are the most frequent contributors to cost overruns (Construction Industry Institute, 1989a).

Cost overruns found in industrial projects can be noticeable. Practically, most overruns are estimated by comparing final costs and planned costs (Construction Industry Institute, 1986). Cost overruns can occur because of an incomplete scope of work during engineering changes, or inefficient procurement and construction (Construction Industry Institute, 1986). As a result, the management team needs to focus on engineering changes and continually improve the efficiency of procurement and construction. Furthermore, actual project cost data need to be collected to illustrate the project status after the development of the cost plan so management can evaluate the potential for cost overruns and implement an appropriate solution to correct the problem.

Kerzner states that the following are the causes of cost control problem:

- Inefficient estimating methods and/or standards, resulting in unreliable budgets
- Inadequate starting and completion of activities and events
- Poor work breakdown structure
- Lack of effective management policy on reporting and control practices
- Insufficient work definition at the lower levels of the organization
- Management to reduce budgets or bids to be competitive
- Inefficient planning that causes unnoticed, or often uncontrolled, increases in scope of work
- Inadequate comparison of actual and planned costs
- Inadequate comparison of actual and planned costs at the certain level by management

- Unforeseen technical problems
- Overtime or idle time costs resulting from schedule delays
- Unreliable material escalation factors

As indicated in their project manual, “Forecast is a prediction of final project cost/schedule at completion based on demonstrated performance to date and is estimate of work remaining,” the following are recommended by Fluor Daniel (1999):

- Forecast an iterative process,
- Forecast may identify adverse trends,
- Trends modified by corrective action, giving new trend,
- New trend suggests alternative outcome

The potential overruns should begin with corrective management (Fluor Daniel, 1999). Evaluation is a continuous process to identify deviations occurring on the construction site before the overrun problem exceeds expectations (Feigenbaum, 2004).

CHAPTER IV

COST CONTROL PROCEDURES AND COST OVERRUNS IN THAILAND

Like other countries, the construction industry plays a major role in the Thai economy (Tungsanga, 2003). Before the economic crisis in 1997, the construction industry in Thailand was predicted to grow at thirty-four percent (Karasudhi, Tachopiyagoon, &Tang, 1990). However, with the real estate collapse of 1997 construction completely stopped. After the crisis, the construction industry began growing again in tandem with the recovery of the real estate sector (Bank of Thailand, 2002).

During 1982, Thai economic growth rate was to eight to ten percent of Thailand's Gross Domestic Product (Supphasri, 2003). Part of the money invested in the economy came from construction generated by both the public and private sectors. This included buildings, infrastructure, civil and large construction works. These works, which were both local and international projects, were performed under new types of contracts which included joint-ventures and consortiums. The amount of money flowing into the construction industry at that time was a billion Thai baths per year (40 million USD per year).

In the meantime, the major projects included high-rise buildings, condominiums, department stores, hotels and hospitals-- these had a great impact on the local industry. Many international companies participated in these projects as owner representatives, investors, consulting engineers, designers, construction management engineers and contractors. This led to problems in communication between local and international participants and among parties involved in the construction (Supphasri, 2003) and resulted in the necessity for international standards of specification and management. The importance of paperwork and construction management is now emphasized more than in past decades.

After the economic crisis in 1997, construction industry work was reduced significantly due to the impact of the currency devaluation (Bank of Thailand, 1998). Many construction companies were confronted with greater competition from both local and international companies, and of these Thai construction companies quickly learned it was necessary to improve their standards of workmanship, productivity, and management in order to compete with larger companies and international companies, and to develop adequate cost, budget and scheduling controls to satisfy the banks underwriting Thai development. Figures 1 and 2 show buildings in downtown Bangkok.

Figure 1: Bangkok Metropolitan Area.

Figure 2: Bangkok Central Business District.

Construction Management

Many construction projects have problems with the complexity of construction techniques and management as well as limitations of funds and time. The critical problems are inability to complete the projects on schedule, low quality work, and cost overruns (Construction Management Committee, 1999). Construction management is an important element in successful projects (Civil Engineer Committee, 1998); nowadays, many large complex projects cannot succeed without retaining construction management.

Construction management is a new concept for the construction industry in Thailand where its roles and responsibility have not yet been clearly defined. The Civil Engineering Committee, member of the Engineering Institute of Thailand (E.I.T.), established guidelines for the roles and responsibilities of construction management entities in 1998 (Civil Engineer Committee, 1998). Construction management companies are composed of a variety of professionals, such as engineers, architects, and surveyors with different experience. As identified by the E.I.T., the types of services provided by construction management companies include the following (Civil Engineer Committee, 1998):

- Inspection
- Supervision
- Construction Management
- Other services cover quality survey and project management

Project Cost Control

Project control can be performed based on DOD Instruction 7000.2: Performance Measurement for Selected Acquisitions (Construction Management Committee, 1999), which states that:

- Contractors must control work progress with a system that can be inspected.
- The data gathered need to be reliable and verifiable.

Another tool that can be effectively applied for project control is effective data collection to manage construction planning, control, budget, time and resources (Construction Management Committee, 1999). Effective data collection can be developed based on 1) management commitment, 2) good system planning, and 3) well trained and educated personnel. The followings are the advantages of collected data for project cost control:

- Estimating the quality of material, labor and time to be used in the future
- Providing the quantity measurement of work progress and change orders
- Forecasting the remaining work to complete
- Comparing the estimated and actual quantity of material and labor and budget
- Establishing construction and resource plans

In order to achieve the objectives of successful project cost control, the steps for evaluating and controlling the work progress can be categorized as follows:

- Establish Work Breakdown Structure
- Identify the Project Budget
- Work Progress Evaluation
- Analysis of Deviations or Problems
- Implementation

The Construction Management Committee (1999) recommends that construction managers implement a work breakdown structure (WBS) in managing project cost control. The features of an effective work breakdown structure should be as follows:

- It should be capable of collecting various levels of data.

- It should be convenient to collect and use the data.
- It should be adaptable for use with other departments.
- It should be compiled with information technology.
- It should be widely used in the organization.

As indicated in the Engineering Institute of Thailand (E.I.T.) Standard manual for construction management, the objectives of a work breakdown structure are as follows (Construction Management Committee, 1999):

- Identify the scope of work
- Provide guidelines and establish systems for cost estimates and resource management in the future
- Provide the principles of data collection for top management
- Assign responsibility to individual departments

Cost Overruns

A critical problem found in the Thai construction industry is cost overruns resulting from lack of effective cost control, lack of reliable data, ineffective planning, insufficiency of updated data, or ineffective management (Construction Management Committee, 1999). One of the causes of cost overruns is ineffective work breakdown structure which some projects do not use for managing project costs. Effective work breakdown structure and cost control can reduce the problems with cost overruns and will help manage the project budget, cost estimate for bidding, and project cost control.

Cost overruns found in Thai construction projects were due to construction delays resulting from the following (Jearkjirm, Ogunlana, &Promkuntong, 1996):

- Owner's Changer Orders
- Incomplete Drawings Originating from Architects
- Inexperienced Construction Personnel
- Unqualified Laborers

Evaluation of Causes and Impacts of Cost Overruns

To achieve a successful project, the deviations and work progress need to be evaluated periodically to deal with contingencies from inside or outside the project (Construction Management Committee, 1999). Project inspection and control are major factors of successful construction management. The deviations that occurred during the construction course must be analyzed to identify the causes and find solutions.

Problems in the Thai Construction Industry

Thungphanich (1997) mentions the following problems that were found in the Thai construction industry:

Quality of Materials

Low quality materials cause higher construction cost than expected because of the loss of materials during construction. This results from a lack of standards for materials and management systems (Thungphanich, 1997, November).

Construction Management System

Some management procedures are not effective and professional. This problem can cause the costs of some construction projects to be 20 or 30 percent higher than estimated costs. Sriprasert (2000) points out that cost overrun problems are caused by ineffective construction management and poorly established cost control systems. This caused many Thai contractors to fail during the economic recession. The problem was associated with two major factors, which were advancement of cost control framework and lack of participation of construction personnel in cost control.

Besides cost control problems, project mission statements and objectives are not well communicated to construction personnel (Silseweekun, 2003). Renggratham (2004) claims that most Thai construction projects achieve quality objectives, but do not accomplish time and cost objectives. The most critical problems originate from inefficient planning, owner's requirements and less experienced, inefficient project manager, and uncontrolled subcontractors (Rengraktham, 2004).

Quality of Construction Personnel

The construction industry does not have enough professional or qualified personnel to operate construction projects, especially in the labor force (Paithoonwattanakij, 2000). Paithoonwattanakij (2000) states that construction personnel normally prepare construction schedules based on past experience without considering other available alternatives.

Lack of Research and Development

Although the construction industry in Thailand is large and has an impact on the economy, it lacks research and development organizations to improve procedures and standards of materials, personnel and management (Thitipaisan, 1999). Thitipaisan (1999) claims that the fast growing industry suffered discrepancies between human resources and technology as a result of lack of research and development focused on construction industry.

Emsley and Makulsawatudom (2003) state that the following factors have an effect on productivity of the Thai construction industry: (Emsley & Makulsawatudom, 2003)

- Lack of Material.
- Incomplete Drawings.
- Lack of Tools and Equipment.
- Rework.
- Change Order and Tools.

- Equipment Breakdown.

CHAPTER V

DIFFERENCES AND SIMILARITIES BETWEEN PROJECT COST CONTROL PROCEDURES AND COST OVERRUNS IN THE UNITED STATES AND THAILAND'S CONSTRUCTION INDUSTRY

This chapter will explore the differences and similarities between the procedures of project cost control and concepts of cost overruns as applied to the construction industry in the United States and Thailand. The review and comparison are based on the literature completed by American and Thai researchers.

Project Cost Control

It can be said that project cost control is the heart of the construction industry in both the United States and Thailand. Construction companies and other entities involved with construction projects understand the significance of effective cost control procedures.

In order to accomplish effective cost control, the cost control system must provide the correct information at the right time (Halpin, 1985). Construction projects in the United States and Thailand are concerned with the importance of information and its accuracy during the estimating stage. Effective cost control will maximize benefits for Thai construction companies (Sriprasert, 2000).

Since project costs are directly related to project cost control, management must be concerned about some matters regarding project costs (Lewis, 2000). Changes in costs before and during the construction can create difficulties for both clients and contractors.

Lewis (2000) claims that project costs will be increased when the performance level, time and scope of work are increased.

In Thailand, the level of construction costs obtained from an estimate can affect the success in bidding (Supphasri, 2003). Because of economic differences, the cost of some components in Thailand, e.g. labor, has less impact on the entire project cost. The low cost of labor makes Thailand attractive to international investors (Jansen, 1997).

Another factor that can influence the costs in both countries is construction time. By dividing construction into phases construction can start before the completion of design and bid documents. In addition, phased construction allows the owner to complete and occupy the building sooner (Killingsworth, 1988). However, phased construction has some disadvantages— construction costs may be higher and there could be coordination problems among the project participants who are working on separate work packages (Killingsworth, 1988). In Thailand, coordination problems can be found in many construction projects that apply phased construction without well-established management system. Difficulties in communication can prolong the construction period and consequently influence project costs.

Besides the accuracy of costs, the deviations of costs that occur during construction are also a major concern for both construction industries. In order to detect deviations in construction costs, management needs to set up a baseline or base cost for reference purposes. Deviations that occur on the project can be identified by comparing initial costs and actual costs.

Gould (2002) states that the first step in the control process is to establish a baseline for estimating project costs. In construction projects, the estimate serves as the cost baseline and the schedule serves as the time baseline (Gould, 2002). He points out that the last step in the project control consists of the following (Gould, 2002):

- All construction activities that occur during the control period must be recorded for future administrative and historical uses.
- The project status and changes in the schedule or budget must be circulated to all participants to keep them up-to-date.
- All the important information such as forecasted completion date, project cost, project milestone dates, major purchases, and governmental or regulatory reports must be distributed to all project participants.

Problems with project cost control are created in the Thai construction industry by the lack of an effective planning process. In the United States, the procedures for project cost control are well established and widely discussed in many publications. On the other hand, well established procedures are rarely found in typical construction projects. An effective system of cost planning and control implemented during the design phase should encompass the following (Brandon & Ferry, 1984):

- Brief establishment
- Analysis of appropriate solutions

- Cost control of design development

Cost planning and control focus on the planning and monitoring costs during the analysis, planning and design stages. This will be completed when the project receives tenders or contract (Brandon & Ferry, 1984). Wilson (1983) claims that both control and planning correspond to each other and each supports the other.

In Thailand the period of analysis, planning and design stages in many projects depends on many factors such as the requirements of the owner or conditions of the market at the time the project will be developed. Because this period is difficult to control, cost planning and controls are consequently difficult to develop effectively.

The project control procedure can help management identify its current position related to a future position (Wilson, 1983). Brandon and Ferry (1984) claim that the cost control procedures should be conducted continuously until the project is completed and submitted to the client or performed until the post contract phase. They further state that the cost control procedure is different from the design cost planning in that the scope depends on the contract documents (Brandon & Ferry, 1984). Consequently, the contract documents play a major role in the construction, since all participants must follow the contract terms. Thai contractors always use the specifications or clauses indicated in the contract documents as the basis for constructing project. Necessary clauses, such as the cost control procedures, need to be stated in the contract documents to indicate that the cost control procedures must be implemented throughout the course of construction.

Although the cost control procedures are not stated in the contract documents, the Construction Management Committee (1999), the Engineering Institute of Thailand, provides guidelines for construction management companies to perform management services which include cost control. In the United States, there is more emphasis on cost control procedures than in Thailand. However, because of higher competition in the construction business, Thai construction companies tend to improve the effectiveness of cost control procedures for the benefit of clients and the contractors themselves (Construction Management Committee, 1999).

Wilson (1983) states that cost control emphasizes maintaining the project costs as the company plans, while cost reduction focuses on maintaining the project costs at the minimum level by establishing standard improvements that can provide a benchmark for cost control. In order to control the project costs effectively, management should consider both direct and indirect costs (Wilson, 1983). The point is the difference between the management system in Thai construction industry, which may not have company plans as effectively as those used in the United States. Most Thai construction companies look for procedures to maintain project costs at a minimum level. However, these may not be standard procedures—each contractor may have his own standard. In addition, ineffective contract administration in many construction companies is another cause of cost overruns found in the Thai construction industry (Kompayak, 1999).

Wilson (1983) points out that construction costs can be controlled by establishing a well-organized framework. In addition, cost control can be achieved by corporation from all levels of management and all individuals in the organization (Wilson, 1983). In Thailand, a well-organized framework may be found in large construction companies who operate large construction projects and have experience in complex or particular types of projects. Most of these large contractors have established their own standards derived from long-time experience in the construction business. The organization framework is strong and effective and the levels of management are clearly identified.

Framework for Cost Control

Before implementing effective cost control procedures, the framework of cost control should be established. The cost will be developed when acquiring and converting inputs into outputs. Thai contractors rarely establish cost control procedures or attach cost control procedures in their bid documents. This can be a result of incomplete design drawings or specifications because the architects do not have sufficient information to design the project or may not have had enough time to complete the drawings.

Accurate cost control has an advantage in planning and reporting the costs in detailed rather than aggregated measures (Wilson, 1983). Wilson (1983) states that standard costs should be derived from efficient operations which are predetermined and represent the objectives of cost control.

The procedures of cost control used in the United States will be compared with those used in the Thai construction industry. This issue will be discussed in the Chapter Case Study.

Project Cost Estimates

As discussed in the previous chapter, the estimating process used in the Thai construction industry is similar to that used in the United States. The Engineering Institute of Thailand (1999) and other agencies provide guidelines for project estimation for estimators working in the construction industry. The items in the bills of quantities used in Thai construction projects may be different from the CSI format due to the complexity and types of projects. Some government agencies also establish and publish material prices, price indexes, and factors used in the construction industry to be used as the standard for both public and private projects. This can be compared with material prices provided by RS Means in the United States. The Thai government agencies responsible for publishing the price index and estimating factors include:

- The Department of Government Procurement
- The Bureau of the Budget
- The Department of Internal Trade

Apart from government agencies, certain private agencies also provide material prices based on market prices, however, most of them use the prices announced by the Department of Internal Trade as the base prices. Estimates for government projects use the price index and factors from the Department of Internal Trade to prepare the project budget.

Although many agencies provide a price index for use in the construction industry, the measurement systems are not standard. For example, the length of lumber sold in the market is measured by metric units, while the size of cross-sections is measured by English units. However, most people working in construction are familiar with this system. Besides lumber and wood products, other material measurements use metric units, including the units used in construction and shop drawings.

Basically, on construction projects in the United States, skilled laborers and common workers are normally paid by the hour and get paid at the end of the week. In Thailand, laborers receive a daily wage and they are paid at the end of each day.

In some cases, the design of the project can influence the cost estimate, since the project cost cannot be estimated without information from the building design and specifications. Initial design cost estimates are prepared based on schematic drawings and specifications available at the time the estimates are conducted. Assumptions for structural design, finishes, and mechanical or electrical system can provide information for preparing these estimates. However, if the assumptions are inaccurate, or other components are submitted later, these estimates could be unreliable and need to be updated (Killingsworth, 1988). Inaccurate information could be found in many Thai condominium projects constructed while the economy was growing because of incomplete design drawings since the architects did not have sufficient time to design and prepare complete building plan for the owners.

Oberlender and Peurifoy (2002) recommend that the estimate be based on the planned method of construction. He also states that construction techniques should be selected before performing the cost estimate since they have a considerable impact costs. This was not done in Bangkok during the period of high competition because many condominiums were built before the completion of final design drawings.

In Thailand, the use of historical cost data or archives is not used by most construction companies because of the differences in each project and the difficulty in establishing a data base.

In order to estimate the general construction cost, engineers use price lists from manufactures. In the case of unit prices, they use market prices or prices from similar projects as the baseline for estimating (Supphasri, 2003).

The primary objective of estimates in the Thai construction industry is to identify the lowest cost by using effective techniques and accurate data from various bidders (Supphasri, 2003). The best technique for obtaining the lowest cost is to compare the costs from many subcontractors and ask for unit prices from various manufactures (Supphasri, 2003).

Basically, the labor cost has the highest contingency. However, because the labor productivity in Thailand is lower than in some other countries, labor cost is not a critical item for project cost estimates.

Productivity is difficult to estimate due to the impact of many factors. Theoretically, the following factors need to be considered when estimating the productivity of labor (Supphasri, 2003):

- Construction Planning and Construction Duration

- Working Conditions
- Weather
- Readiness of construction team
- Readiness of equipment
- Historical Data from Similar Projects
- Working Hours per Day

The unit price of labor cost in Thailand is based on amount of wages rather than working hours; this differs from the international standard (Supphasri, 2003).

The types of estimates applied in the United States and Thailand's construction industry are identical in several aspects. Estimate types can be categorized based on purpose of estimate, requirements of the project client, and the accuracy of estimates.

Concepts of Cost Overruns

"Cost growth," which is referred to as cost overruns, can be defined as the difference between the original cost and the actual cost when the project is completed (Avots, 1983). Civil and Environmental Engineering (2004) states that cost overruns can be defined as the result of changes in unit prices, labor productivity or the amount of material used in the construction. Although there is no specific definition for cost overrun in the Thai construction industry, most people working in the industry understand the meaning, and realize how important it is. This study will use the definition of cost overruns as applied in the United States construction industry as a guideline for analysis.

Usually, estimates will not indicate that the design has exceeded the project budget. However, it is necessary to identify possible cost overruns, and develop alternatives for design and/or materials that can keep project costs within budget (Killingsworth, 1988).

Overrun budgets are critical for managing construction projects (American Society of Civil Engineers, 1985). On construction projects, overruns occurring in certain cost categories can indicate problems that need to be solved (Civil and Environmental Engineering, 2004).

Basically, construction companies in both countries are encouraged to finish projects on time and within the proposed budget, especially when the contractors are offered an incentive clause or a fixed-price bid from the clients. In such cases, the budget overruns have no impact on the contractors (Ritz, 1994). This strategy can also be found in Thai construction projects.

Besides human failure which can lead to inaccurate estimates, the contract documents can also affect overruns. An effective contract document can avoid disputes and reduce cost overruns resulting from time expansion (O'Leary, 1999).

Cost Overrun Evaluation

Avots (1983) states that cost overruns and schedule delays can happen on many projects, but they are not necessarily related. He also argues that schedule delays do not always increase project costs regardless of overhead costs and interest on construction which are dependent on the construction period. In the Thai construction industry, the reasons for cost overruns could be a result of personnel or the management system. The processes of evaluating cost overruns applied in the United States construction industry are well-established and have been continuously improved during the past decades. Many pieces of research conducted in Thailand show that the evaluation of cost overruns evaluation needs more attention and improvement.

Avots (1983) points out that the impact of schedule delays does not affect cost overruns directly. However, management needs to consider the possibility that project costs may change because of construction delays (Avots, 1983). He mentions that additional costs can be allocated even if the construction is completed on time. There may be problems in achieving the planned production rate so the contractor may allocate more resources to accelerate the construction which can lead to additional man-hours (Avots, 1983).

This study will use the cost overrun evaluation process as applied in the United States construction industry to evaluate and analyze cost overruns in Thai construction projects. This will be discussed in the Chapter Case Study.

Cost Overrun Prevention

The primary way to avoid cost overruns is to ensure that top management makes decisions based on their business expertise. Bent and Humphreys (1996) point out that when the top management is not guided by a strong business ethic, cost overruns and schedule delays can be common and predictable. As seen from Thai research, top management in many construction companies does not often implement effective procedures to prevent cost overruns (Sriprasert, 2000). Lack of ability to prevent cost overruns or to control construction costs causes many Thai construction companies to fail (Sriprasert, 2000).

Killingsworth (1988) claims that overruns can result from omission of some construction items and outdated data bases. In some cases, management needs to consider the possibility of cost overruns in labor and other categories (Civil and Environmental Engineering, 2004). Change orders are another reason for cost overruns because of problems with project claims. In Thailand, construction claims can result in cost overruns. In order to avoid construction claims, owners should select qualified contractors, and all participants should fulfill their responsibilities as indicated in the contract, and that all claim procedures should be clearly stated (Sruntummakul, 2003).

A large contractor like Fluor Daniel responds to cost overrun prevention effectively. Standard procedures are implemented and indicated in the project manual to ensure that all personnel understand how to manage the project successfully. Fluor Daniel (2004) mentions that a principle of cost overruns can be found in field cost, especially indirect field costs. They also state that the estimates for project budgets frequently fail to fully achieve and include all field requirements or current construction trends. Fluor Daniel (2004) suggests the following:

- Assigning construction personnel to the project in the early stage to participate in all project planning, estimating, constructionability and team building.

- Maintaining a reliable and precise historical data base for evaluating the field estimates.

While many large contractors in Thailand establish their own procedures to prevent cost overruns, most medium and small-sized contractors still lack the knowledge to implement efficient procedures to respond to cost overruns. In the United States, better processes to develop realistic budget estimates and quantity bulk material requirements, and better systems to control changes are the components that can contribute to scope control (Construction Industry Institute, 1986).

Cost overrun prevention procedures as recommended by major American construction organizations will be applied to analyze the effectiveness of the cost overrun prevention procedures used in the Thai construction industry.

CHAPTER VI

METHODOLOGY

This research will deal with human behavior and organizational relationships related to understanding cost overruns. A qualitative approach will be employed as the primary research tool for the study (Rothe, 1993; Thomas, 2003). Since my study will cover contextual conditions, a case study method will be applied (Yin, 1994). This approach is further justified when I focus on contemporary events within a real life context not within my control. The case study approach will be used to explore the progress of the work and describe certain interventions that occurred during the actual construction period. In addition, the technique will be employed to examine the interplay of all variables in order to provide as complete an understanding of an event or situation as possible (Yin, 1994).

Through a case study, I will address the research questions and investigate why a cost overrun occurred and how cost control could be applied to reduce the level of cost overruns on Thai projects. The data required for this study include the project's initial costs, the actual costs after completion, monthly reports, project's location, starting and completion date and information about the parties involved in the project.

The cost control procedures and cost overrun theory based on American construction industry and those used in the Thai construction industry will be analyzed to identify their differences and similarities.

This research is a pilot study in this field using a single case study which represents some particular features of a typical project and provides a basis for investigation into the fundamental research question related to the prevalence of cost overruns in the Thai construction industry (Yin, 1994). The case study is based on personal observations of the site where I was part of the original management team.

There are two rationales to apply single case study in this research (Yin, 1994). The first rationale is that the selected case study meets all of conditions to answer the research questions. This case was a successful condominium project with high occupancy rate which was developed before the economic crisis of 1997. It can represent a significant contribution to knowledge. In addition, this single case study will also help to refocus future research in this field. The second rationale is that I had an opportunity to observe and analyze the events prior to begin the research. My observation of the problems of cost overruns occurred in Thai condominium projects formed this significant case study.

Residential construction project developments were the largest portion of the Thai construction industry before and after the economic crisis of 1997. The rate of construction of residential projects has tended to be higher since economic recovery in 2003 (Jaruthat, 2003; Sansiri, 2003). Furthermore, as indicated in the report completed by Chulalongkorn University, condominium buildings are the major construction projects in Bangkok, especially in the downtown area (Jaruthat, 2003). The potential for condominium building development tends to be increasing in 2004 (Sansiri, 2003). Since this research focuses on typical condominium projects in the 1990-97 period of high growth which were not influenced by the economic crisis, a condominium project completed before 1997 has been selected. As a result, the case selection will focus on a completed condominium project in downtown Bangkok which was under construction from 1990 to 1996.

In this research, strategies and techniques will be established to identify cases and established a methodology for analysis (Groat & Wang, 2002). The completed condominium project, which is the unit of the study, illustrates cost overruns occurring with conventional projects. The project case study has data from the beginning to the completion of the contract. The building represents the typical features and management of a regular project without the impact of economic crisis. Typical features of the case include ownership, contract types, management concepts, and scope of work performed by the construction management firm and the contractor. Events occurring from the beginning to the completion of the project will be analyzed and examined to identify the potential causes of project overruns. The steps in conducting the study are data collection, data analysis, and analysis of cost overruns.

The following are the steps for conducting the study:

- Data collection
- Data analysis
- Analysis of cost overrun concepts
- Data Interpretation

In this study, a form of qualitative descriptive will be applied. A case study will focus on an individual or a small participant group and will draw conclusions only about that participant or group and only in that specific context. I will not place emphasis on the discovery of a universal, absolute truth, or seek for cause-effect relationships; instead, I will focus on exploration and description.

I selected a case from the projects I had participated in when I was working for the a construction management company, a construction management company. This will allow me to go deeply into the project detail and obtain information from my observations while working for the project. The case study will focus on a project that was completed before the financial crisis of 1997 to provide regular project management without the impact of an economic crisis. The problems with project cost control and cost overruns on a conventional project being built during a regular period will be examined.

Data Collection

To obtain as complete a picture of the project as possible, I will employ a variety of methods which include protocol analyses, field studies, interviews, and participant-observations (Creswell, 2003; Rothe, 1993). I will collect data about participants using direct observations, interviews, protocols, project pictures, examination of records, archives, and collections of writing samples. Since I had participated in the construction, I will be able to reconstruct the behaviors of other participants and certain events that occurred on the site (Groat & Wang, 2002).

Much of the data for the case study will be gathered and categorized to identify the possible causes of cost overruns. The data will be categorized into two types; observer's notes and subjects' documents (Creswell, 2003). First, the observer's notes will be derived from site observations from my personal diaries. All events occurring during the construction were recorded to identify any circumstances that could have influenced project cost control management. The type of data focuses on some contingencies which happened unexpectedly and the failure of people working on the project.

The next type of data is the subjects' documents, e.g., documents required by law or by constructing contracts, including meeting logs, monthly reports, construction schedules, project payment and records detailing events which occurred during the course of construction. The data needed will be categorized based on the characteristics and requirements indicated in the construction contract documents and will be analyzed and examined chronologically. This will help identify the sequences of events that occurred in the head office and on the construction site from the beginning to the completion of the project and can illustrate the relationships between internal factors and external factors that may have had an impact on project cost control. The internal factors refer to all factors caused by all parties involved with the project including change orders requested by owner, designer and clients. Internal factors may or may not be controlled. External factors refer to all other factors resulting from outside sources or natural phenomena which may not be controlled or anticipated.

In conducting the qualitative research, a coding system is useful for recording data from observations (Creswell, 2003). The activities that illustrate the changes or particular events will be recorded by a coding system based on the coding system used for estimating, so that both systems can be cross referenced. The level of detail applied to the coding system will be the same as the levels or subcategories illustrated in CSI Standard Format or other format used by the contractor (Civil Engineer Committee, 2002). This coding system will illustrate the types of activities and the time when the activities occurred. The relationship between the activities and time will indicate the deviations that occurred with some specific activities that may happen repeatedly at the same period during the year. The coding system used to record the activities will include the construction parties who were responsible for or involved with the activities. The amount of money may be included in the coding system, since it can identify funds allocated to those activities during a specific period. The relationship between the money paid and the deviations resulting from some activities at a specific time can indicate cost overruns (Halpin, 1985). In conclusion, this coding system could be composed of three or four components, which are types and levels of activities, time, the construction parties related to the deviations and amount of money.

The data for the case study project were collected from July 1994 to August 1995. These data consist of construction schedule, bills of quantities, monthly report, pictures taken during construction, and other documents regarding construction management services. The data from observations do not cover the first few months of the project. Most of the data will be obtained from the construction management company for the project. In order to update the information about the project, some project participants will be interviewed. Besides the updated information, this interview will provide different perspectives regarding project cost control procedures. The data that can affect the project cost overruns will be collected. These data include the changes in the inflation rate while the project was being constructed, since this can affect construction costs (Neil, 1982). Although the project was completed some years ago, it represents the effect of inflation on the construction of a current condominium project because inflation plays a significant role in project cost estimates.

Data Analysis

Practically, subjects' documents will be categorized based on their data types and time period (Flick, 1998). The time periods in this study refer to the time construction activities were performed. The analysis of all notes and documents will be based on construction phase.

The case analysis was based on construction periods so that all events or activities can be tracked and compared. By using the same standard, the comparison will be performed effectively.

An advantage of analysis based on time periods is that the sequence of construction activities can be examined and compared with other phenomena that may affect the performance of those activities during particular periods. This allows the study to identify the influences of environment, people involved with the project and natural phenomena.

Coding the Events and Activities

As mentioned in Data Collection, the events and activities which occurred in the case study project during the construction will be coded as different types of events and activities. For example, construction activities will be recorded based on the standard CSI system. The codes for the study will use the CSI system as a guideline for establishing the activity codes (Supphasri, 2003). The activities that involve concrete work will begin with number 3 to illustrate type of activities. In a series of an activity code, other numbers will indicate the time that the activity occurs. In addition, these codes will also reflect the relationship between the activities and accounting codes, because the codes will also relate to the accounting system. This will show the relationship between activities with problems and the cost overruns resulting from those activities.

Analysis of Cost Overruns Concepts

After analyzing the collected data, the next step is the analysis of cost overrun obtained from the data collected and analyzed from the second step. The analysis will be conducted by using criteria obtained from the literature review and the data analysis step. The similarities and differences between the cost overrun concepts applied by the construction industries in the United States and Thailand will be explored and used as a guideline to examine possible causes of cost overruns occurring in the case study project. The results of the analysis will generalize how the cost overrun concept applied in the United States can or cannot be applied to reduce the cost overrun problem in the construction industry in Thailand.

To explore the project cost control procedure applied in the case and the causes and problems with cost overruns, observations from project start to completion will be analyzed by focusing on the following documents; bills of quantities, monthly and weekly reports, project archives, personal diaries, change orders, cost codes and cost accounting system, sources of project cost data, and pictures of the project (Rothe, 1993).

Bills of Quantities

Bills of quantities will provide the cost estimates and actual costs incurred after building activities were completed. The study will examine the comparison of estimated and actual costs to explore the deviations occurring during the construction. These comparisons can identify what caused the deviations and tell when the deviations occurred. The time that deviations occurred may be affected by natural phenomena or other factors that could happen during specific times of the year such as long vacations or an annual festival. The bills of quantities will focus on the changed amount of materials and equipment used in the project and the money allocated to individual items and activities. The bill of quantity for additional work will also be analyzed.

Monthly and Weekly Report

Monthly reports that were prepared by the construction management company and submitted to the owner every week will be analyzed chronologically to review deviations. These reports are legitimate and reliable documents because they are required by the contract. They illustrate all events happening on the jobsite and include all change orders. These documents indicate work progress which can be compared with the bills of quantities.

Project Archives

This document provides all information about the project. Some events recorded in this archive may also appear in the weekly reports. It identifies the start and completion dates as indicated in the contract. Other information can be found in this archive such as the names of all entities involved in the project. Other documents that can be found in this archive are the contract document, construction schedule and meeting minutes.

Personal Diaries

This personal diary will provide information about the events occurring on the jobsite. I wrote the dairy every day while I was working for the construction management company. Part of the dairy discusses what happened in the head office which may relate to the events on the job site. The diaries cover events from 1994 through 1995 and are based on my observations of the people in the head office and on the job site plus some personal opinions or comments.

Change Orders

As mentioned previously, change orders are one cause of cost overruns. As a result, I will analyze the change orders as seen in the project archive or weekly reports to explore their impact on the project schedule which may consequently affect project cost control. I will examine the causes and results of change orders in this case which can lead to cost overruns. Solutions for change orders implemented in the project will also be studied.

Change orders resulting from revising the building specifications in response to client requirements are the primary cause of cost deviation. Changes of some units in the buildings are not typical because they may require particular materials or time-consuming installation methods for unique material.

Cost Codes or Cost Accounting Systems

The cost codes or a cost accounting system is another tool that can help the construction manager effectively control the project cost. In this case, the cost codes or a similar system used by the contractor or construction management company will be examined to identify their effectiveness in controlling project costs.

Sources of Project Cost Data

The sources of project cost data from both the contractor and construction management can illustrate the reliability of cost data used by the estimators. The reliability of cost data will be examined to explore its impact on project estimation. Outdated data may lead to project cost overruns or influence project cost control because of failures in cost estimating.

I will explore the sources of cost data used in this project and evaluate the reliability of those sources, which include the historical data, market prices, and the price from manufacturers' product catalogs. The baseline used in the study to identify the reliability of data can be obtained from government or public agencies responsible for managing material prices.

Pictures of the Project

All pictures were taken throughout the project as required by the contract between the owner and construction management company. The pictures were part of the monthly reports and incorporated with the request for monthly payments. All pictures are legitimate and can be used in court if there is conflict between the owner and other parties.

The pictures can identify the conditions of the buildings under construction. The pictures also show weather conditions which can help verify the impact of weather on the construction and cause delays which could consequently lead to cost overruns.

Most of project pictures were taken by the technicians working for the construction management. Most of them are the property of the construction management company. These pictures are part of weekly and monthly reports as required by the contract documents to be submitted with request for payment progress of construction. In addition, the pictures were required when there were conflicts or claims between construction parties.

In this study, the pictures cover the entire sequence of the construction of Tower G from substructure to superstructure. These identify the physical problems that occurred on the construction site, including the impact of the weather on the construction process. They also show the specific locations of the building that had problems during construction.

Since the pictures were taken chronologically as part of the weekly reports, the sequences of construction can be analyzed to identify the unusual events that occurred on the construction site. These pictures are significant evidence that can be checked with the reports submitted for progress payment since the amount of work completed can be seen in these pictures.

Additional work claimed by the general contractor for extra time or money can be verified by pictures. For example, the claim for a temporary dam that was built to protect the site from flooding would be included in the monthly project payment.

Pictures also identify changes in design related to the physical condition of the building. As indicated in a meeting log, the general contractor proposed to change the building color due to the unavailability of the color specified in the drawings. The pictures allowed the construction management company to specify new color schemes similar to other buildings. This change order could cause a delay for several weeks. Delays on other buildings in the project affected the construction of Tower G, since the general contractor used the same group of workers on several projects.

Comparison Models

The models of project cost control, cost estimate and cost overrun evaluation used in the American construction industry (Ahuja, 1976; Halpin, 1985) will be used as guidelines to analyze and compare the similarities and differences in project cost control procedures and cost overrun concepts applied in the Thai construction industry.

Data Interpretation

After all gathered data are analyzed, the next step is to interpret the findings. It will begin with identifying the differences and similarities between the cost overrun concepts and cost control procedures used in the United States and Thailand. This will provide the basic theories that will be used as the guideline to establish the criteria for observing and analyzing the events related to the case study project. The results of data analysis will be explained based on the etho-methodology which emphasizes the knowledge, procedures, circumstances, reasoning and considerations that ordinary people can understand (Thomas, 2003). In this theory, the relationship between behavior of participants and their responsibilities on the project will be interpreted to illustrate which factors result in ineffectiveness of project management and poor cost control.

After all data are analyzed and the results are concluded, the recommendations will be made. Triangulation method is applied to make recommendations. This method can provide tentative recommendations proposed to improve cost overruns in Thai condominium projects. The recommendations will be obtained from the combination of theory and principles from previous research and the results from case study analysis. By using this method, I can overcome the weakness and problems that come from single case study (Hilton, 2004).

CHAPTER VII

CASE STUDY

Condominium projects occupied a significant part of the Thai construction industry during the period of economic growth with many condominium projects developed in the Bangkok Metropolitan Area. The case I selected is a low-rise condominium project located in downtown Bangkok. Construction of the entire project began in January 1994 and was completed in November 1996. It consisted of nine eight-story residential buildings and an eight-story parking garage. The project has a total of 188 condominium units; however, this study focuses on one building with 64 units.

This project is similar to typical condominium projects in Bangkok in that there are three major parties involved in the construction; the owner, the designer and the contractor. It used a lump sum contract. However, it should be noted that the scope of work for each party on this project is different from other condominium projects. These differences will be discussed in the Scope of Work later in this chapter.

Project Participants

In the case study, many parties played a crucial role throughout the course of construction. The Sales Department, representing the owner, stepped into the construction and played a significant role after the main construction work had been completed.

The Owner

The owner of this project was a development company that invested in many residential projects. Most of the projects handled by this company were condominium projects -- low-rise and high-rise buildings located in downtown Bangkok. This development company had developed three condominium projects when the case study was under construction. The first condominium project developed by the company was a successful low-rise condominium with a low vacancy rate. The case study was the fourth project investment by this company. Two other condominium projects developed after this project were larger in terms of leasable areas and construction budget.

In this case study, the owner played a critical role during the construction with a different perspective toward project completion. His strategies were to reduce the project budget and allow for certain changes during the construction.

In order to cut some of the project expenses, the owner hired the architect and engineer to provide only the primary design and prepare only the sufficient architectural and structural drawings to receive the building permit. As a result, the details of drawings and specification were sufficient to file for the building permit, but not sufficient for construction. The drawings lacked data necessary for construction including the proper data for the general contractor to prepare for the project estimate.

According to his strategy for future modification, the owner did not clearly specify the details of certain materials used in the project. Since competition for the condominium was very high, many specifications were prepared for future changes to attract more purchasers.

As a result of this strategy, many design changes were anticipated to capture the trend of the condominium market and respond to a variety of purchasers.

The design changes created problems with construction delays and cost overruns. Since the perspective of the owner was different from other project participants, certain procedures for project control could not be implemented. Although many effective procedures were discussed in the meeting, those procedures were never applied to control the construction schedule or cost.

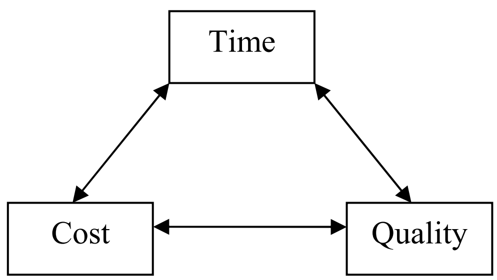

Figure 3: Project Component.

The owner knew that the impact of the design changes would lead to construction delays and higher construction costs. He considered three major components in the project which were time, cost and quality, see Figure 3. When the costs were higher, he decreased the quality of materials to offset the higher costs resulting from design changes. In order to control the time, he reduced certain parts of the project such as parts of the parking garage, and project facilities. This helped him to control the time, although this was not completely successful.

The construction was behind schedule for months and some purchasers complained about delays in occupying their units. He solved this problem by offering some incentives to the purchasers and negotiating with the general contractor to accelerate the completion of the project.

The General Contractor

The general contractor for this project was an affiliate of the development company which was developed primarily to construct the projects for this development company. The case study was the third project built by this general contractor. Most personnel working for the company had three to ten years experience and the project manager had ten years experience in construction.

The general contractor was responsible for the structural and architectural work and prepared the site for landscaping but hired subcontractors to perform electrical and mechanical work. The HVAC system and finishes were also performed by other subcontractors. The furniture for the residential units was ordered directly from the furniture manufacturer who was responsible for its installation.

The Construction Management Company

Construction management responsible for this project was a construction management company, an affiliate of a famous architectural firm in Thailand. This architectural firm was established more than 20 years ago, while the construction management company had been established for almost three years by the time the case study was being constructed. Most personnel working for the company had five to fifteen years experience in design and construction, since they had worked for the architectural firm before.

The construction management company provided a variety of services to the owner. It was authorized by the owner to prepare design drawings and construction drawings in response to the modifications required by the owner and purchasers.

The construction management company conducted all meetings in the site office and at the developer's head office. As indicated in the contracts, the construction management company assigned a technician to supervise the construction every day and sometimes during the weekend.

The Electrical Subcontractor

The electrical subcontractor had more than five years experience in construction. Most personnel had been in the construction business for almost ten years.

The Mechanical Subcontractor

The mechanical subcontractor had almost ten years experience in mechanical work. Most personnel working for this project had more than five years experience.

The Sanitary Subcontractor

The sanitary subcontractor had been in the business for almost ten years. Most personnel had more than five years experience in construction, especially sanitary work.

The Sales Department

The Sales Department was under the owner's authorization. Most policies regarding the project sale needed to be approved by the owner. However, the owner allowed the sale representatives to perform the market strategies based on their own expertise.

The sale representatives were responsible for increasing sales and serving project purchasers, and in many cases, they acted as middlemen to coordinate between the project purchasers and the construction parties. Sales representatives would pass all requests from the purchasers to the head of the Sales Department, and he would discuss these requests in the monthly meeting with the owner and the construction parties which were composed of the general contractor and construction management company.

Most of sales representatives had experience in project selling. They knew how to negotiate and convince the purchasers to buy the units. Their profit depended on the amount of units sold; as a result, they had tried to sell as many units as they could to receive higher commission. The sale of so many units caused many modifications which interrupted the work schedule prepared by the general contractor and construction management company. The turnover of sales representatives in the project was high, thus when a sales representative resigned from the company, other representatives did not have sufficient information regarding the purchasers serviced by the resigned representatives. This created many difficulties for the construction parties in tracking the changes in units sold by those sale representatives.

Project Characteristics

Location

This project is located in a commercial area close to downtown Bangkok, Thailand along a small canal that runs through a community. The site can be accessed from a street connected to a business road which is an important business thoroughfare in Bangkok which connects many of the business districts in downtown Bangkok.

The accessibility to the construction site was difficult because the street was not wide enough for large vehicles to run side by side. A large truck needed to wait until another large truck passed before it proceed so additional personnel was needed to control the traffic around the site during the construction.

Building Characteristic

The residential buildings were labeled A, B, C, D, E, F, G, H, and I. All condominium buildings were located over a large underground parking garage. There were three types of buildings. Type one, with four condominium units on each floor, included Buildings A, B, C, D, E, and F. These are stand-alone buildings and with identical floor plans. Type two included Buildings G and H--twin towers that combine two typical buildings of Type one. Building I, which is a combination of three Type one buildings, belongs to Type Three. Each Type one building has 32 units, whereas each Type two has 48 units. Type three has 64 units.

All nine condominium buildings are located on the same concrete deck above an underground parking garage. The roof garden and swimming pool were constructed on this deck to serve all residents in the condominiums. The parking building is located in another area of the project near the main entrance.

All buildings are of reinforced concrete structure built on concrete foundations sitting on concrete piles. They are concrete structures with column and beam system. All of the exterior and interior walls between units are of brick masonry on the beams and each wall with a span of more than 2.50 meters (approximately 8 feet) will be supported with additional small columns. All floors are concrete slab with reinforced steel rebar.

Towers A, B, C, D, E, and F have one elevator in the building. Tower G and H have two elevators in each building. Tower I has four elevators in the building. The parking garage in the basement can be accessed from all towers by stairs and elevators. All buildings have doors on the deck level that connect to the main lobby, the swimming pool and roof garden on the deck level. All doors on the parking garage are secured by an electric system. Occupants have their own security cards issued by the Condominium Owner Association to access the entrance on the basement area. These security cards were issued to all occupants after they purchased the units.

This study will focus on Tower G whose floor plan was modified to allow the combination of two typical buildings to be functional (see Figure 19, Appendix C). Basically, the floor plans are similar to the typical floor plans found in other buildings. The difference is the location of elevators which needed to be moved to conform to the building footprint and floor plans. The original area for the elevator was changed to an atrium for the purpose of ventilation.

Residential Units

Each floor of Tower G has eight units which can be divided into 4 types, Unit A, B, C, and D, see Figure 20, Appendix C. The typical unit has two bedrooms, one living room, one dining area, one kitchen and one bathroom. Each unit has its own balcony that can be accessed from the living room or master bedroom. The standard finishes for typical units are carpeted floor and 8”x8” floor tile in the kitchen. The walls are decorated with wallpaper or are painted in specified colors. The kitchen has ready-made furniture. Purchasers could select the color and finishes of the kitchen furniture. Furniture in other rooms was optional and purchasers could change colors or styles to match the wallpaper or color of the walls.

Besides the color and style of room finishes and furniture, the purchasers could change the type and capacity of air conditioning units to be compatible with the number of residents in the units. However, they had to follow the policy of the Sales Department and pay an additional cost for installation if it was higher than that of standard conditioning units.

Building Construction

Because there are many buildings on the same concrete deck above the underground parking garage, the general contractor separated the deck into many parts based on the phases of construction which were in accordance with the condominium buildings. Appendix L shows pictures of the project under construction.

The first phase consisted of Towers A, B, C, and the deck to support these three towers. The second phase was composed of Towers D, E, F, and the deck supporting these three towers. The third phase was Tower G and the deck supporting it and the parking building. The next phase was the construction of Towers H, I, and the supporting deck.

After all four phases were completed the deck would be connected as a large concrete slab covering the underground parking garage. While the deck was being built in separated pieces, the swimming pool and roof garden were built on the deck, followed by all mechanical systems used for the garden and the swimming pool. Because of the structure of swimming pool, it was constructed after the other parts of the deck were completed.

Limitations of Site Location and Conditions

Because the construction site is located in a community which can be accessed by one road, the traffic is congested during peak hours in the morning and evening on working days. In addition, this road is too narrow for large trucks coming in and out. This road, which ends at the site, goes through the nearby community and links the main road and the site together.

Traffic management around the construction site was necessary to provide efficient access, because many people live in the community. The traffic on the weekend was less dense than during the week. The construction crew usually worked on Saturday. When there was some activity such as concrete pouring that needed to be performed continually, the construction site was open on Sunday. In addition, some activities such as the delivery of steel or cement needed to be performed during weekends to avoid heavy traffic around the site.

Another critical problem was flooding during the rainy season. This problem was more critical because the site is on the bank of a canal which is prone to flooding during heavy rain. The general contractor built a temporary dam around the construction site to protect against flooding and installed water pumps to pump the water from the site. As a result, the water level in the construction site was lower than that in the community. This was a problem for people living there during the construction.

Weather Conditions

Weather conditions are another factor that can affect the construction work. As can be seen in the daily report, the weather was recorded every day. Heavy rain can affect outside activities such as pouring concrete or rebar, or other activities that need electrical power. Welders cannot work in heavy rain because of the danger of electrical shock.

In this case, heavy rain had an impact on site preparation and excavation. Workers' productivity was lower when they worked on the soft soil and some heavy equipment was difficult to use in this environment. In case the general contractor needed to pour concrete in the rain, some preparation was needed which could cause delays and increase construction costs.

The costs of implementing protective measures during the rainy season could increase overall project costs. More shifts of workers were needed during the weekend to avoid the coming rains.

The heavy rain also created moisture which created problems with material storage, especially steel, cement and wood. However, after the first two phases were completed, there was covered storage area for these materials. These buildings also provided space for a site office under the superstructure.

The high temperature during the summer season could decrease the productivity of workers since they were likely to be exhausted. Dehydration also affected the construction activities such as concrete curing.

As can be seen in the daily reports, the weather caused lower productivity and even stopped of some activities. These delays could result in the delay of succeeding activities which may cause excusable delays. For example, the heavy rain created moisture that caused the loss of some material if it was not protected properly. It was the responsibility of the general contractor to store all materials appropriately.

Project Archives

This part will discuss the components mentioned in the project archives. In this case, the project archives provide the primary data of the construction project to be compared with data updated after the construction began. These documents also indicate the roles and responsibilities of all parties in the project. The contract documents, the scope of work and construction schedule are included in the project archives. However, since these two topics are important, they are discussed and analyzed separately from other topics in the project archives.

Certain changes in the contract documents can be found affected construction delays and project costs. Additions to the contract document can indicate that certain extra work needed to be performed by new parties. This consequently identified changes in the scope of work which became larger than the initial construction phases.

These archives indicated that the owner was looking for a landscape design firm and a subcontractor to perform landscaping work, therefore it could be assumed that the scope of landscaping work was not included in the primary construction contract or the requirement for landscaping work did not exist at the beginning of the project.

Incomplete Design Drawings

The architectural drawings provided by the architectural firm were prepared for the purpose of filing for a building permit from the Department of Civil Work, the City of Bangkok, and lacked some detailed drawings. Some information was not sufficient for construction. Because of incomplete design drawings, the construction management had to prepare certain design and shop drawings for the owner and the general contractor. As a result, incomplete drawings caused construction delays because the general contractor had to wait for approval of specifications that were not specified before construction.

In some case, the incomplete design drawings created problems with specifications for the floor and wall finishings. The finishing of common areas is not a critical problem because it does not occupy a large building area. The significant problem is the finishings in individual units in the building.

Construction Contract

The project used a lump sum contract which is widely used in Thailand's construction industry. However, the procedure to award the contract to the general contractor is different from other projects. Because the general contractor is an affiliate of the developer, it was awarded the without the bidding process. The construction costs of the project were negotiated to meet the budget. In this case study, the general contractor was responsible for preparing and awarding contracts to subcontractors and reporting to the owner.

The construction management company stepped into the project after the owner awarded the contract to the general contractor. As a result, the construction management company was not involved with the bidding process, but served as a project supervisor providing advice to the owner and monitoring the construction. All of the changes had to be approved by the owner. Figure 24, Appendix D, shows the diagram of contracts used in this project.

The following are the contracts found in the project:

- Contracts between the owner and the architect
- Contracts between the owner and engineer

- Contracts between the owner and the general contractor
- Contracts between the owner and construction management
- Contracts between the owner and part-time engineer
- Contracts between the owner and clients
- Contracts between the general contractor and subcontractors
- Contracts between the purchasers and subcontractors

Scope of Work

This section will discuss the scope of work and responsibilities of the parties involved with the construction (see Figure 23, Appendix D). The owner hired an architectural firm to design all the buildings in the project. However, the scope of work performed by the architectural firm covered only the schematic design. All changes regarding the building design were the responsibility of the construction management company. The preparation of construction drawings was the responsibility of the primary contractor. Subcategory work would be performed by other companies. For examples, a landscape design company was responsible for designing the landscaping.

The responsibility of the architect ended when the primary design drawings were completed. Any design changes after that were the responsibility of the construction management company. As a result, some changes had to be made after the construction started due to incomplete design drawings.

Basically, the contractor completed only the structural and architectural work. The installation of furniture and decorative materials by general contractor was optional. As indicated in the contract between the project owner and purchasers, all purchasers could select subcontractors themselves or hire the general contractor to perform additional work as they preferred. The general contractor prepared certain standard conditions as specified in the drawings and contract document; however, the additional requirement would be based on an agreement between the project owner and individual purchasers.

As mentioned previously, the general contractor would do structural and architectural work, while the main and rough mechanical work would be performed by subcontractors under the control of the general contractor. The sequence of work for the general contractor began from site excavation to building construction including the common areas such as main lobby and staircases. The interior work in the individual units was performed based on the requirements of individual purchasers, as mentioned before. Basically, the subcontractors installed only a rough plumbing system, HVAC system and circuit breaker in each unit. The schedules were complicated by many sets of contract documents.

As indicated in the contract documents, some of the tasks for general contractor included:

- Constructing the structure of the entire building and all architectural work as specified in the architectural drawings.

- Preparing shop drawings for the owners, the construction management company and other parties.

- Monitoring all of the work performed by the subcontractors.

- Cooperating with the architects, engineers and the construction management company.

- Installing a security system by coordinating with the electrical subcontractor.

- Providing security cards for construction personnel during the construction period and for the condominium management personnel who would provide these cards to the purchasers.

The responsibilities of the construction management company as indicated in the contract document included:

- Monitoring the work performed by the general contractor and other subcontractors.

- Preparing architectural drawings and specifications for the general contractor and subcontractors.

- Coordinating all parties involved with the construction.

- Assisting the owner to make decisions regarding construction techniques and materials.

The responsibilities of mechanical subcontractor were as follows:

- Preparing mechanical shop drawings.

- Cooperating with the general contractor and other subcontractors.
- Constructing and installing mechanical and related systems.
- Preparing the necessary mechanical systems for the swimming pool such as water pump and treatment system.
- Coordinating with mechanical suppliers such as the elevator manufacturer and swimming pool equipment suppliers.

The responsibilities of electrical subcontractor were as follows:

- Preparing electrical shop drawings.
- Cooperating with the general contractor and other subcontractors.
- Constructing and installing electrical and related systems such as communications, telephones, and television systems.
- Coordinating with suppliers of electrical instruments such as electrical generators as well as the electricity provider.

The responsibilities of the sanitary subcontractor included:

- Preparing sanitary shop drawings for the clean and waste water supply system.
- Cooperating with the general contractor and other subcontractors.

- Constructing and installing sanitary and related systems such as sanitary ware, and fixtures.

- Coordinating with electrical suppliers when electrical equipment is needed to be installed such as boilers in bathrooms.

- Preparing equipment and systems for fire protection.

Construction Schedule

The complexity of contracts caused difficulties in managing the construction and affected the work schedule. The analysis of the construction schedule will focus on the work schedule performed by the general contractor and the subcontractors controlled by the general contractor as indicated in the main contract between the owner and general contractor. Practically, the construction management company monitored construction schedules. The analysis does not include the contracts between the individual purchasers and subcontractors, because they were not included in the scope of main construction.

In this project, four types of construction schedules were submitted to the construction management company (see Appendix E). These four types were:

- Schedules for Structural Work (eight updates, see Figures 25-32, Appendix E).

- Schedules for Architectural Work (eight updates, see Figures 33-40, Appendix E).

- Schedules for Electrical Work (one update, see Figure 41, Appendix E).

- Schedules for Sanitary Work (one update, see Figure 42, Appendix E).

The general contractor was responsible for scheduling structural and architectural work, while sanitary and electrical subcontractors were responsible for their work. All schedules were presented in Bar Chart format which illustrated the major construction activities. During the construction of Tower G, the general contractor submitted eight updated structural and architectural schedules. The sanitary and electrical subcontractors submitted one updated schedule for their work.

Structural Work

The construction of Tower G began in late July 1994 (see Appendix E), but the construction schedule indicates a beginning date of August 1994. The sequence of work prepared by the general contractor began with mobilizing all personnel and equipment into a temporary storage area after the completion of site preparation. The construction process was typical for condominium projects. The substructural work started first, then superstructure and architectural work. Mechanical and sanitary systems would be installed after some part of structure was completed. The last activity, which is not shown in the schedule, was installation of furniture which had to wait until the purchasers identified their choices of decorative materials and furniture. The structural work was most critical because it took the longest time to complete and needed to be finished prior to the architectural work.

In this case, the general contractor performed the structural work from basement to the roof while they assigned subcontractors to work on piling and footing construction. All of equipment required for piling and footing construction was mobilized to the construction site after the general contractor finished site excavation and prepared the areas for the subcontractors. The sequences of work were monitored by the construction management company.

If the structural work was delayed, other tasks could not be performed since the structure is the main component of the building. Without this component, the other materials or equipment could not be installed and difficulties arise in rescheduling.

Basically, the structural work began with site preparation and excavation and proceeded from ground level to the upper levels. In this case, with one basement level, the site preparation would be performed to prepare the area for ground work. Next, basement construction would begin immediately after the foundations were completed. While the structural work was performed, the contractor prepared for other work such as mechanical rough-in and electrical rough-in which needed to be closely coordinated with the structural work. The sequence of construction of each was repetitive until the roof deck which needed some specific treatment to prevent the building from leaking. After the structural work was completed, the subcontractors would install the large mechanical equipment such as the elevators and support systems.

Because Tower G was a combination of two typical buildings, the contractor divided the building construction into two parts; G1 and G2. Each floor was separated into two parts. The sequence of construction began from one part of each floor and then went to the upper floors.

After the completion of two parts on each floor, the next level was constructed. The general contractor and subcontractor had limited equipment and workforce because some of the equipment and workforce were allocated to the construction of other buildings in the same project. The rotation of workforce and equipment needed to be coordinated. All parties used the gridlines of columns as a reference when they mentioned specific locations in the building. The gridlines were also referred to in the reports to relate the sequence of work.

Piling Work

Similar to other buildings in the project, the construction of Tower G began with site preparation for piling work. The work began on the first section, G1 (see Figure 19, Appendix C) and took many weeks to complete. During the site excavation and piling work, the weather conditions were a major concern for all parties, because heavy rains could delay the process because of difficulties in excavating saturated soil. In wet condition, large construction vehicles and machine, such as excavators, backhoes and trucks were difficult to control and operate. The general contractor had to have water pumps on hand in case of rain. During piling work, the soft soil caused a problem with the stabilization of the crane used for driving piles so the crane had to be fixed and stabilized to avoid miss-positioning of piles. However, as can be seen in the weekly reports, at least two broken piles were found during the construction of Tower G. This was solved by driving extra piles to replace the broken piles immediately after the foreman found the broken piles without waiting for approval from the general contractor. After the piles were in positions, the top of each pile was leveled for footing work. The process of piling began on the first section, G1, and then the second section, G2, of the building as the general contractor had arranged. After G1 was completed, all equipment and vehicles were moved to the G2 section to begin the same process. Work progress can be seen in weekly reports from July to September 1994.

Footing and Foundation Work

When the piles were leveled on the first section, the formwork and rebar for footing were placed. The process began at the first section following the completion of site excavation and piling work, similar to the sequence of site excavation and piling work. However, the construction of footing of the first section began before the completion of the piling work on the second section. The overlap of work on both sections helped the general contractor to perform effectively with limited equipment and labor. The concrete work for footings began in August 1994. The subcontractor had to build a temporary cover for all footings to avoid the water coming from heavy rain. The poor weather caused low productivity of concrete work although some temporary cover was built. The operation of the tower crane was limited during heavy rain and some work had to stop completely while it was raining. After pouring the footings, they had to be protected from the rain with plastic sheets. However, most of the rain occurred in the evening so the subcontractor could accelerate the work in the morning and afternoon.

Basement

Once the concrete in the footings was cured, the formwork and rebar for the basement slab and retaining wall were placed. The work on retaining walls was prepared first to create a barrier to prevent the soil from coming into the construction area since the basement was located about 10 feet below ground level. Because Tower G was part of the project, which is close to the boundary line, the retaining wall was located only to the west of the building and occupied part of the whole retaining wall around the basement. The retaining wall under Tower G was part of the overall retaining wall and was connected to the retaining walls under nearby buildings, Towers F and H.

Because the area of the basement slab was large, it was divided into many parts for concrete pouring in order to control the quality of concrete. The concrete for the basement slab was placed part by part as arranged by the general contractor based on the gridlines of the columns as mentioned previously. The placement of concrete began on the first section after the formwork and rebar were placed. The sequence of work was performed similar to previous work.

The basement slab needed to be constructed very effectively in order to protect the underground water so all water-proof membranes had to be in place before the concrete was poured. Water resistance was the primary concern for the project because it was located near a canal and was subject to impact from underground water.

Superstructure

After the basement was constructed, the superstructure construction was begun in November 1994. Figure 20, Appendix C, shows the schematic drawings of Tower G. Figure 21, Appendix C, shows a partial elevation of Tower G. The process began with placing formwork and rebar for the columns on the basement to support the first floor structure. After finishing the columns, the contractor next placed formwork and rebar for the beams supporting the first floor concrete slab. The sequence of work of construction was repeated from the first floor to the roof deck.

Architectural Work

As can be seen in the construction schedules for architectural work, there were no significant delays at the beginning of construction. At that time, most construction parties focused on the structural work since it was critical. As a result, the delays that occurred with the architectural work can be found in the weekly meeting minutes. Several delays in the architectural work were discussed in the meetings after some units were sold. This resulted from the unit modifications submitted by the Sales Department and design changes proposed by the owner.

Sanitary and Electrical Works

Since there is only one updated schedule for each phase of work, the deviations in activities or delays cannot be seen. As recorded in the weekly and monthly reports, the delays associated with the sanitary and electrical work resulted when the unit modifications were performed.

Project Meeting

This part discusses the meetings that were held during the construction. There were two types of meetings in this project; one held in the construction field office and the one held in the owner's head office. The construction management prepared the reports of all meetings for the owner and other parties involved in the project. Appendix F provides the meeting details and participants.

Meeting Types

Daily meetings and weekly meetings were held on the construction site. Figure 43, Appendix F, shows the types of meeting. The daily meeting was run by the general contractor. The general contractor and subcontractors attended this meeting to summarize their work at the end of every working day. This study will not discuss this meeting in detail. The weekly meetings were prepared by the general contractor and the construction management company and were held in the general contractor's field office. The meeting could be divided into three major parts: first, the summary from the previous meeting, second, discussion of the current construction progress; last, topics to be discussed at the next meeting. All of the work assigned to the parties in that meeting can be seen in the last part. The first and second parts of the meeting were recorded in the meeting log and illustrate the work progress and any unexpected events that occurred during the week.

The meeting held in the owner's head office included the owner, the general contractor and the construction management company. This meeting was conducted once a month to report all work progress and changes during the construction to the owner. In some cases, the Sales Department attended these meetings to propose some specific policy regarding sales and construction.

Besides the meetings that were conducted according to the contract document, a meeting would be held when there was an emergency or an urgent decision needed to be made. This meeting was usually held at the office of the owner. Basically, the biggest concern for the owner was cost and the time. In some cases, other departments under the control of the owner might ask for a special meeting when they needed an urgent response from the general contractor and the construction management company or when they needed cooperation from both parties to accelerate the project sales. This often occurred when departments that usually attended the monthly meeting could not wait until next regular monthly meeting.

The format of the weekly meeting reports indicates the name of the companies responsible for any assigned tasks, the duration and cost of work performed, and the topics that would be discussed in the next meeting. Updated information and reports were sent to the office of those parties who did not attend the meting.

If the meeting is correctly implemented, all key project parties will be constantly updated about all project problems and variations, so a formal cost overrun situation would then be more routine than alarming (Bent & Humphreys, 1996). In this case, although most parties usually attended the meetings, some problems with overruns were still found and could not be solve immediately.

Meeting Participants

Basically, all project participants on the construction site attended the weekly meetings and only the construction management company and general contractor attended the monthly meeting held at the head office of the owner. Figure 44, Appendix F, details meeting participants.

Although there were many parties involved with the project, only the major parties attended the meetings. These major parties passed information from the meeting to the subordinate management level and brought back the progress report to the next meeting. This reduced redundant orders to levels of operations on the construction site. It also reduced conflicts that could have occurred in the meeting because of having so many parties involved.

According to observations from the meetings, the stratified management among all of these parties was effective since the results they brought back to the next meeting were acceptable. They could control their lower management and expect some acceptable outcomes from their people.

The project participants sent their representatives to attend the weekly meeting on a temporary site office. Among them were representatives from the owner, the construction management, general contractor, and subcontractors. Usually there were two representatives from the general contractor—the project manager and his assistant. There were four persons from the construction management company: the project manager, the project architect, the site architect, and a technician.

The meeting began with the project manager from the construction management company. At the beginning of the meeting before all participants stated the progress of their work, they logged in on a sign-up sheet to indicate the presence of all participants, and allowed the construction manager to know who was absent and did not receive updated information. The construction manager had to ensure that all participants receive the same updated information. After all participants signed in, the project manager discussed the previous meeting and went to other parts as mentioned before. Usually, copies of the meeting minutes were distributed to all participants on Thursday or Friday so that they had time to review information from previous meetings.

At the beginning of construction, the owner did not assign any representative to attend the weekly meeting. Later, however, the owner assigned a representative to attend the weekly meeting after the construction was on a critical path. This made communication between the construction parties and the owner more effective.

Bills of Quantities

This part provides the explanation of the bills of quantities that had been used in this project from the beginning to the completion of the project. There are many levels of bills of quantities used in construction projects depending on the purpose or the detail of items indicated in the bills. Bills of quantities can be submitted at the beginning of the project before the construction begins or during and after the construction. There are three levels of bills of quantity as the following (Ranasinghe, 1994):

- The first level reflects amount of construction resources used in the construction and the anticipated unit market prices to evaluate a bill item rate.
- The second level is the bill item cost that consists of a bill item quantity and a bill item rate.
- The third level is the project cost.

The bills of quantities used in this project consisted of all levels as previously mentioned. The first level can be found in the bills of quantities that were submitted at the beginning of the project. The second level was preparation for change orders. The last one was seen in the attachment with the reports which indicated the cost of the entire project. Appendix L shows the bills of quantities used in this project.

In this project, there were two sets of bills of quantities; one from the general contractor and one from the construction management company. The bills of quantities from the construction management company were used as mean price for preparing price comparisons and negotiation. The information illustrated in the bills of quantities from the general contractor can show the base costs of the project to be used as a reference to analyze the deviations of costs that were found during the construction period. The bills of quantities attached to the proposed estimates of change orders illustrate the effect of the change orders on project costs. The general contractor submitted the proposed estimate whenever the owner or construction management requested design changes. In addition, the changes in unit prices can illustrate cost overruns.

The bills of quantities can also reflect the effectiveness of cost management by considering the systems that the general contractor or other related parties stated in their bills of quantities. The bills of quantities in this case study can be found in the project archives and construction reports that were submitted to the construction management company during the weekly and monthly meetings.

The bills of quantities will be analyzed chronologically together with the weekly and monthly reports. As a result, the relationship between the deviations of construction activities and costs will be identified.

The first issue to be analyzed was the cost items indicated in the bills of quantities to show how many resources the general contractor or other parties allocated to the activities which can be compared to the productivity and other factors affected the project costs. The amount of personnel and materials can also be compared with those indicated in the construction reports. This can identify the sequences of events or problems that arose during construction.

Examples of Bills of Quantities

The first bill of quantity as indicated in the construction report is the bill for the swimming pool. This bill was not included in the scope of construction when the construction of Tower G was begun. As a result, this work is not indicated in the progress payments proposed by the general contractor. The construction of the swimming pool was estimated at 5,598,561.00 Baht or approximately $223,949 in 1995 (one dollar was equal to 25 Baht). The detail of this bill can be seen in Figure 48, Appendix G. This bill was submitted after the construction of Tower G began because the information and specifications for the swimming pool were not clarified.

The items associated with the structural work can be seen in Figure 45 in Appendix G. In this bill of quantities, the general contractor divided the bill into major categories. The bill was submitted at the beginning of the construction of Tower G. It was prepared separately from the one that was submitted before the construction of the first phase began. After the project started, there were many factors that cause deviations in project costs. As a result, the general contractor had to resubmit the bill of quantities for Tower G. This bill lacked some detail such as the amount of steel, formwork, or unit price of materials. The other bills which provided more details associated with the change orders of Tower G were found in the bills of quantities of the construction of the entire project. The general contractor decided to place the costs of additional work of Tower G in the last payment which indicated the construction costs of the entire project.

Figure 47, Appendix G, provides the detail of a bill of quantities for architectural work. This bill is similar to the bill for structural work in that it lacks detail for each item and shows only the major categories of architectural work. Neither bill shows the percent of overhead and profit. These data can be seen in the table of construction costs mentioned in the Progress Payment Analysis.

Another example of bill of quantity is the bill for the construction of the underground parking area (see Figure 46, Appendix G). The construction cost of the underground parking garage is included in the fourth item in the progress payment. Figure 46 provides more details of parking garage construction which was 2,876,904 Baht or approximately $115,076.

Inflation Rates

Another issue seen in the bills of quantities submitted during the construction period is the influence of external factor (inflation rate) on the project cost estimates when they were prepared. Since the construction period might span many months, these factors can play a significant role in affecting cost estimates. In addition, the project under study was built during a period of high economic growth when the prices of construction materials fluctuated, and the inflation rates tended to be high.

The estimators were aware of the fluctuation in inflation rates and included this in their estimates. This illustrates how changes in unit prices can cause overruns.

The average inflation rate during the construction period were 5.4 percent (FAQ.com, 1999). Table 2 illustrates the average inflation rates from 1994 to 1996 and the Consumer Price Index from 1994 to 1996 . As shown in the bills of quantities, the material prices were not significantly affected by the inflation rates since the project was completed in twelve months. As can be seen in the case study, the inflation rates are not the major factor that influenced the construction costs compared to the change orders from the owner or the Sales Department. In addition, the estimator for the construction management company who prepared the estimate for the project stated that the project was not significantly affected by the inflation since the construction of Tower G took only twelve months.

Table 2

Inflation Rates

Year	1994	1995	1996
Inflation Rates	5.1%	5.5%	4.8%

The calculating factors used in the estimates are another consideration in analyzing the bills of quantities. Some factors were announced by government agencies or private organizations. The estimators may use these standard factors or their own factors that can have an impact on the outcomes of estimating, depending on their experience in construction.

Besides indicating the deviations in costs, the bills of quantities also illustrated some additional work. A bill of quantities indicated the extra work for the roof garden and swimming pool found in the submittal from the construction management. This bill dealt with the landscape work. This document shows the additional cost resulting from landscape work and the swimming pool which was not included in the scope of work performed by the general contractor. This bill of quantities lists items for landscape work consisting of material prices and fees. The awarded design firm was the one who offered the lowest prices. The awarded subcontractor also submitted the bill of quantities for landscape work to the construction management company. The project used the bill of quantities prepared by the designer to make the price comparison and negotiate with the subcontractor. The detail of this additional work can be found in the meeting logs that were prepared when Tower G was under construction.

As mentioned previously, two sets of bills of quantities were always used in this project for the purposes of price comparison and negotiation. Different sets of bills of quantities allowed the owner and project manager to select the lower bid and to negotiate with the bidder in case that they believed the prices were not reasonable.

Monthly and Weekly Reports

Monthly and weekly reports identify the events which occurred on the construction site during the working days. Preparing the weekly and monthly reports was one of the responsibilities of the construction management company. In this case study, the monthly and weekly reports were important communication tools to keep all construction parties up to date during the construction. Both reports contained useful data required by the contract including the following:

- Personnel and Equipment Reports.
- Records of Construction Delays.
- Progress Payment.

The weekly and monthly reports provide necessary data for analyzing the project cost overruns. One piece of critical data is the report of personnel and equipment allocated to the construction. This was a daily report attached to the weekly report. Other data obtained from the weekly and monthly reports are the records of construction delays, construction payments, and updates of the construction schedule. In this study, the weekly and monthly reports cover the construction period from July 1994 to February 1995.

The construction delays can be found in the monthly report submitted to the owner which indicated how far the construction was behind schedule. The causes of delays can be seen in the weekly reports which also detail other events that occurred on the construction site.

Some delays found in the project construction were caused by incomplete structural drawings. The general contractor had to wait for the structural drawings of Tower G, when they were ready to perform concrete formwork and rebar. The contractor had to stop structural work for weeks. This led to delay in architectural and mechanical works because they could not proceed until completion of the structural work.

Progress payments, which were attached to the monthly reports, provide the financial data related to construction. Changes or deviations of construction may be found in this progress payment.

Personnel and Equipment Reports

These reports listed the amount of personnel and equipment allocated to construction. The detail of these reports can be found in Appendix H. The numbers of personnel and equipment reflect the amount of work being performed at a given time and indicate the relationship between the amount of personnel and equipment and the request for payment filed with the owner through the construction manager. The effectiveness and productivity of workers and equipment can be seen from these reports.

The personnel and equipment reports were attached to weekly and monthly reports showing the number of skilled laborers and workers, the amount of construction equipment and tools used on the construction site and administrative personnel working in the field office. The number of personnel and equipment can be analyzed and compared with other reports to explore their interrelationship. For example, the number of personnel and equipment can be compared with those indicated in the progress payments.

Since these reports illustrate the amount of personnel and equipment used on the construction site, they can identify the productivity of labor or equipment allocated to construction activities. The data from these reports also reveal unusual events that occurred in relation to the amount of personnel or equipment. For example, when more or less labor and equipment was used on the construction site a larger number of laborers could mean that the contractor needed to accelerate some construction activities because they were behind schedule.

1. Equipment and Personnel Allocation

As can be seen in the construction reports for the construction of Tower G, more personnel were allocated to the construction after the contractor received the completed structural drawings. It can be assumed that after the general contractor received the completed drawings, he could allocate appropriate resources to accelerate the construction which was behind schedule. In another case, there could be fewer laborers, because of a long vacation or the project is waiting for another subcontractor.

2. Impact of Season and Holiday

There is a long vacation period during the summer in Thailand which had a significant impact on the project under study. This vacation lasts from four to seven days during which most laborers go back to the suburban areas. The lack of laborers caused a delay in this construction project because some of them did not return to work because they found jobs that were more convenient to their homes. In addition, summer is the critical time for construction because there is usually no heavy rain or flooding. As a result, the contractors could pour concrete and weld steel which could otherwise be obstructed raining. Other work that needed to be performed in summer season was substructure work or basement construction because flooding during the rainy season could cause delays in site preparation and excavation. The contractor avoided performing basement construction during the rainy season. In case that they needed to perform this task, the construction sites needed to be protected from heavy flooding that can occur after heavy rain. The site protection could cause a large amount of money dependent on the locations and the topography of the construction site. The reports that were prepared during the rainy season show a number of tolls and equipment used for flood protection.

3. Personnel Reports

For the case study project, there was no exact number of laborers coming back to work for the general contractor or subcontractors. As can be seen from site observation, only a small number of laborers did not return to work. To cope with this problem the general contractor accelerated construction before the long vacation to ensure that all construction tasks would not fall behind schedule. This could reduce the problem resulting from a shortage of labor during critical phase of construction.

4. Quality of Laborers

As shown in the reports, certain laborers on the construction site were not certified laborers or craftsmen. Some of them were farmers from suburban areas which is why they left the construction site to visit their homes during long vacations.

On the construction site, the laborers were managed by a general contractor's foreman. Besides these workers, the foreman was also in charge of carpenters, welders, iron workers, crane operators and skilled labor for specific tasks such as furniture installation or finishing. The project manager managed many foremen who were experts in different fields. These foremen sometimes were in charge of or monitored the subcontractors' foremen. The number of foremen changed from time to time depending on the construction activities being performed.

5. Report Preparation

As part of the contract, the construction management company assigned a technician to the construction site every working day from Monday to Saturday to prepare the work progress reports for the project manager of the construction management company. All of the reports prepared by the technician were summarized and distributed to all participants in the weekly meeting to identify the work progress performed by the general contractor and subcontractors. They were compared with reports prepared by other parties to determine accuracy.

Construction Delays

During construction, changes can cause delays and increase construction cost, therefore, all records of the delays and changes will be discussed and analyzed in these reports. The analysis will be conducted chronologically based on the order of reports submitted to the owner. The monthly reports were usually prepared once a month; however, due to the amount of work, some monthly reports covered more than one month. Usually, each monthly report consists of four weekly reports, each containing the data of daily reports based on the working days from Monday to Saturday.

The analysis of construction delays that occurred in this project will be conducted based on the data available from the construction management company. In order to identify the delays precisely, the types of delays will be stated and used to categorize the delays found in this project. Trauner (1990) states that there are four types of delays: excusable, concurrent, compensable, and critical. He also recommends several techniques for analyzing the delays. Due to the limited data, only some techniques can be applied. In this project, the general contractor prepared the construction schedule in the form of a bar chart attached to the monthly reports. These construction schedules are not highly detailed. As recommended by Trauner (1990), if the schedule cannot provide sufficient detail, other construction documents will be used to analyze the construction delays. Hence, two techniques will be used to analyze the delays: 1) delay analysis with bar charts, and 2) delay analysis with no schedule. This analysis will be conducted by using the bar chart and other project documents including the weekly and monthly reports, the meeting minutes, and project progress payments. After these data are analyzed, the as-built schedule will be used to identify the delays (Trauner, 1990). According to the definitions by Trauner (1990), the delays found in this project are excusable and critical.

Delays that occurred to the critical and non-critical construction activities can cause the general contractor to reschedule the construction. This updated schedule can show the productivity of the general contractor or subcontractors. The as-built schedule (Appendix E) used in this study is based on the updated schedule prepared by the general contractor and represented in bar charts to reflect the original schedule format. O'Brien (1976) states that poor quality drawings and specifications are a source of delays so the quality of drawings and specifications will be examined.

The various delays will be discussed based on the data indicated in the weekly and monthly reports. Some delays may be stated in many reports if they were not solved. The analysis assumes that the delays that are not mentioned in later reports were solved and not counted as delays. In the following discussion, only the reports that indicate delays will be mentioned. As a result, some monthly reports may show fewer than four weekly reports. The analysis will focus on the results of delays that affected the cost overruns and project cost control.

The analysis will first discuss the monthly reports and then weekly reports. After the delays found in the reports are discussed, the causes and impact of delays will be analyzed. The analysis in the latter part will identify the causes of delays and show how the related parties responded to those delays.

1. Monthly Report: July 22 to September 30, 1994

The first reviewed monthly report is dated from July 22 to September 30, 1994. This is the first report that mentions the construction of Tower G.

A first sign of delay can be found in the weekly report on August 1, 1994, which indicated 14 days behind schedule as a result of waiting for structural drawings for Tower G building. This was an important cause of delay due to inefficient design scope. The owner retained an independent engineer to design the modified structures of the buildings. Since the engineer was not a fulltime engineer in a design company, his office hours were flexible but sometimes uncertain; this caused difficulty in providing the drawings on time. As seen in this case, the drawings were submitted to the contractor weeks after the structural modification was approved. In the case of Tower G construction, the area with a problem was the part connecting the main tower and first floor deck.

Because the owner wanted to adapt the function of the deck, he retained a landscape architect to design a small garden which would be located next to the swimming pool and used as a recreation area for the residents. Since some trees would be planted on the deck, the structure needed to be modified to support the weight of soil, trees landscaping equipment.

1.1 Weekly Report: July 22 to July 30, 1994

An event recorded in the same report indicated a work stoppage because the construction of Tower G disturbed the neighborhood during the piling and footing work which required certain large, noisy machines. As a result, the contractor had to stop working for one day on July 31, 1994 to negotiate with the neighborhood.

1.2 Weekly Report: August 1 to August 6, 1994

This weekly report records event that occurred due to a technical with a broken pile. One of the piles of the Tower G footings was broken while it was being driven into the ground. The subcontractor solved the problem by driving another pile to replace the broken one. This caused a few hours more than scheduled, but had no effect on the overall schedule. The problem with a broken pile is seen again in the weekly report from August 8 to August 11, 1994. The pile was broken while it was being driven into the ground on August 11, but was not fixed immediately because the crane was broken. There was long holiday from August 12 to August 14, and accordingly, there were no maintenance personnel available.

1.3 Weekly Report: August 15 to August 27, 1994

The malfunctioning crane was indicated in the daily report on August 16. The weekly report from August 15 to August 27, 1994 indicated that the subcontractor had stopped working on piling work from August 17 to August 26 due to the problem with the crane. This consequently had an impact on driving a new pile to replace the broken pile as indicated in the previous weekly report.

1.4 Weekly Report: August 29 to September 3, 1994

There is a report of delay due to mobilization of a new subcontractor causing work to stop for 7 days.

Besides the problems with drawings and broken piles, the design changes were listed in the weekly report of August 29 to September 3, 1994. The floor plans of Units C and D of Tower G were changed to meet the owner's requirements. Possibly these changes were the result of unit area expansion or problem with the functions of both units that may not have been attractive to purchasers. Since the changes were proposed before the completion of structural work, the contractor could adjust the schedule. However, this could affect the progress of the project due to the advanced orders for materials.

As indicated in the weekly report from August 29 to September 3, 1994, the construction was one month behind schedule. The contractor spent 14 days waiting for structural drawings for the first floor. It can be concluded that the delays this time was a result of incomplete structural drawings.

After the completion of the piling work, the crane was removed to prepare the site for other work.

1.5 Weekly Report: September 19 to September 24, 1994

This report indicates a delay caused by flooding on September 27. Water accumulated from heavy rain on the footing pitches obstructed the formwork and rebar for the footing. The contractor used a water pump to make the pitches ready for installing formwork and rebar, but it took a few days to pump all the water out. This also affected the site excavation because the area of Tower G was divided into two parts. While the piling work of the first part was being completed, another part was being excavated to prepare the site after the piling work. In addition, because of the excavation and piling work, the area was at a lower level than others and received the accumulation of water from the entire construction site.

One change of design was indicated in the weekly report was the change of Units C and D of Tower G.

1.6 Weekly Report: September 26 to October 1, 1994

The design change for units C and D of Tower G was still found in this weekly report. The report stated that the change in units C and D was the redesign of the balcony. There is no detail about the delay from this change.

The report indicated that the construction was 55 days behind schedule because the contractor had to wait for the structural drawings for the concrete deck on the first floor. This shows that the problem with structural drawings had existed since previous reports and was not being solved to accelerate the completion of drawings.

2. Monthly Report: October 2 to October 29, 1994

The second monthly report covers one month of construction work. Most site excavation and piling work were completed as indicated in the previous monthly report. The structural drawings were still a major delay, although the contractor received some of the drawings.

2.1 Weekly Report: October 25 to October 29, 1994

The contractor stopped working and waited for the rest of the structural drawings. The balcony change for Units C and D was still mentioned in the report, but had no impact on the construction schedule. The report indicates that the project was 15 days behind schedule since construction was accelerated and the delay dropped from the previous 55 days.

3. Monthly Report: October 30 to December 2, 1994

This monthly report covered a few days more than a normal month and indicate indicated that the contractor received the additional structural drawings on November 4 and December 2 after waiting for 22 days. This 22-day period would be counted after receiving the prior parts of structural drawings.

3.1 Weekly Report: October 31 to November 5, 1994

The contractor stopped working from October 25 to November 5, 1994 because he needed another part of the structural drawings.

3.2 Weekly Report: November 7 to November 12, 1994

The contractor stopped work from November 6 to 12 and returned to work on November 14, 1994.

3.3 Weekly Report: November 21 to November 26, 1994

The contractor stopped work from November 24 to 26 due to the long public holiday.

3.4 Weekly Report: November 28 to December 3, 1994

More construction personnel were allocated during this time as illustrated in the report since the general contractor would lose a number of working days due to the long holiday in December.

The balcony change for units C and D was still indicated in the report.

4. Monthly Report: December 4, 1994 to January 1, 1995

This monthly report covers a period with many public and private holidays. Some public holidays last more than 3 days when combined with the weekend. As indicated in this report, the construction was 15 days behind schedule.

4.1 Weekly Report: December 5 to December 10, 1994

December 5 and 10 were public holidays. The contractor stopped working on December 5 but worked on December 10 to accelerate the construction.

4.2 Weekly Report: December 19 to December 31, 1994

Because there were many public holidays, the report was prepared on a two-weeks basis. Part of the construction was stopped on December 21, due to a new subcontractor mobilizing on the site. As indicated in the report, the new subcontractor would move to the site on January 5, 1995.

The changes in Units C and D can still be found in this report. In addition, design changes in unit A and D were listed in the report.

5. Monthly Report: January 2 to January 29, 1995

This report covers the period after New Years to the end of January; some companies were still on holiday during the first of January.

5.1 Weekly Report: January 2 to January 14, 1995

The contractor stopped work on January 8 with no reason indicated in the report.

5.2 Weekly Report: January 9 to January 14, 1995

At this time, the construction was 12 days behind schedule. This indicated that the contractor had accelerated the construction, probably the result of allocating more resources as indicated in the previous report.

6. Monthly Report: February 1 to February 28, 1995

This report provided the record of weekly meetings held in February.

6.1 Weekly Report: February 6 to February 11, 1995

The schematic drawings for unit modification are found in this report (see Figure 22, Appendix C). This architectural change was the combination of units A and D as required by a purchaser. As can be seen in the drawing, some basic features of the floor plan were modified; for example, there is only one unit entrance. Some walls were relocated to fit the new function of the unit. There are three bedrooms and two living spaces. The bathroom in unit D, which had two doors to serve the bathroom and the living room, was changed to have one door serving the master bedroom which was the combination of two bedrooms. This modification was proposed to the construction management on February 8 and was approved on February 13.

The monthly and weekly reports prepared after this time do not indicate any construction delays. It should be noted that delays decreased after the contractor received all the structural drawings since he did not need to wait for additional drawings. However, other items listed in the reports are changes in building design, mistakes during operation, and malfunctions of construction equipment. Most of these events did not impact the construction schedule but caused the contractor to work a few extra days to complete or solve these problems. Although design changes resulting from incomplete drawings can be seen in many reports, some of them did not cause significant delay because these changes dealt with architectural work which could be performed after the completion of the structural work. This allowed the contractor to adjust the schedule for the changes and prepare for other issues resulting from different design such as new materials or equipment required for new functions. The design changes requested by the Sales Department are more critical; however, they were not indicated in the monthly and weekly reports but were recorded in the project archives and meeting minutes.

As can be seen in the table indicating the relationship between work progress and payment, the construction was behind schedule (see Figure 85, Appendix I: Schedule and Payment). During the first few months, the general contractor could not perform the work effectively. The analysis of the Schedule and Payment will be discussed in the Cost Control Procedure Part of this chapter.

Progress Payments

The general contractor submitted progress payments to the construction management company based on the requirements stated in the contract documents. All progress payments were attached to the monthly reports submitted to the owner. Five progress payments for the construction of Tower G were submitted to the construction management company. Each progress payment has two parts; payment for materials and payments for labor (see Figures 75-84, Appendix I). The categories of work performed by the general contractor can be seen from the items in the progress payment. The progress payment also indicates the percentage of work completed, since the payment was based on the amount of completed work. Usually the progress payment was submitted together with the construction schedule so that the construction management could compare the progress of work with the construction schedule to determine the amount of payment. The amount of work may be less than the general contractor expected in the construction schedule but the cost may be high compared to the portion of work. This imbalance between the amount of work and cost was verified by the construction management company. Some costs may be deducted or disapproved based on the analysis of the construction management company.

As seen in the progress payment submitted by the general contractor, the total material cost for Tower G was 33,696,679 Baht ($1,347,867) and the total labor cost was 10,244,284 Baht ($409,771). These costs did not include overhead and profit. The exact cost of the construction should be 50,308,008.54 Baht ($2,012,320). This cost was prepared by the construction management company. The construction management company included the percent of overhead and profit in the construction of each building or each phase, while the general contractor showed the percent of overhead and profit in the bills of quantities of the entire project. This caused some confusion about the exact costs. As can be seen in this case, certain data needed to be analyzed together to provide accurate analyses.

The progress payment shows the overruns that occurred during construction. The construction management company could identify these overruns and apply appropriate measures to control and prevent a reoccurrence during the remainder of construction. The construction management company would send a notice to the general contractor to monitor the construction and prepare a strategy to reduce cost overruns.

It should be noted that all progress payments submitted to the construction management company indicated the same amount of total construction cost for Tower G (see Appendix I). During construction, there would be certain additional jobs as indicated in the weekly and monthly reports which caused an increase in construction costs because the general contractor placed the additional costs resulting from change orders or unit modifications in the last payment. This reduced the redundancy of work for the general contractor.

Personal Diaries

The personal diaries are the observations that I made while on the project from July 1994 to July 1995. However, the construction of Tower G had been performed during the year the July 1994 to August, 1995. The diaries that provide the record for Tower G during that period will be analyzed to identify the events affecting the construction. Some events may have effects after the completion of the project, such as the project claims resulting from unit modifications. Besides the information recorded in the diaries, this part will discuss the information obtained from interviewing project participants.

The records in my diaries cover all events I was involved with, including the events that occurred in both the head office and field office such as monthly and weekly meetings and site visits. I attended the weekly and monthly meetings from July 1994 to July 1995, see Figure 89, Appendix J, for the meeting schedule. Usually, all events would be recorded the day after the meeting or observation. Only the records related to the behaviors and events that occurred in the case study project will be discussed and analyzed.

Observations of Project Participants

Most project participants were observed when they were attending the meetings. Usually all major parties attended the weekly meetings held on Monday afternoons from approximately 3:30-5:30. The representatives of all parties were personnel working in the site office except for those from the owner and the construction management company. The owner's representative came from her office about five miles away and the representatives from the construction management company also commuted from the head office also about five miles away. Only a technician from the construction management company worked in the site office. The general contractor, electrical subcontractor, sanitary contractor, and the technician from the construction management company were working in the same area. Appendix J shows the observation log that illustrates the events that occurred during the observation.

Basically, most parties except the general contractor and the construction management assigned one representative to attend the meeting, see Table 3. The general contractor had two representatives – the project manager and his assistant. The construction management had three representatives – the project manager, the project architect and the site architect. The representatives from the subcontractors were project managers.

Table 3

Project Meeting Participants

No	Participant	Position
1	Owner	Representative
2	Construction Management Company	Project Manager
3	Construction Management Company	Project Architect
4	Construction Management Company	Site Architect
5	Construction Management Company	Technician
6	General Contractor	Project Manager
7	General Contractor	Assistant Manager
8	Electrical Subcontractor	Project Manager
9	Sanitary Subcontractor	Project Manager

Although the meeting schedule was set up one week in advance, the schedule of meeting was flexible due to traffic around the construction site. The meeting time was close to the end of the school day, which sometimes caused a delay of meeting, because some parties commuted from their offices.

Most participants were eager to attend the meeting and show their work progress. The meeting atmosphere was friendly – there were no serious arguments. When there was a problem, all parties would accept the solution agreed upon by all participants.

The basic problems found in the meeting were the absence of some parties and communication among participants. During the observation period, there was no problem with labor strikes. The problems with labor found during the observation period were the lack of labor during some specific times and some minor accidents as mentioned in the Construction Delay part. Some laborers left the construction for their hometowns during long vacations or certain festivals.

During the construction period, the architect and engineer did not attend the weekly or monthly meeting because the contract did not require their participation. As a result, the general contractor and subcontractors needed to rely on the construction management company for architectural modifications and a part-time engineer for structural modifications. Besides the problems with the drawings, the project also lacked a full-time architect and engineer to provide advice when there was a problem with architectural work or structural modifications.

In many cases, the construction manager provided advice to the general contractor and subcontractors for material selection and specifications. This helped the project save money and created good meeting environment since all parties were encourage to participate in this process. The subcontractors proposed economical alternatives for the project including the selection of sanitary ware and bathroom fixtures. The selection of furniture installed in all residential units was also made by the construction management company

Most of the basic fixtures used in the bathrooms in all units were specified by the construction management company. However, because of the Sales Department, some purchasers were allowed to change the types of fixtures in their bathrooms. The additional costs of these fixtures were the responsibility of individual purchasers. This caused a conflict between the construction parties and the Sales Department due to lack of communication because the representative from the Sales Department did not attend meetings on the construction site. According to my observations, the sales representatives rarely attended the weekly meetings.

A problem noted while observing the meetings was the disagreement about the changes in the residential units. Some subcontractors complained about the requests from the Sales Department. Before the purchasers were allowed to change bathroom fixtures, the general contractor and sanitary subcontractor did not have a problem with material delivery and estimates because the basic fixtures indicated in the specifications allowed them to order the fixtures and sanitary wares in large quantities and received a discount.

Another problem observed was the updated data. The project estimates needed to be updated continually since the general contractor submitted the work progress report every three or four months dependending on the contract. Because the general contractor is an affiliate of the project developer, the cost of change orders can be offset by the increased number of units sold by the Sales Department or by reducing the quality of materials used in the project.

Participants Interviewed

As mentioned in the methodology section that the project had been completed several years ago. The interviews were conducted to obtain updated information about the project cost overruns and cost control procedures and consisted of two sections. The first section asked questions regarding the technical problems found on the construction site. The second section asked about the personnel behavior on the project. Some events that happened after the completion of the project were derived from telephone interviews which were conducted from October 11 to October 15, 2004. The following is the list of the interviewees:

- Project Manager.
- Project Architect.
- Estimator.
- Project Secretary.

The project participants I interviewed worked for the construction management company. All participants were involved in the project in a variety of capacities and responsibilities, such as monitoring the construction process, conducting meetings, estimating construction costs, and preparing documents for the meetings. Some participants played a significant role during construction. For example, some had authorization to approve or disapprove the progress payments, and some prepared specifications which could affect project costs.

The participants were asked about the management of the project, the problems with cost overruns and cost controls occurring during the construction period. They were also asked for their opinions regarding project participation and the effectiveness of the construction personnel. This process took approximately 30 to 40 minutes. The detail of questions can be seen in Appendix K.

Technical Problems

Although the construction was managed properly, some problems with cost overruns and cost control were found during the construction period. The reasons for cost overruns and problems with cost control that were obtained from the interviewing the project participants are identical to those analyzed and discussed previously.

1. Causes of Overruns- Owner's Requirement and Inflation

The data obtained from the interviews indicated several causes of cost overruns and difficulties with project cost control. One of the major causes of cost overruns found in this project was the owner's requirements. Another cause of cost overruns was the impact of inflation rates which caused increased material costs during the construction period. The interviewees pointed out that the inflation rates had a significant effect on the cost estimates. However, if it considered only Tower G, the impact of inflation was not as serious as that of the entire project because there were many buildings which took more than two years to complete. Tower G took approximately one year to finish. They provided some examples of progress payments that the general contractor submitted to the construction management company. The cost of construction indicated in all five progress payment did not change during the course of the construction of Tower G. This implied that the longer the project duration, the higher the impact was from inflation. The data from interviewees regarding the impact of inflation rates is in accord with the analysis of the bill of quantities found in the construction reports.

2. Incomplete Drawings

Besides the causes of overruns resulting from the owner's requirements and external factors such as inflation, the other major reason for cost overruns and cost control resulted from delays caused by incomplete architectural and structural drawings. The interviewees believed that these delays could be found throughout the construction period. Apparently the project participants did not expect to have problems from incomplete architectural drawings and believed that the construction management company could identify the problems before construction activities began. The truth is, it was difficult to identify the problems. Most of the incomplete details or specifications were found a few weeks or days before the parts related to those specifications were built. Some problems were found when the construction of that part was almost finished. For example, there was an omission of a window in two units of Tower G. This problem was found when the general contractor had almost completed the Wall Finishes. This cost extra time and money. The common problem in the incomplete architectural drawings was incomplete specifications. Because the architectural drawings were not completed, the architects could not specify the types or quality of materials. As a result, the specifications needed to be verified again during the construction period. The process of approving materials was time consuming because it was submitted through many management levels and the owner was not always available when the submittals needed to be approved.

Apart from the incomplete architectural drawings, the incomplete structural drawings created another serious problem. As discussed previously, the structural work on the concrete deck above the parking garage was one of the critical activities that needed to be completed on time. This construction was stopped for many weeks because the general contractor did not have the structural drawings. All materials, labor and equipment that were ready for the structural work were held on the site for weeks. Because the general contractor could not anticipate the date he would receive the drawings, some equipment and workers were moved to other buildings. When he received the drawings, the work had to be reorganized and the construction activities had to be rescheduled. Most interviewees stated that this is one of the critical events that occurred during construction and caused delays for many weeks which consequently resulted in overruns.

3. Design Changes

Delays also resulted from the requirements of the Sales Department. The project architect working for the construction management company indicated that the requests from the Sales Department caused difficulties in managing the construction schedule. Most of the requests were design changes requested by the purchasers to modify their units to fit specific requirements. Some changes were difficult to accomplish since they were beyond the standard scope of work and conflicted with the as-planned construction schedule. Many purchasers wanted to change the physical layouts of their units – for example, to change the position of the door between two bedrooms or between bedroom and bathroom. Some wanted to change the finishes of floors or walls. Another serious problem arose when some purchasers wanted to merge two units into one single unit. This needed skilled labor since it required structural modification and finishes. The floor plan of both units needed to be modified and the structural engineer needed to approve all changes affecting the building structure. Since the structural work was already completed, any relocation of walls was a concern. Some walls needed to be demolished to allow two units to be combined. At the time this change was proposed by the Sales Department, the general contractor had to change many units in the building. As a result, he did not have sufficient skilled labor to perform some requests. Although some purchasers hired other subcontractors to work on their units, the general contractor had to prepare and manage the construction schedule to allow the mobilization of those subcontractors. This caused the delays in other parts of the construction and, consequently, overruns.

Most of these changes could have been performed properly without any conflict with as-planned construction schedule if the general contractor had received the requests before beginning to work on the units. However, most of these requests were submitted to the general contractor when those units were being built or were almost finished creating a major problem. It can be said that the problem was the results of poor communication between the Sales Department and other parties and poor management by the Sales Department in handling the requests from purchasers. Most interviewees complained that the Sales Department did not understand the problems involved in changing the standard specifications indicated in the architectural specifications and structural drawings.

4. Summary

Three components caused overruns of project costs – incomplete drawings, the requirements of the owner and the changes from the Sales Department. Although the construction management company tried to coordinate all requirements and solve the problems of incomplete drawings, this was often beyond its ability. The interviewees mentioned that problems with project cost control were more serious after the Sales Department decided to increase the number of units. Toward the end of the construction of Tower G, the construction parties had some difficulties in finishing the construction. Although the construction was completed not far behind schedule, the general contractor and some subcontractors continued to work on the project and tried to complete the modification of units requested by purchasers.

Personnel Behavior

The results from the interviews regarding the project participation and effectiveness of the construction personnel are similar to those recorded in the diaries. The atmosphere of weekly and monthly meetings was friendly, even though all procedures were formal. All participants seemed to be eager to complete their jobs on time and avoid an adversarial environment. When there was a problem, negotiation was the primary method used.

1. Communication

The communication among all construction parties was effective, and there were no critical relationship problems among construction parties. All personnel understood the situations and problems. Most of the construction activities were performed routinely because there were many buildings on the construction site and most personnel were familiar with construction procedures as a result of using a typical building design. Occasionally there was a problem with construction procedures, when new subcontractors began work.

2. Quality of Construction Personnel

Most interviewees believed that the quality of the construction personnel was another cause of cost overruns and cost control. Although the work environment was friendly, there was sometimes a lack of effectiveness in performing some construction activities. In addition, certain personnel at the lower management level did not consider delays a critical issue. Problems resulting from delays could be negotiated among all participants. Many participants had worked closely together and they tended to have a good time together after office hours. Thus they knew each other very well and this familiarity was sometimes advantage in carrying out construction assignments. Even though most construction jobs assigned during the meetings were accomplished some jobs were performed ineffectively and were sometimes late.

3. Summary

Overall, this project did not have serious arguments among the construction parties. I never saw any strong arguments during the monthly and weekly meetings. When the construction was completed the general contractor provided a dinner for all parties who primarily discussed the problems that occurred during construction.

Change Orders

According to the literature review, change orders are a major cause of cost overruns. In this case, the change orders indicated in the construction reports or in other resources will be analyzed to identify their effect on cost overruns. Some researchers found that the main reasons for change orders include designer's omissions in tendered documents; coordination defects in tendered documents; changes in owner's requirements; and new information on existing site conditions (Cox, Morris, Rogerson, &Jared, 1999).

In this case, the general contractor responded to most change orders submitted by the construction management company. Any changes in the construction were passed by the owner through the construction management company. One unique facet of this project is that the construction management company served as a designer providing some advice about the architectural modifications. As indicated in the contract, the responsibility of the architect ended after the design drawings were submitted to the owner. After the construction began, all design changes would be prepared by the architects working for the construction management company. This included preparation of shop drawings submitted to the general contractor.

The major causes of change orders found in the reports came from design changes requested by the owner. These design changes can be categorized into three types:

1. Owner's Requirements

The first design change came from the owner was required to make the design of the building conform to the condominium management law. It can be assumed that the necessity for this design change came from the incomplete project scope and objectives. Although it was indicated in the contract documents that the architects would provide schematic or primary architectural design drawings, some parts of the architectural drawings were not clarified as a result of an insufficient scope of work. In addition, while the project was under construction, some condominium laws were changed. Accordingly, the original building design had to be modified. In some of the drawings the line of walls does not attach to the line of columns and some walls were relocated to make larger rooms to conform to the new condominium laws.

In this project, the construction management company also specified the materials used for architectural work. For example, the design drawings did not specify the types and color of floor tiles used in the main lobby of the building, therefore the construction management company specified the detail of floor tiles and submitted a proposal to the owner for approval. After the general contractor submitted the shop drawings to the construction management company, the cost was estimated and negotiated with the owner before approval.

A change order caused a large modification of physical space when the owner decided to change some residential units on the first floor for other uses. The construction management company had to discuss this modification with the owner many times. Finally, the owner approved the new design on the first floor.

2. Errors in Design

A second design change resulted from errors found in the design drawings. Some rooms were designed without appropriate windows. As a result, changes were made on the solid walls to provide enough openings for the windows. This delayed the schedule and necessitated extra materials. Two units of Tower G had no windows. There was a door accessible to the balcony in each unit. The general contractor asked the construction management company to relay this problem to the owner. A few weeks later, the shop drawings for design changes prepared by the construction management company were approved. The general contractor then had to demolish part of the wall to make room for installing the window frame. This helped the owner sell these units, so the cost was a responsibility of the owner.

3. Purchasers' Requirements

The third design changes came from the requirement of purchasers after some of the units were sold. Certain purchasers wanted to change some features of their units to meet specific requirements. These changes varied from minor adaptations that needed a few craftsmen to large modifications that needed demolition. For example, a purchaser wanted to change the original floor finish from tile to carpet. This needed only a few workers and did not affect the overall schedule. Another minor adaptation was necessary when a purchaser wanted to have more air conditioning units, but there was no available space. The subcontractor offered larger air conditioning units. As a result, the carpenters were not able to install woodwork and furniture because they could not begin until the air conditioning units were installed. A large modification occurred when the purchasers bought two adjacent condominium units and wanted to merge them into one.

In many cases, the problem would be critical and cause delays if the requirement was submitted to the general contractor after the modifications of the units were begun or almost finished. This could require the general contractor to demolish some of the walls and floor. Some purchasers required specific decoration or finishes which required non-standard materials. This often caused delays in material delivery. Some materials were not stored by the general contractor due to high cost. In addition, ordering small amount of materials could sometimes take more time than ordering in large amounts since some specialized materials were not in stock in the suppliers' inventory.

Another problem resulted from design changes when some purchasers wanted to buy the materials themselves. This resulted in communication problems between the general contractor and the material suppliers due to the effect on the construction schedule.

Although the project established the standard specification for floor and wall finishings of each unit, the Sales Department decided to change certain standards in order to attract more clients. The purchasers could select the finishes that fitted their requirements, thus variety of finishes caused difficulty for estimating the cost of materials and labor needed to complete additional work in each unit.

There were conflicts between the Sales department and the general contractor as detailed in the project archives and meeting minutes. Because their objectives in doing business are different, both parties often had problems with specifications and standards of room furnishes. Updated documents regarding improving or changing room finishes can be found in the reports every month after the project began selling units. Several purchasers preferred to change the original plan and certain features; so the Sales Department submitted request forms for these purchasers. However, the request forms had many alternatives based on the level of changes which were beyond the standard scope of work and would have to be charged additional fees. It can be said that incomplete drawings caused many problems during the construction which later led to cost overruns.

Coding System

As mentioned in the Methodology section, a coding system was used to record the events from site observations. These observations were performed from the beginning to the completion of the project. However, because this study focuses on Tower G, the observations of other buildings will not be included here.

The coding system used in the study was categorized into 16 divisions according to the CSI master format (See Figure 16, Appendix A). Figure 4 shows the system of digits used in the coding system. The events related to the structural work may be categorized into more than one subcategory because structural work involved many activities. A major concern of categorizing events is determining the type of activity as applied in the CSI master format. For example, concrete work may be found in structural work such as beam or column concrete pouring, and may also be listed in architectural work as concrete lintels used to strengthen doors and window frames.

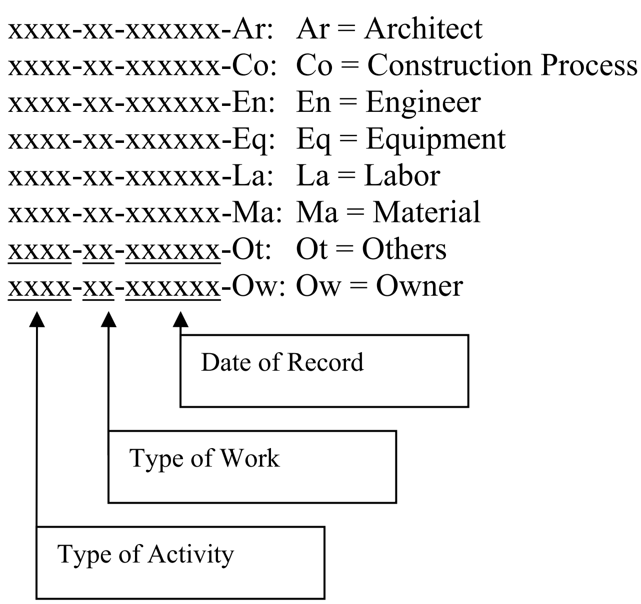

Figure 4: Coding System.

The two digits that indicate the type of work are shown in Table 4. This helps identify the type of work associated with activities.

The delay of structural drawings will be categorized into General Condition Division because it was the responsibility of the engineers designing the building structures. However, events related to the structural work which occurred under construction will be categorized in another division based on the type of activity. In the case of design changes, the events will be categorized in General Condition to indicate the responsibility of the designers. However, related events will be assigned by certain numbers.

Table 4

Example of Coding System

Number	Type of Work
01	Structural Work
02	Architectural Work
03	Mechanical Work
04	Electrical Work
05	Sanitary Work
06	Sales Department

The events that are related to or caused by weather conditions as indicated in the daily or weekly reports will be categorized based on the activity specified in the CSI master format. For example, the events that are related to construction of doors and windows will be categorized in the Doors and Windows Division.

Since the project did not use CSI as the standard system for cost estimates and cost codes, this study assigned appropriate numbers to illustrate the events that occurred during the construction period as previously mentioned.

Example of Coding System Used in the Study

01300-01-080194-En

The first example is a set of numbers obtained from observation. The first four digits indicate type of activity – General Condition. The second two digits indicate the type of work – Structural Work. The next four digits indicate the date of record. The last set of letters indicates the cause of the events. These numbers indicate an event associated to the General Condition with the structural work recorded on August 1, 1994. The cause of the event is associated with the engineer.

Summary of Construction Events from Observation and Construction Reports

The events that occurred during the construction period are summarized from several sources of data, from meetings and site observations. They are listed based on the sequence of events. The table is shown in Figure 89, Appendix J.

I recorded 64 events in the Observation Log. These events were recorded in accordance with the construction reports. Most events that are recorded in the meeting log occurred during the first five months of construction. These events contain many variables such as construction process, construction material and equipment and owner. One event, the design change of the units, happened in May 1995. Most of events that occurred during the first five months can be categorized in the division 01- general requirement, 02- site construction, 03- concrete, and 04- masonry. The other events that were recorded in meeting logs but not were indicated in the construction reports were associated with the design changes in the last phase of the construction of Tower G. Most of these events involved the finishing work, installation of air-conditioning systems and furniture in modified units. These events were not recorded in the observation logs due to the lack of exact dates.

I attended and recorded 53 weekly meetings in the construction site office and was able to visit the construction site after the meetings. In addition, I observed the personnel working in the construction management office and noted when they were working on cost estimates and preparing architectural drawings. I noticed that there were more requests for design changes from the Sales Department from February to May 1995 which caused delays because the general contractor had to make on unit modifications. Figure 88, Appendix I, shows the construction delays during this period. Besides the weekly meetings, I also attended and observed the monthly meetings at the owner's head office.

Figure 89, Appendix J, shows the time taken in each meeting – usually one or two hours to discuss the work progress and maybe 20 or 30 minutes to visit the construction site. When there were many issues to be discussed, the meetings would take more than two hours. Some meetings were canceled due to bad weather or for unidentified reasons.

The observations that were made for approximately one year provided useful information for analyzing the events which occurred during construction. In addition, these observations were cross-checked with other sources of data; most sources provided the same information.

Sources of Project Cost Data

The project estimator used the cost data from several sources including government agencies and some private organizations. Apart from these sources, some historical data in the company's database were also used. Another source of data was derived from the price lists provided by the suppliers while the project was under construction.

In the case of the construction management, three sources of data were used to prepare the cost estimates. The first source was the database of historic costs that the company collected from several past projects. Another source was the updated price lists from manufacturers. The last source of cost data was obtained from the price index provided by the government and private agencies. Some private organization provided updated material prices monthly. This is similar to material prices provided by RS Means in the United States. The company used the price lists from many sources in order to compare the material prices from suppliers and manufactures.

In this project, the estimates were calculated from many sources, thus some items in the estimates shown on the bills of quantities may or may not have been the same as the prices shown on the bills of quantities prepared by the general contractor.

The analysis of the material prices illustrated in the bills of quantities indicated that the sources of data used in this project were reliable. This analysis was made by comparing the price lists in the bills of quantities prepared by the construction management company with the prices quoted by the general contractor in his bills of quantities (see Figures 45-48, Appendix G and Figures 71-74, Appendix I). Both prices in the bills of quantities have minor differences.

Limitations

Reliability of the Sources of Data

Because the project was already completed and some companies working on the project, moved to new locations or gone out of business, some sources of data were not available for this study. However, the construction management company is still in business and provided most of the data used in this study.

The information obtained from the interviews may not be completely accurate since the project was completed years ago and most of the information from the interviews was derived from the memories of interviewees. Some information needed to be compared with other sources such as observation of participants. However, the information from some participants may be confused with that from other projects which were constructed at the same time.

Project Personnel

The impact of the economic crisis caused some companies to decrease their size. As a result, some personnel working on the project resigned or went to work for other companies or in different businesses. Only a few personnel from the construction management company were available to answer the interview questions. However, most of these people were top management who could provide useful information for analysis.

The top management people working for the general contractor and subcontractors were not available, so it was not possible to determine their attitude toward the project management.

Availability of Data and Insufficient Recording System

Some data have been lost because some companies have gone out of business. Only data from the construction management are available. However, some of the data were not in good condition, especially the data recorded in hard copies which were stored inappropriately. Even drawings which were kept in electronic files were lost due to company relocations and some mistakes in system restoration.

Besides the methods used to preserve the data, the system of data collection was another problem. Most of the weekly and monthly reports were kept as paper copies rather than kept electrically. Some reports were kept electrically while the project was under construction; however, new reports were recorded over old reports. As a result, the electronic copies are only the last updated reports. All of the old reports were kept in hard copies which later were lost due to the vulnerability of paper. Another major loss of data occurred when companies moved to a new location.

As a result of the limitation of available data, certain types of data have been used together with the data from interviews to analyze the effectiveness of project cost control procedures conducted in this case study.

Analysis of Case Study

This part provides the case study analysis based on the information discussed previously. This part is composed of the analyses of 1) the construction schedule, 2) causes and impacts of construction delays resulting from certain factors, and 3) cost control procedures used in the project.

Analysis of Construction Schedules

The general contractor submitted eight updated construction schedules for structural work during the construction of Tower G (see Appendix E). The first schedule does not indicate any delays in the structural work. However, the second update showed delays in footing and basement construction, and the parking ramp of Tower C which was included as part of the third phase. The third update to the last schedules showed delays in piling work, footing and basement, first floor construction, and the parking ramp. The delays in the piling work indicated in the schedule are in accordance with that illustrated in the weekly reports. The delays in piling caused delays in the footing and basement. Note that there is no difference in the third update to the eighth updated schedule. All delays found in the early stage of the construction were also seen in the last stage of construction. The schedule indicated that the delays at the beginning of construction affected other activities for months. In the case of the sanitary and electrical work, the schedules for both works were not highly detailed or updated. Therefore it was difficult to identify the delays in both works based solely on the construction schedules.

Since the Bar Charts representing sequence of most construction works were not highly detailed, the information from weekly and monthly reports was also used to analyze the delays in the project. If the analyses were conducted based on the construction schedules only, the results would be unreliable. The detail of reports should be well organized to sufficiently illustrate the events which occurred on the construction site.

Construction delays were found at the beginning of the construction while the general contractor performed structural work and then almost at the end of construction while the general contractor was performing architectural work. These two significant delays occurred as a result of two events. First, the general contractor stopped construction due to incomplete drawings happened at the beginning of construction. The incomplete drawings were a result of a decreased project budget. Second, the Sales Department submitted many changes to the general contractor which originated from the purchasers. This was part of the owner's strategy to allow the purchasers to change their units. When the owner realized that individual purchasers needed different unit decorations and features he made the units flexible for modification and made the project more attractive to purchasers. However, this strategy caused the general contractor and construction manager to reschedule the sequence of work and they could not finish the construction on time because there were more design changes than they had expected.

1. Shifts of Work

Shifts of work originating from ineffective scheduling caused the general contractor and construction management company to reschedule construction many times due to the design changes that occurred almost at the end of construction. Confusion resulting from shifts of work caused damage to materials and furniture in many units. Certain purchasers hired subcontractors from outside the project which caused conflicts in the construction schedules of other subcontractors working for the general contractor. Shifts of work also created construction delays in the entire building and additional costs due to replacing damaged materials and furniture. The following part shows examples of ineffective shifts of work.

After the architectural work was completed, air conditioning systems and furniture were installed in the units. In many cases, the sequence of work was not properly managed. As a result, there was a damage of room furnishings and furniture when the general contractor allowed technicians and carpenters to install air conditioning units and furniture at the same time and the furniture was damaged by the air conditioning technician.

In other cases, the room finishes, wallpaper and paint were damaged by the furniture installer or air conditioning technician. During an air conditioning installation it was necessary to make holes in the wall in order to connect the condenser unit and coil unit. Thus the walls needed to be repaired and repapered or repapered.

The installation of furniture was a problem created by insufficient shift management. Before the furniture was installed, the carpenter needed to know the exact dimension of spaces for the furniture, because most of it was built-in. The installation of wallpaper needed to be done after the installation of furniture. A more complicated problem was found in the units that used floor tile in the kitchen area because the kitchen floors had to be finished before the furniture came in. In addition, damage to the floor tile was found after the completion of furniture installation. Sometimes, both furniture workers and laborers charged each other for damages. As a result, the construction management company needed to work hard to reschedule the sequence of work.

Analysis of Causes and Impacts of Construction Delays

The following section analyzed the causes and impacts of delays found in the case study. These analyses are conducted based on data obtained from a variety sources including the project personnel. The reasons are listed based on their importance.

1. Analysis of Cause and Impact of Construction Delays Resulting from Incomplete Drawings

Incomplete drawings were a result of the contract documents which did not specify a full-time engineer to design and prepare the complete drawings. Also, the architectural drawings were mostly prepared by the construction management company. Besides the incomplete structural drawings, the changes that occurred during construction made it necessary to revise the structural drawings to conform to new functions.

The incomplete structural drawings caused not only the delay of the concrete deck but also other subsequent work. The landscape subcontractor could not mobilize on the construction site because the landscape area on the deck had not been completed. In addition, the storage area was not adequate for landscape materials such as soil, plants, and other decorative materials which needed a large storage area for materials that needed covered storage.

It should be noted that the general contractor and construction management company could not work with the incomplete structural drawings. As indicated in the meeting minutes, the engineer were asked to complete the drawings faster; however, the drawings were sent to the general contractor and construction management company behind schedule.

2. Analysis of Cause and Impact of Construction Delays Due to Design Changes

Many design changes were recorded in the construction reports and meeting log, many of which were the result of incomplete drawings. Since the owner wanted the unit decoration and features to be flexible for modification, he did not decide these before construction began. This strategy led to incomplete drawings because certain materials or features could not be specified at the beginning of the construction. When the owner or the sales representatives submitted requests for design changes, the general contractor and construction management company needed to reschedule construction and material delivery. Certain materials had to be returned to the suppliers or replaced by new materials due to the design changes. As a result, construction was behind schedule and incurred higher project costs.

As can be seen from the reports previously discussed, there were two cases of design changes. The first was the change of the balcony in Units C and D as a result of incomplete drawings, and the owner's requirement. Since the architectural drawings were incomplete, there were several specifications and information that were not available for the general contractor. In addition, the owner wanted to modify some physical features of the building to attract more clients.

Another design change found in the reports came from a purchaser who wanted to combine two standard units into single unit. However, the request was sent to the general contractor and construction management company after the units were partially completed. The general contractor had to demolish some walls and change floor finishes due to relocating the walls.

In both cases, the general contractor had to allocate more workers to finish these jobs. In the first case, all the Units in C and D had to be modified, a total of sixteen units. These design changes caused the delays in the architectural work and delayed the project execution of Tower G.

3. Analysis of Cause and Impact of Construction Delays Resulting from Malfunctioning Equipment

Although the malfunction of construction equipment indicated in the reports was not critical and did not cause significant delays, affected the cost of maintenance and replacement. During the piling and footing work, there were two broken piles. The malfunction of the crane was more of a problem than the broken piles since the subcontractor needed to wait until the crane was repaired. In this case, it the delayed other activities because the subcontractor had only a few operating cranes.

The general contractor and subcontractor responded to this problem by looking for technicians to fix the crane. Because the problem occurred during holiday, technicians were not available on the construction site.

4. Analysis of Cause and Impact of Construction Delays Resulting from Changing the Subcontractor

The problem with the shift of subcontractor was unexpected. However, this could have been prevented by establishing communication among all participants involved in the project so parties mobilizing to the construction site could prepare themselves in advance and coordinate with the general contractor's schedule. In this case, the subcontractor may have had a problem with his labor force or equipment. The delays in mobilization caused construction to lag behind schedule for weeks because of the time needed to set up equipment and the working area before beginning to work. It was difficult to solve this problem because the contract had already assigned this subcontractor, and the contract could not be changed immediately without an appropriate reason. The subcontractor had to accelerate the work which was delayed because of the late mobilization. The general contractor responded to this problem by sending a notice to the subcontractor to accelerate the work.

5. Analysis of Cause and Impact of Construction Delays Resulting from Long Holidays

There are many public holidays in Thailand. In this case study, certain holidays caused construction delays due to unavailability of labor. Some religious holidays which are counted on the lunar calendar are not specific days. As a result, the same religious holidays may be different from year to year. There will be a problem when two religious holidays are adjacent to a weekend. For example, if the holiday occurs on Thursday and Friday or Monday and Tuesday, this resulted in a four-day holiday, including Saturday and Sunday. Moreover, some festivals last three days and create a four-day holiday when it is adjacent to a weekend. Most laborers do not work during a long holiday, even at double wages. The contractor needed to allocate more resources before a long holiday to compensate for low productivity due to the lack of workers.

As indicated in the reports, the project had problems with long holidays during November and December 1994, and January 1995, see Appendix L for the calendar showing the holidays. There are many public holidays in December and January, however, these holidays did not cause as great an impact as those in April which has longer holidays. In addition, the weather during the end of the year, which is the winter season, is not as critical as that during the rainy season from August to November. If the problem with long holidays had occurred during the rainy season, the effect of delays would be more critical. In order to solve this problem, the general contractor allocated more workers before the long holidays.

Analysis of Cost Control Procedures Based on the American Construction Industry

The following are the analysis of the procedures based on the analysis from the case study. Procedures and concepts related to cost control procedures that are used in the United States construction industry will be used as guideline to analyze those used in the case study. The topics that are discussed in the following parts include 1) cost codes and accounting system, and 2) project cost control procedures. Under these major topics, the subtopics will be analyzed to explore in more detail.

1. Cost Codes and Accounting System

As discussed in the literature review, the cost codes and accounting systems illustrate the effectiveness of the general contractor or other parties involved with the construction. However, only some accounting systems from certain companies involved with the project are available. One of the available accounting systems is from the construction management company. Although this accounting system was not prepared by the general contractor, it is the system that recorded the cost management and its detail can be compared with the accounting system mentioned in the literature review and methodology. The job cost elements or cost codes can be derived from specific items in the detailed estimate. The development of a system of cost accounts requires an appropriate numbering and coding system which will synthesize the data associated with cost information (Civil and Environmental Engineering, 2004).

Halpin (1985) recommends a model, which identifies the flow of an accounting system in a construction company. Figure 5 shows Halpin's model which indicates that estimate and budget development are two major issues in cost planning that need to be thoroughly understood. According to this model, the contractor develops the project cost estimate which is the foundation for submitting the price to the client. After the project begins, this estimate is distributed throughout the construction period by plotting the amount of cost against time during each phase of the project. This estimate then becomes the budget.

As can be seen in the model in Figure 5, the job cost system is the center of cost control and cost engineering activity. It provides the conceptual relationship between the center of cost control and cost engineering and the general ledger, which is a subsystem of the cost accounting system. Conceptually, the entire accounting system gathers all information of all project costs to summarize the general administrative costs, selling costs, and other costs that are not directly related to the project.

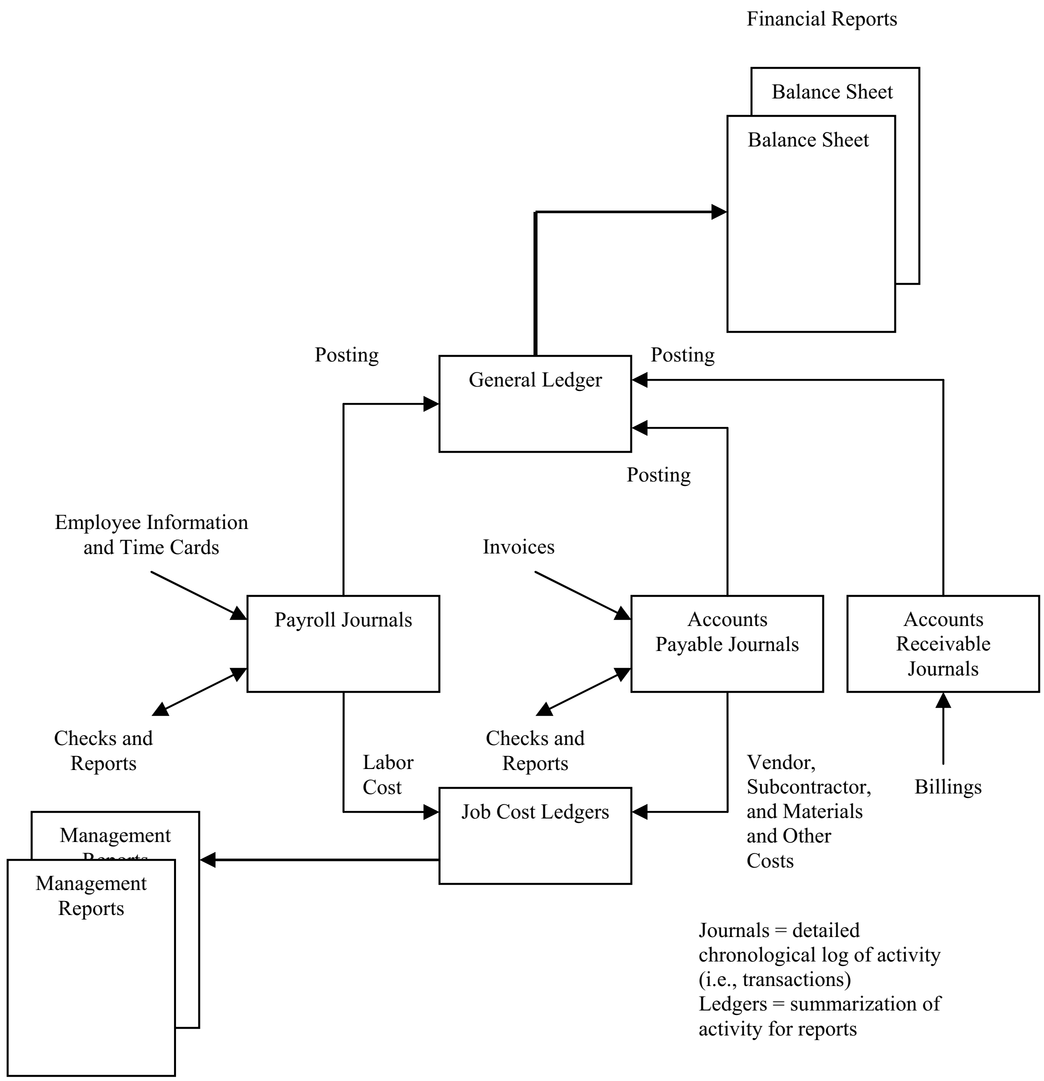

Figure 5: General Account Flows by Halpin (1985).

The job cost system identifies project expenses as they occur and distributes them to the physical subcomponent and cost generating subcomponent of the project under construction. The job cost system is a management information system used to collect information that is designed to assist the project manager to control the project. Besides collecting information, another object of the job cost system is to collect the data that will be used for estimating project costs in the future.

In this project, the appropriate coding system or cost codes are not found in the bills of quantities and progress payment submitted to the construction management company. The general contractor used his own system to identify the cost items. The bills of quantities and progress payment provided only the major items of construction work. However, the detailed cost codes or accounting system would be used for internal purpose only. As a result, these data cannot be found or are not available from the general contractor since he did not use an effective cost coding system in the construction.

Basically, the general contractor preferred to categorize the cost based on the progress of work which is illustrated in the numbers of floors; this allowed the construction management company and other parties to know which floors were under construction. The construction management company could then identify the progress of the work compared to the construction schedule.

Since the document showing the cost accounting system prepared by the general contractor is not available, the same type of document was gathered from the construction management company and from interviewing project participants. The flow of information can also be found in the cost accounting system established by the construction management company. Most project participants believed that the general contractor used the same procedure for preparing the accounting system, because it is the basic system for most contractors in the Thai construction industry. However, it should be noted that there may be fewer details in the system than proposed in Halpin's model because of the complexity of the project and business culture or the lack of experience of construction personnel. Although this project is composed of many buildings, most buildings are typical and used basic construction methods.

The system that the general contractor used in preparing an accounting system for his own use, as shown in Figure 6, is similar to the model recommended by Halpin (1985). The employees' information regarding the man hour and checks paid to the subcontractors and suppliers were recorded in the payroll journals. The amounts of money paid by checks to the subcontractors and invoices from suppliers were recorded in the account payable journals. The copies of bills sent to other parties were recorded in accounts receivable. These were performed on a weekly basis.

After all data were recorded, they would be posted in the job cost ledger, if the data were associated with the job costs. The other data would be posted in the general ledger. In this case, the job cost ledger and the general ledger were kept in the same place. Then, these data were kept in the balance sheet as part of the financial report. However, it is not clear whether the general contractor kept the data associated with job costs in the management reports for future use. The construction management company has kept all data and records associated with the job costs for use on future projects.

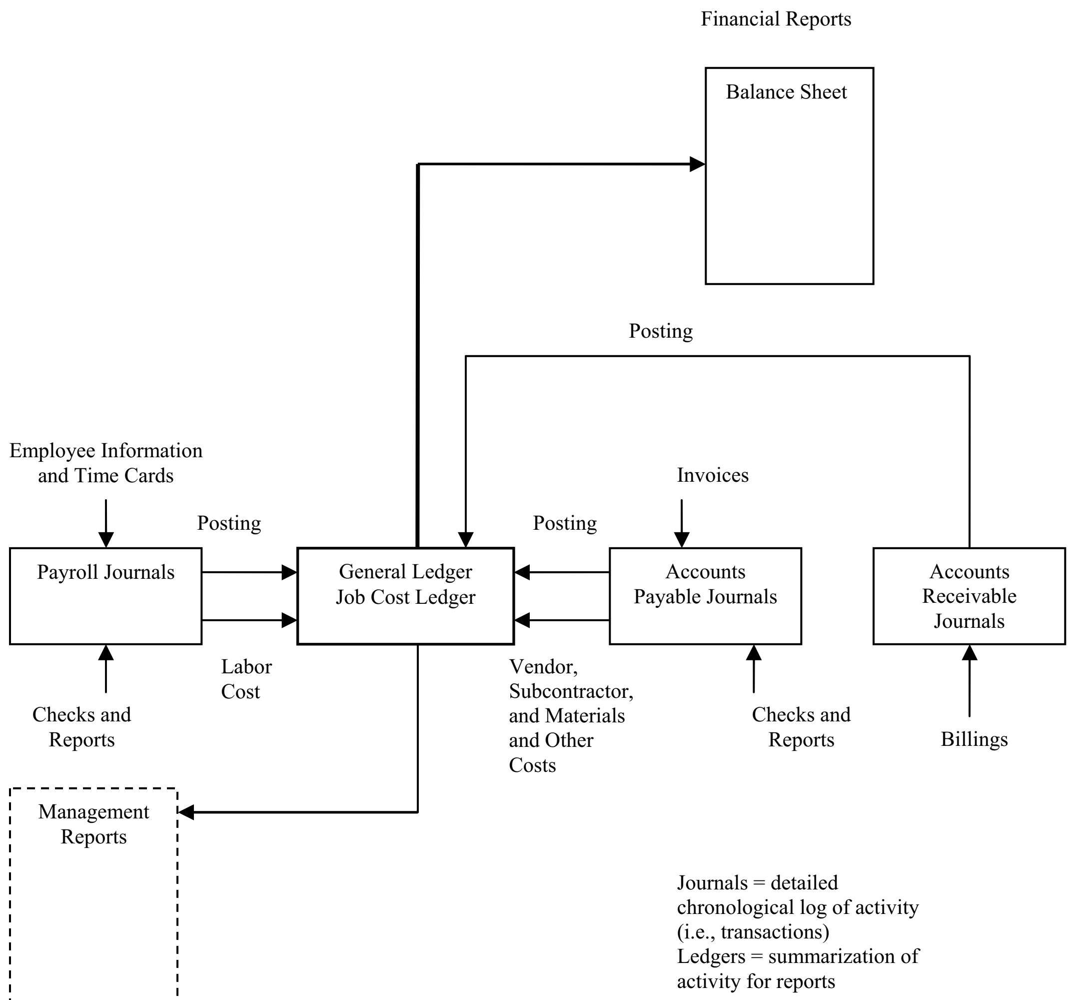

Figure 6: General Accounting Flows from Case Study.

It can be seen that the majority of the cost codes that were used by the construction management company followed the general contractor's cost code system which is widely used in the Thai construction industry. This coding system allowed both parties to communicate very effectively. However, these cost codes could be used only on this project since they were not a standard system. As can be found in the correspondences between two parties, many data could be shared and tracked successfully. The general contractor used his own system because he was affiliate of the owner's company and was hired to work primarily for this development company. The general contractor used the same system that was used in previous projects developed by the same owner.

2. Project Cost Control Procedures

The project cost control procedures used in the project were analyzed from the discussion of prior information to identify the effectiveness of the procedures that the project participants applied in controlling the construction costs and budget. The two purposes of these procedures were to record the financial transactions and give the construction managers an indication of the project status. It should be noted that the objective of a project control system is to identify cost overruns and delays.

The analysis is conducted by comparing the procedures used in the project and the procedures recommended by other researchers. The analysis will focus on two issues, i.e., cost control management and cost overrun evaluation procedures.

3. Cost Control Management

The first model that is used for comparison is the Cost-Control Management Cycle recommended by Halpin (1985), see Figure 7 which shows the preparation of the cost plan, the first step in the cost control cycle. After construction of the project begins, certain factors can cause deviations in the original plan. The project status, which can reflect the deviations from the conceptual plan, must be verified and reported to the cost engineer. In addition to achieving effective control, the reports should identify the cost deviation in a timely manner to help management to correct the variations and maintain the project within acceptable cost variance limits. Halpin (1985) suggests that the cost plan should be based on the cost estimate and the time frame of the project.

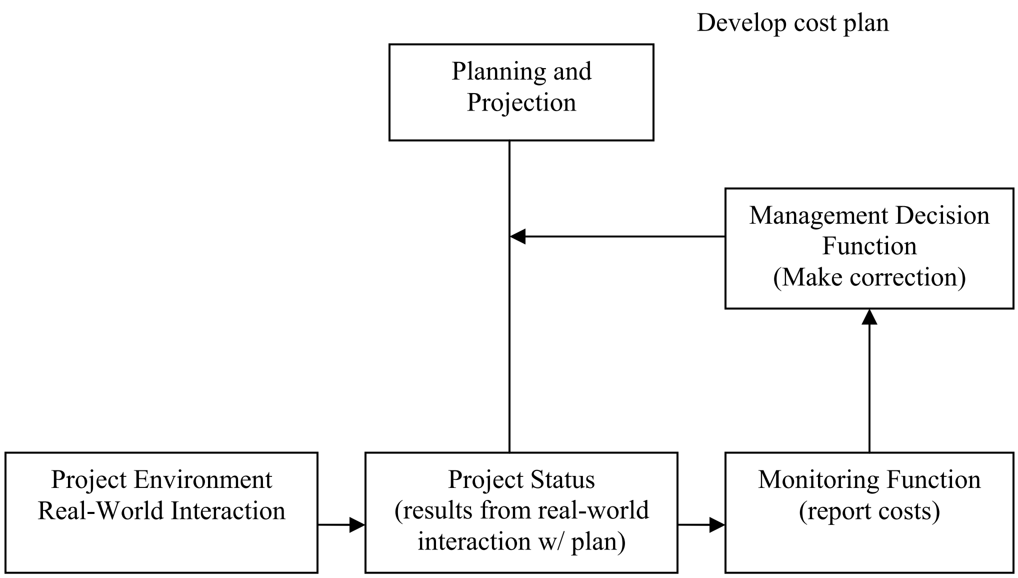

Figure 7: Cost-Control Management Cycle by Halpin (1985).

After the cost plan is utilized, management must gather the cost data to indicate the project status. The format of the reports should be well organized so the cost engineer can easily identify deviations from the original cost plan.

In the case study, while the work was completed by the general contractor, the cost control management procedure was not used during the construction. Figure 8 shows the procedure used by the construction parties to control the project cost. This model was created from project observation and participant interviews. The components with a dashed line indicate the functions that are omitted or were not managed properly by the construction parties neither the general contractor nor the construction management company applied effective procedures to manage cost control. Although certain cost deviations were found, the general contractor did not mention any the procedures to control them. He reported only the design changes or some problems found on the construction site to the construction management company and the owner. The development of a cost plan was not indicated in the construction reports and it was not discussed in the meetings. The changes in costs were mentioned in the meetings without proposing a procedure to control or manage these deviations. Only the current status of the project and some problems found on the construction site can be observed in the construction reports and the meetings. The project status was indicated in every weekly and monthly report. However, there was no record of cost control procedures in the reports.

It can be noted that the causes and results of cost deviations were sometimes discussed in the meetings, but no effective procedures were seriously discussed or implemented, possibly because the project manager did not have much experience in managing large construction projects and the general contractor was hired primarily to construct the project developed by the owner. As a result, the changes in costs or budget could be negotiated with the owner.

Halpin (1985) states that the process of developing a cost coding system and related system of expense account can influence the management of costs. In order to control the project cost effectively, a cost center which is a component of the cost account structure, should be established. However, the cost center recommended by Halpin (1985) was not established in this project by either the general contractor or construction management.

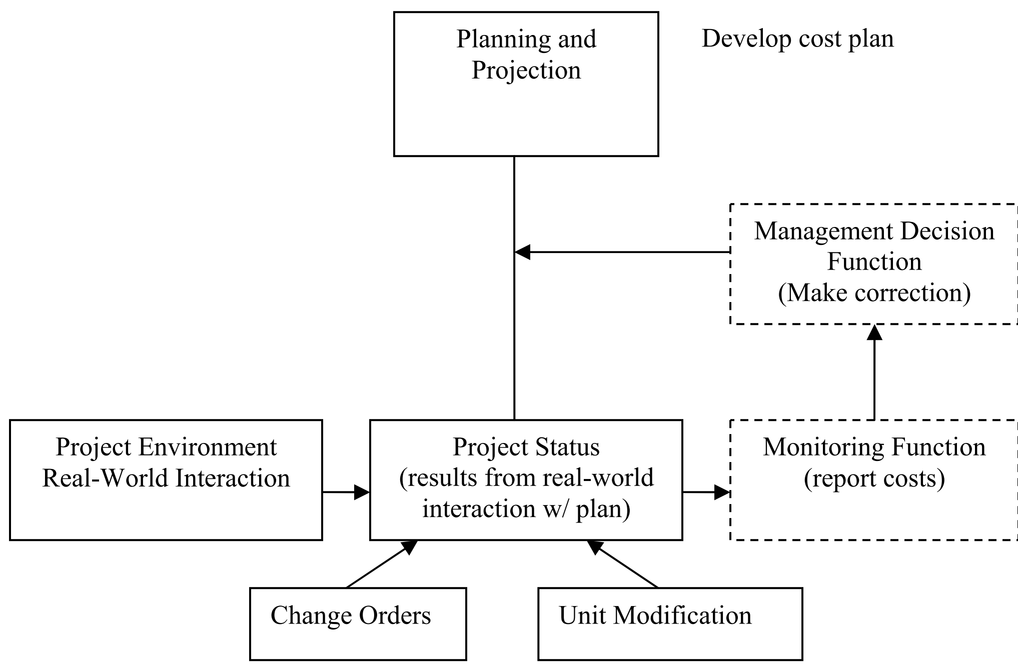

Figure 8: Cost-Control Management Cycle from Case Study.

James (1982: page 72) states that "Cost engineering is that area of engineering practice where engineering judgment and experience are utilized in the application of scientific principles and techniques to problems of cost estimation, cost control, business planning, and management science." Cost engineering, which is recommended as an effective tool to control construction cost, was not mentioned in the meetings in this project. Although most top management knew about the procedures or tools that could be applied in the construction, they were not very concerned about these issues. As indicated in the Interview

Part, top management indicated that it was very difficult to apply all of these effective issues since the construction process in Thailand is different from that of the United States in terms of business culture, quality of construction personnel, construction regulations, and project characteristics. In addition, the owner of the project was not concerned about implementing cost control procedures.

As can be seen in the case study, construction management performed the services based on standard procedures. However, some problems with construction delays or overruns were caused by the owner. Although some effective procedures were applied, they did not mitigate the problems. The results from interviews reveal that all participants in the project dedicated all of their efforts to accomplish the project goals. The cooperation among construction parties was well organized. Problems arose from insufficient communication between the Sales Department and the construction parties and the changed sales policy implemented by the owner.

4. Cost Overrun Evaluation Procedures

The second model is used for evaluating project overruns. Ahuja (1976) suggests the model of “Process for Evaluating Overrun” as seen in Figure 9. It shows the decision process which is needed to be conducted from the identification of a cost overrun to the required action. Ahuja (1976) mentions that overruns found in lump sum contracts will have no alternative – the project owner will have to revise the budget. In some cases, faster or cheaper alternative methods can be applied to solve the problem with delays or overruns, In this case study, several overruns were found after they had already occurred and the solutions could not be implemented on time. Figure 10 shows the procedure that was implemented in the case study. The components shown in the boxes with dashed lines were the ones that were used but were not effective. Certain events that caused overruns were found by both the construction management company and the general contractor.

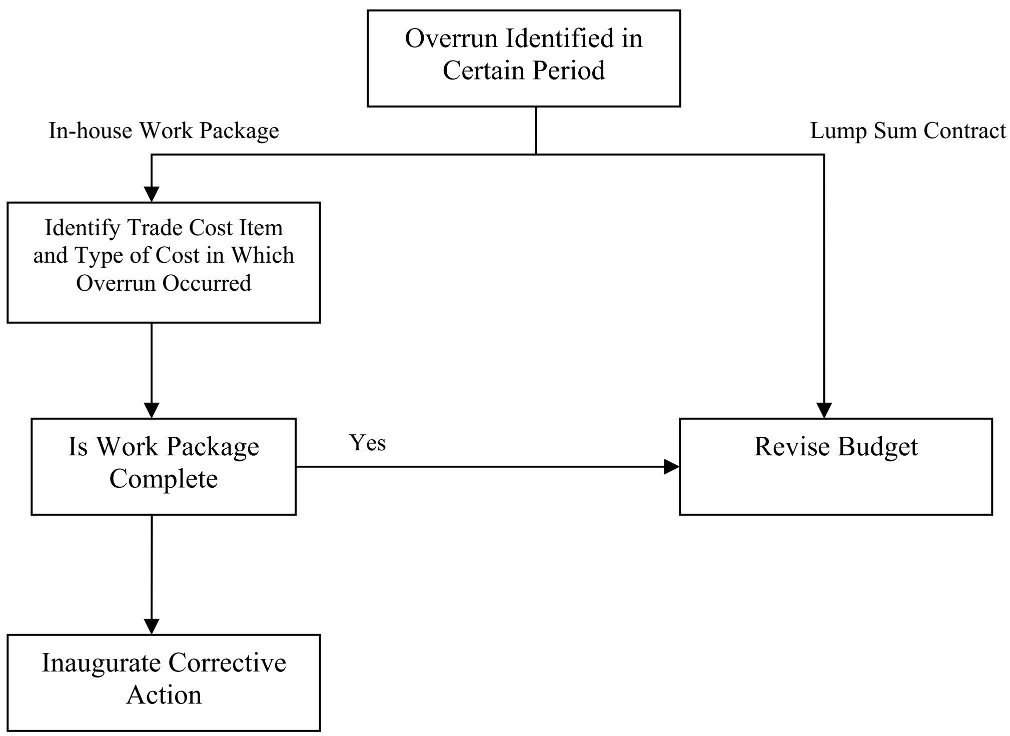

Figure 9: Process of Evaluating Overrun by Ahuja (1976).

Since the project used a lump sum contract, certain events that occurred during the construction period caused the owner to revise the budget. The basic problem was the design changes which were a result of incomplete drawings. Another result of incomplete architectural drawings recorded in the project archive was the lack of complete specifications. The following parts outline events that caused difficulty in evaluating cost overruns in the project.

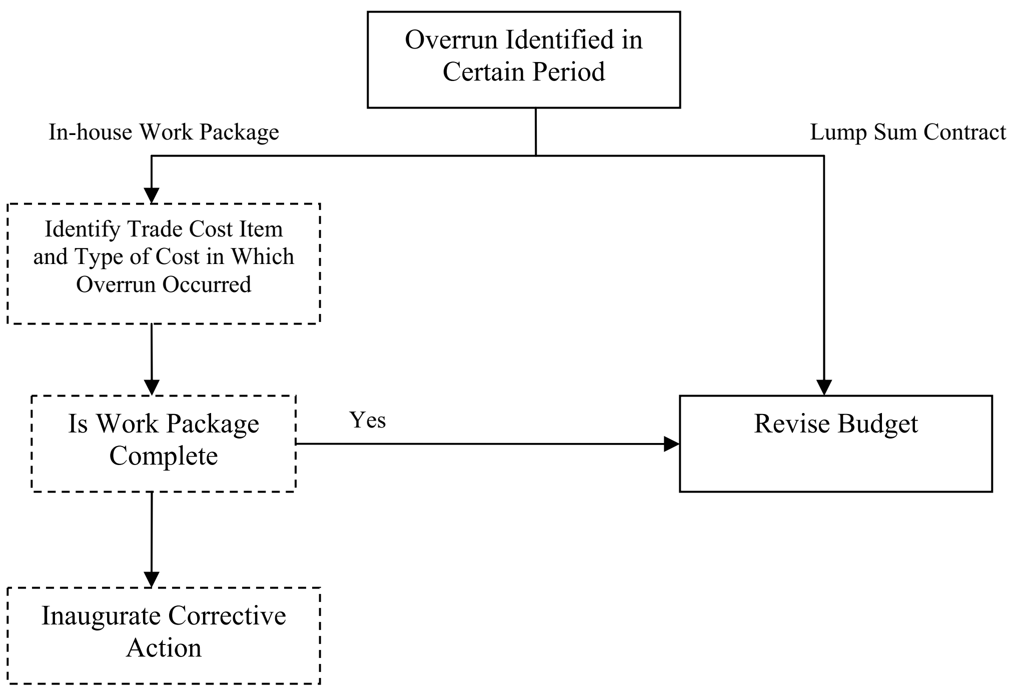

Figure 10: Process of Evaluating Overrun from Case Study.

One problem that is indicated in the project archives is the change of the exterior building color. The building was painted a new color chosen by the general contractor due to unavailability of the specified color since this was not acceptable to the owner and the construction management, certain parts of building were repainted. The other problem that occurred in tandem with this change was the weather. When the request for repainting the building was approved, there was rain for weeks which caused the general contractor to wait until the weather was suitable for painting. This was a major concern for the project manager of the general contractor because he tried to repaint the building under poor weather conditions. The request to repaint the building came from the owner because he wanted the building to be more attractive for the purchasers. Since the project wanted to sell more units at that time, the reapinting work could not wait for good weather. The result was that most of the paint peeled off the exterior walls. This caused more overruns.

The delay of structural work caused an overrun since the general contractor had to stop working on structural work for weeks due to the lack of structural drawings and the project lost money to labor and equipment costs. Some labor and equipment were on site, but they could not work on schedule and wasted time and money. Since structural work is critical, it delayed other work and had a significant effect on the completion date of the project. This also influenced the redesign of the recreation area on the deck in front of Tower G since the certain structural system was also changed to support a new function. This was another reason that caused the delay of structural drawings, since the project could not conclude the function of the recreation area before the structural drawings were prepared.

As can be seen from the overruns recorded in the project archives and construction reports, the procedures to evaluate cost overruns on the project were not effective and were not implemented at the right time. Although some overruns were found, there were many factors that caused difficulties in implementing effective procedures to evaluate overruns.

Besides the previous model, Kerzner (1995) recommends "Variance and Earned Value" method to analyze the performance of construction. He states that in addition to calculating the cost and schedule variances, an analyst needs to know how efficiently the work has been accomplished. He also mentions that a variance is defined as any schedule, technical performance, or cost deviation from a specific plan. In order to calculate variance we must define the three basic variances for budgeting and actual costs for work scheduled and performed:

- BCWP refers to Budgeted Cost for Work Performed.
- BCWS refers to Budgeted Cost for Work Scheduled.
- ACWP refers to Actual Cost for Work Performed.

The formulas that are applied to calculate the performance efficiency as a percentage of BCWP are:

$$\text{Cost Performance Index (CPI)} = \frac{BCWP}{ACWP}$$

Since delays are a significant cause of overruns, the delays which occurred on the project will be examined based on the schedule of work prepared by the general contractor. Because data showing the percent of work progress from February 1994 to October 1995 are not available, the percent of work progress during that time was projected based on the analysis from two scenarios, project observation and meeting minutes to identify the performance of construction. Figure 85, Appendix I, shows the original schedule from the general contractor.

In order to analyze the performance of construction after January 1995, two scenarios were proposed. The first scenario , see Table 5, assumed that the general contractor did not increase the costs after January 1995, which conformed to the progress payments that were attached to the construction reports, while the second scenario assumes the increase of construction costs. Both scenarios use the same percent of work completed. Figure 86, Appendix I, provides the analysis of the first scenario. There Budgeted Cost for Work Performed is likely different from the Actual Cost for Work Performed. The construction was completed two months behind schedule. Figure 86, Appendix I, indicates that the lines of Budgeted Cost and Actual Cost are parallel.

The second scenario, see Table 6, assumed that the general contractor increased the costs of certain items after January 1995, which is supposed to be possible. Figure 87, Appendix I, shows the result of the second scenario. The Budgeted Cost for Work Performed is significantly different from the Actual Cost for Work Performed, which is a result of increased construction cost. As seen in the Figure 87, the lines of Budgeted Cost and Actual Cost are parallel. Both Figures indicate the same trend, although both scenarios use different construction costs. This indicates that the costs of construction did not impact the delays as long as the general contractor maintained his performance, which can be seen from the percent of work complete. On the other hand, the increased costs are a result of delays. It can be summarized that the delays in construction were caused by factors which occurred at the beginning of construction. These factors include the incomplete structural and architectural drawings. Another factor that played a critical role in the mid life of the construction was the requests for change orders from the Sales Department which prevented the general contractor from accelerating the construction to get on schedule.

Scenario 1: No Increased Construction Costs

Table 5

Scenario 1: No Increased Construction Costs- Cost Performance Index

BCWP	= \$1,786,322.52
ACWP	= \$1,786,411.19
Cost Performance Index (CPI)	$= \dfrac{BCWP}{ACWP}$
	$= \dfrac{1{,}786{,}322.52}{1{,}786{,}411.19}$
	= 1.00
Scenario 1: No Increased Construction Costs- Cost Variance	
Cost Variance (CV)	= BCWP-ACWP
	= \$1,786,322.52-\$1,786,411.19
	= -\$88.67

Scenario 2: Increased Construction Costs

Table 6

Scenario 2: Increased Construction Costs- Cost Performance Index

BCWP	= $1,786,322.52
ACWP	= $2,054,373.70
Cost Performance Index (CPI)	$= \frac{BCWP}{ACWP}$
	$= \frac{1,786,322.52}{2,054,373.70}$
	= 0.87
Scenario 2: Increased Construction Costs- Cost Variance	
Cost Variance (CV)	= BCWP-ACWP
	= $1,786,322.52-$2,054,373.70
	= -$268,051.18

If CPI is equal to 1.0, the project has perfect performance. If CPI is higher than 1.0, the project has exceptional performance. If CPI is lower than 1.0, the project has poor performance. A negative variance indicates a cost-overrun condition.

The results from the Variance and Earned Value method indicate that the project performance is acceptable in the case of the first scenario, but it is unacceptable for the second scenario. However, both scenarios have cost overruns according to the results of Cost Variance calculations. The results from both scenarios indicate that the performance of the general contractor was related to the extent of cost overruns. Since certain data in the table are assumed, the results of the analysis may not be completely accurate. It needs to be analyzed together with other available data.

In order to identify the delays which occurred in the project, the graph in Figure 88, Appendix I, was created based on the assumption from the two scenarios mentioned previously.

Figure 88 shows the degree of delays that occurred during the construction of Tower G. It is apparent that construction was significantly behind schedule from October 1994 to January 1995 and from May 1995 to July 1995. During the first delay, the general contractor was waiting for structural drawings which caused him to stop construction for weeks. The second delay occurred after the requests for unit modifications were submitted to the general contractor and construction management company. This caused both parties to revise the construction schedule. However, since there were many requests that were associated with physical modifications, the general contractor needed to extend the construction schedule. The delays that happened at the beginning and at the third quarter of construction caused two months delay in construction of the entire project. Figures 86 and 87, Appendix I, show that both expected percent of work complete and actual percent of work complete are parallel as a result of accelerating the construction by allocating more construction personnel after the completed structural drawings were received. This also indicates that the general contractor could manage the design changes from the Sales Department effectively, since the construction during the last two months was performed faster. The construction of unit modifications was accelerated and the delayed time dropped from three months to two months, as shown in Figure 88, Appendix I.

5. Cost Control Procedure

The next model, shown in Figure 11, which is recommended by Halpin (1985), is a model that provides the steps in cost control. He states that the design and format of a cost control system can depend on the requirements of the contractor. In addition, the system implemented by the contractor must provide benefits that exceed the cost of operating the system. In this study, the model he proposed will be used to analyze the cost control procedure that can be applied by the general contractor.

The model is composed of five major parts. The first part is the Chart of Cost Account which illustrates the level of detail of job cost information that the contractor needs to maintain. The second part, which is the Project Cost Plan, shows the cost of the project at the beginning of the project which the owner expects to pay. The cost plan and project estimate will be compared with the actual cost which is recorded on the construction site. Data Collection, \ the third part, is the place where all cost data are collected and recorded to indicate all data regarding the project cost.

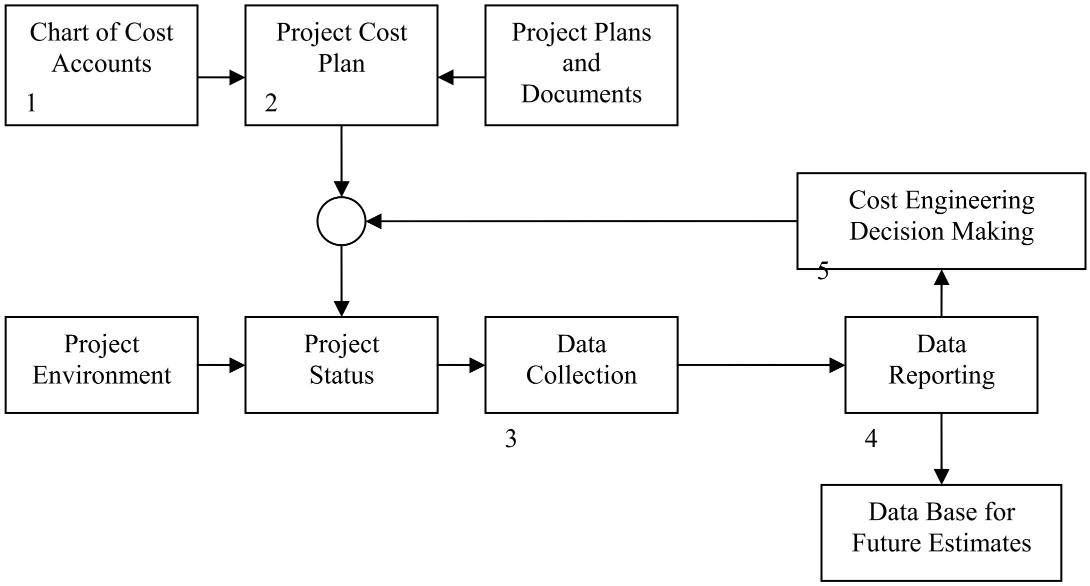

Figure 11: Steps of Cost Control by Halpin (1985).

However, the collection system needs to be integrated into the cost reporting system effectively. The fourth part is the Project Cost Reporting which is required by the project management. In addition to effective reporting, the management needs to identify the relevant costs that will be used for cost management. The last part is Cost Engineering which helps management analyze the costs of the project. The implementation of this model will help the management to control project costs.

The construction reports and the observations from the meetings indicate that the general contractor and other subcontractors did not implement effective cost control procedures. Figure 12 provides the steps of cost control implemented by the construction parties in the case study. The steps in the boxes with dashed lines were the ones that were not found in the project. However, most project participants indicated that they realized the impact of ineffective cost control procedures which consequently led to cost overruns. They stated that with the change orders it was sometimes beyond their ability to implement appropriate measures or procedures to prevent cost overruns immediately. In addition, some cost overruns resulted from delays which they were unable to control such as incomplete structural drawings and the unit modifications requested by the Sales Department.

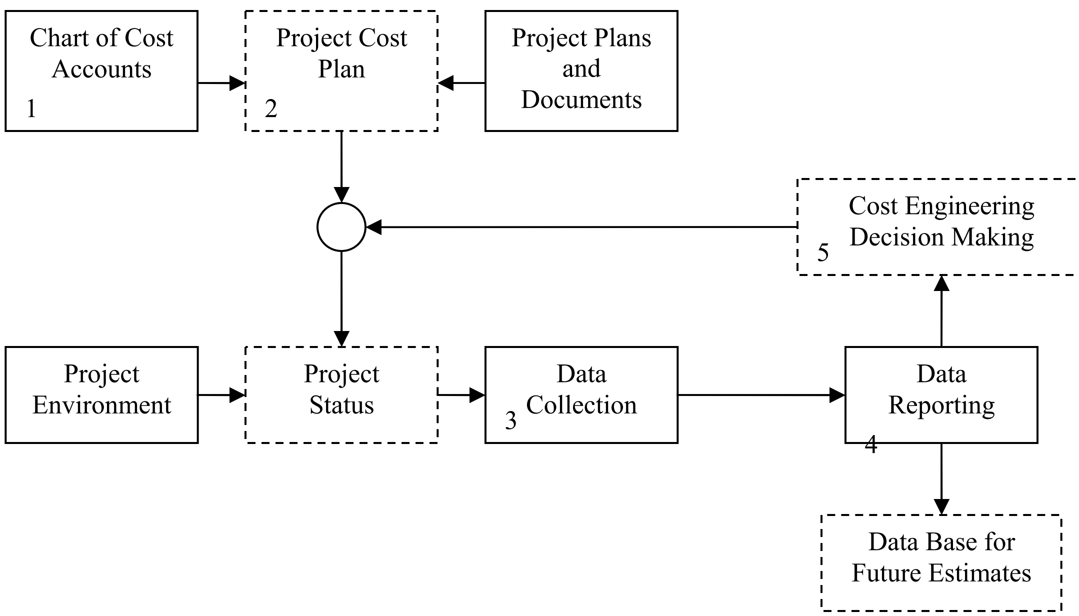

Figure 12: Steps of Cost Control from Case Study.

Although the construction parties could control the construction schedule of certain activities, some activities were difficult or impossible to state in the as-planned schedule. Since the requests for unit modifications were submitted almost at the end of construction, none of the construction parties expected such a large number of modifications. The incomplete architectural and structural drawings created difficulties in controlling costs and caused delays at the middle of construction, furthermore, the significant number of changes from purchasers caused more difficulties. Even though the general contractor could accelerate certain parts of construction after receiving the completed structural drawings, he could not move the construction fast enough to catch the as-planned schedule.

As mentioned before, the construction parties, including the construction management team, could not implement appropriate measures to control the schedule and costs of the project. Certain cost overruns could be detected prior to their existence, but the appropriate procedures could not be implemented immediately because when an overrun was found, other cost overruns were also occurring. This was beyond the ability of the construction personnel to manage, even at the top management level.

The primary reasons for this failure were insufficient project objectives and changes in scope of work, and ineffective decision making by the owner. The project began before both architectural and structural drawings were completed. As a result, many change orders occurred during the construction course with a negative effect on project cost control procedures which ultimately led to cost overruns. The incomplete drawings created not only an inaccurate estimate, but also inaccurate schedule.

Summary of Case Study

This part will summarize the factors that affected the management of the project and caused cost overruns based on their importance. According to the case study, the owner are the major cause of construction delays and cost overruns.

Factors Affecting Cost Overruns

As discussed previously in this chapter, there are many factors that caused cost overruns in the project. Certain factors led to a chain reaction of problems. The major causes of overruns were construction delays which resulted when the owner wanted to change the building design or specifications and general contractor and construction management had to wait for approval before implementing those changes. Another factor was incomplete drawings which caused the majority of delays in construction. Figure 13 summarizes the causes of delays.

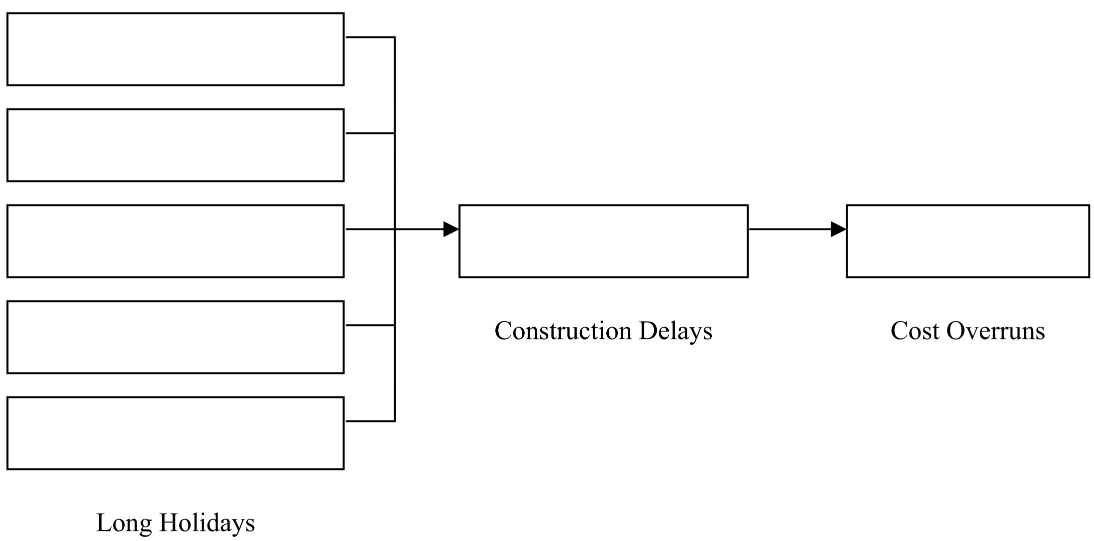

Figure 13: Cause of Construction Delays Indicated in Construction Reports.

The factors that caused construction delays are categorized based on the level of their impact found in the case study.

1. Owner's requests for change orders

These change orders can be found through out the construction period. This is the major cause of construction delays. The first construction delay was primarily the result of the owner's request for changes.

2. Requests for unit modifications from the Sales Department

These requests can be found after the Sales Department began to sell some condominium units. The delay that resulted from the Sales Department can be seen in Figure 90, Appendix J, which occurred almost at the end of construction.

3. Incomplete structural drawings

The problem with incomplete structural drawings was found at the beginning of the construction because the general contractor had to wait for completed drawings to perform structural work which was critical to construction.

4. Incomplete architectural drawings

The problems with incomplete architectural drawings could be found throughout the course of construction. However, the general contractor and construction management company could solve most of problems resulted from the incomplete architectural drawings since they had enough time to prepare for those problems.

The major reasons for incomplete structural and architectural drawings are the limited responsibility and scope of architectural and structural designs and the project strategy which allowed for flexible modifications. Figure 13 illustrates the summary of major costs of delays that were indicated in the construction reports. This problem occurred because the owner wanted to reduce the fees for architects and engineers and offer more alternatives to the purchasers. Since the architect and engineer could not complete the drawings and provide sufficient specifications, the general contractor could not prepare an accurate cost estimate. The incomplete drawings caused the construction management company and the general contractor to spend more time identifying the specification and completing the drawings. Hence, this caused the delays of construction because the general contractor had to wait for complete drawings. The delays from incomplete drawings consequently resulted in cost overruns due to allocation of more materials and workers.

CHAPTER VIII

CONCLUSION

Expected Outcome

Since many Thai construction companies are preparing to compete with multinational companies in international markets, they need to enhance the quality of their construction personnel and productivity. Project cost control procedures and estimating are major concerns for Thai construction companies which will determine their success or failure in both local and international construction markets.

The results of this study are expected to answer research questions and provide guidelines for Thai companies developing condominium projects.

This chapter is organized into three parts. The first part discusses the conclusions from the case study and the second part summarizes problems found in the Thai construction industry. The last part provides suggestions for adapting the theories used in the United States to the Thai construction industry.

Case Study Conclusion

The following conclusions are made from the analysis of the case study. The major issues in these conclusions are the problems of cost overruns originating from decisions of the owner which include poor definition of scope of work, incomplete drawings, design changes, and construction delays.

Poor Scope of Work

Because the owner wanted to reduce the fees for architects and engineers, their input was limited and incomplete drawings, insufficient specifications and inaccurate estimates caused many problems during construction. In addition, the owner did not identify the scope of work because he wanted flexibility for future changes.

Incomplete Drawings

As mentioned previously, the incomplete drawings were a result of reducing the project budget and allowing unit modification after construction began. The drawings were sufficient to file for a building permit, but not for construction. Furthermore, the drawings did not provide sufficient data for an accurate project schedule.

Design Changes

Because the architect and engineer did not provide detailed drawings and specifications, the general contractor and construction management company needed to prepare drawings and specifications which were not indicated in the contract documents. Another reason for design changes was the owner's strategy to allow the purchasers to modify their units after purchasing which created many requests for design changes after the units were sold.

Construction Delays

Construction delays were the result of all the reasons mention above. The limited scope of work, incomplete drawings, and design changes caused the general contractor and construction management company to reschedule construction many times.

In this case study, the owner focused on three components throughout the construction, see Figure 14 – time, cost and quality. The owner had tried to maintain a balance among these three components. When the costs tended to be higher, the quality of materials was decreased. However, the quality was not reduced to lower than minimum standard indicated in the specifications. In case that the construction took longer time to complete, the quantity of work was reduced.

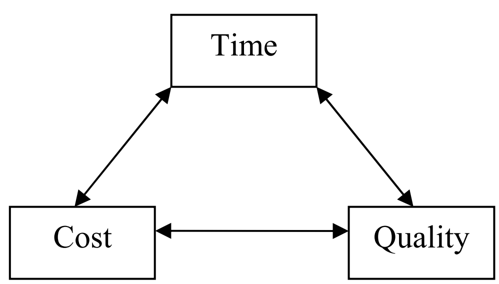

Figure 14: Owner's Project Components.

Thai Construction Industry

The major problems discussed in Chapter 4 were found in the Thai construction industry; some of the same problems were also found in the case study including incomplete drawings, cost overruns, and cost control procedures. The following provides a summary of these problems.

Incomplete Drawings

Incomplete drawings are one of major problems in the Thai construction industry which resulted in construction delays and cost overruns. In addition, incomplete drawings are a major factor that affects the productivity of the Thai construction industry (Emsley & Makulsawatudom, 2003). This problem is created by the following factors:

- Limited Construction Budget
- Limited Time to Prepare the Drawings
- Limited Scope of Work
- Insufficient Design Data
- Inexperienced Designers

Cost Overruns

According to the definition of cost overruns discussed in the literature review, cost overruns were found in the project under study. The final cost of construction was higher than expected. The cost of construction increased after delays which were caused by insufficient specifications and change orders from the owner. Problems with incomplete drawings arose after the construction began and tended to become more critical when some units were sold. Significant delays and cost increases can be found in the structural and architectural work.

As mentioned in the case study, most top level construction personnel were concerned about project cost overruns; however, there were several factors that made them unable to prevent overruns and certain factors were beyond their ability and responsibility. Among factors were inappropriate project goals, construction delays and change orders. It should be noted that both this case study and other Thai construction projects are confronted with the same situations regarding cost overruns. The differences that can be identified in this study are the quality of construction personnel and the owner constantly changing requirements. The following are factors that create cost overruns.

1. Unavailable Data

Lack of data creates risk for the general contractor in managing project cost. In this project, the general contractor did not receive sufficient data to prepare a cost estimate because the goals of the project were insufficiently established and the structural and architectural drawings did not provide enough information to prepare detailed estimates. As a result, the estimate was not accurate.

2. Omission of Construction Items

The omission of some items, such as floor finishings in some area or bathroom fixtures, at the beginning of the project can be a possible reason for overruns. This problem was found in the case study at the beginning of the project. These items were not included in the estimates, due to incomplete architectural and structural drawings.

3. Project Strategy

Besides the design changes resulting from the owner's requirements, the project strategy of the Sales Department was another reason for design changes. Because of high competition, the Sales Department decided to attract more purchasers by offering the purchasers modifications after they decided to buy units. As mentioned in the previous chapter, the design changes from the Sales Department caused construction delays and, consequently, project cost overruns.

It can be concluded that the cost overruns incurred in the case study were mainly caused by the delays and design changes.

Cost Control Procedures

Cost control is a major problem for the Thai construction industry (Thungphanich, 1997, November). As discussed in the literature review, the scope of cost engineering covers many issues such as planning, estimating, scheduling, and cost control in construction (Neil, 1982). In this case study, although the construction parties on this project did not critically discuss cost engineering in the meetings, they applied certain measures during construction which can be included in the scope of cost engineering.

1. Procedure Implementation

Observations and interviews indicate that the top construction management personnel in the project were eager to adopt effective procedures to control project costs. The basic procedures that the construction personnel planned to implement are similar to those used in the United States. However, procedures used in the American construction industry are more complicated. This could be seen when the construction participants discussed possible procedures to reduce the cost of construction. The construction management company tried to communicate with all related parties in order to develop appropriate coordination which could lead to effective cost control. Some of the discussions about project control were found in the meeting minutes.

2. Architect Responsibility

It is recommended that the architect design the project in accordance with the cost plan (Brandon & Ferry, 1984). However, the goals of the project were not clearly established, therefore, the project cost plan could not be implemented. In addition, the scope of work performed by the architect was significantly limited because the owner wanted to reduce project expense and the project information was limited due to insufficient project objectives. Hence, the architect had limited information to design the buildings in accordance with the project cost plan. As a result, the procedure recommended for the architect was not implemented on this project. Since the project did not establish the cost plan at the beginning due to limited information and insufficient project objectives, the architect could not design the buildings to conform to the cost plan. The result was incomplete structural and architectural drawings which ultimately led to ineffective cost control and cost overruns.

3. Communication

A communication problem can be found in this project. As indicated in the meeting minutes and data from interviews, the communication between the construction parties and the Sales Department was a critical problem, which caused construction delays and affected the project budget.

Adaptation of Project Cost Control Procedures and Cost Overrun Concepts between the United States and Thailand's Construction Industries

According to this study, project cost control and cost overruns concepts could not be adapted by the management of construction in typical condominium projects since the owner is a critical factor which cannot be controlled. Another significant factor is the quality of lower level construction personnel. Although the top management attempted to implement several effective procedures, this could not be accomplished without the support from the owner and the effective cooperation between the personnel at the top and lower levels. The following are factors affected the adaptation.

Owner's Perspective

The first factor that affected the adaptation was the owner's actions. As can be seen in the case study, the project goals were not established appropriately and the owner tried to reduce the budget by limiting the responsibility of the architects and engineers. In addition, the owner placed the responsibility for controlling project costs on the construction parties which created many problems because of incomplete drawings and specifications. Before the construction began, the owner should have established project goals and identified the responsibilities of all parties necessary, and realized that his decisions could have a great impact on the scope of work and project budget. Although the general contractor and construction management company tried to manage the schedule in order to avoid the delays which could lead to cost overruns, change orders from the owner occurred several times throughout the construction period. In this case, because the general contractor was an affiliate of the development company, the owner had a different perspective about the cost control. There were ongoing negotiations between the owner and the general contractor during the construction of this project, however, this specific relationship is beyond the scope of this research.

Practically, the owner may place the responsibility for project cost control solely on the construction parties. In order to control time and budget, the owner needed to provide effective coordination and understand the process of construction management.

Quality of Construction Personnel

Besides the owner's actions, the quality of construction personnel was another problem.

1. Quality of Construction Labor

The case study found that many workers in the Thai construction industry are not certified or skilled. Most of them lack experience and knowledge of construction practices. Cost overruns can be decreased or prevented not only by effective management, but also by hiring high quality construction personnel. Although skilled labor is more costly than unskilled, its' higher productivity can help management plan the construction more effectively.

2. Quality of Top Management Personnel

Most top management personnel were qualified for managing the construction since they understood their responsibilities and knew how to implement appropriate procedures to cope with cost overruns based on their education and experience. According to the ability and knowledge of personnel in the project under study, they could incorporate most cost control procedures used in the United States into their management concepts. Certain construction procedures used in Thailand, such as the bidding process and estimating have followed those used in the United States (Supphasri, 2003). The point is that management may not have had an opportunity to implement successful cost control procedures since the owner did not provide the opportunity. This would be an important opportunity to improve the management system and roles of all parties in the construction industry, including the project owners.

Summary

The adaptation of cost overrun concepts and cost control procedures used in the United States is necessary but not sufficient to mitigate cost overruns in the Thai construction industry. However, the knowledge should be disseminated to all levels of management and the owner. Since this research is a pilot study, certain issues need to be explored further. As mentioned previously, some data were not available which could have affected the results of the study. The subject of the case study was a project that was completed before the economic crisis in 1997 which had a significant impact on the Thai construction industry. After the conclusion of this crisis, many changes in the Thai construction industry have occurred and need to be studied to identify their impact on the construction processes and management systems that have been used in Thailand for decades.

CHAPTER IX

RECOMMENDATIONS AND FUTURE RESEARCH

Proposed Recommendations

As mentioned in previous chapter, the problems occurred in the case study are also found in Thai construction projects. These problems include incomplete drawings and design changes originating from the owner, contract, construction procedures and personnel which can cause project cost overruns. This chapter provides tentative recommendations to improve construction management and mitigate problems with cost overruns that occurred in the case study and provide general recommendations to mitigate problems found in Thai construction projects. The first part of the proposed recommendations is based on the problems that were found in the case study. These recommendations focus on the construction of condominium projects. The second part of the proposal is based on the problems found in the construction industry and suggests procedures that can be adapted for other conventional commercial and residential projects.

Figure 15 provides the structure of the recommendations. There are two major parts which focus on the case study and the Thai construction industry. The first recommendations regarding the case study focus on the owner and contract. The second recommendations for the Thai construction industry focus on construction personnel and procedures because it lacks qualified personnel and effective construction procedures.

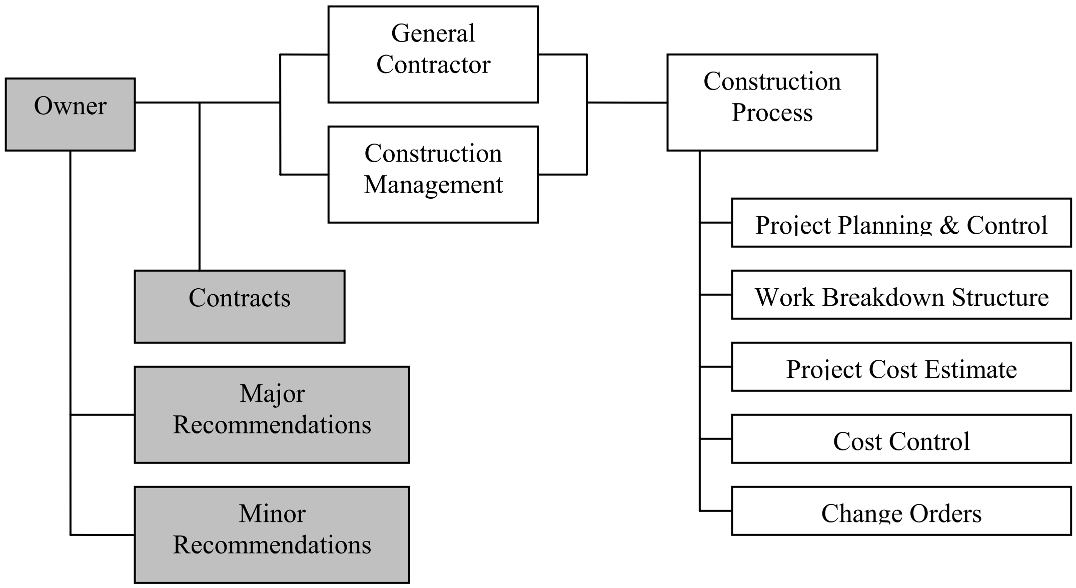

Figure 15: Recommendation Diagram.

Recommendations for Improving Problems Found in the Case Study

The following recommendations are categorized based the analysis of problems mentioned in the previous chapter. The recommendations are presented in the order of importance, first focusing on the owner.

Owner

In the case study, the owner created many problems during construction such as poor scope of work, incomplete drawings, and design changes. These problems led to construction delays and cost overruns. Since the owner was the major cause of construction delays and cost overruns, the following provides major and minor recommendations based on the problems that were found in the case study. These recommendations are expected to help Thai condominium project owners mitigate the problems occurred during construction.

Recommendations for Major Problems Originating from the Owner

The following recommendations focus on the major problems occurred during construction of the case study which caused critical impact on construction from the beginning to project completion. The recommendations can be applied at the beginning of construction to avoid unexpected problems.

1. The owner should establish project objectives and identify strategies for accomplishing the project. Project objectives may differ based on the types and functions of the projects and may include the following:

- Avoiding Unproven Equipment
- Emphasizing Safety during Construction
- Keeping Final Costs within Budget
- Minimizing Startup Time
- Designing for Specific Project Life
- Focusing on On-time Completion
- Assessing Reliability of Operations

- Encouraging Early Completion Time
- Overseeing Quality of Product
- Making Lowest Capital Investment
- Maintaining Lowest Operational Costs

2. Because the project was to make certain unit decorations and features flexible for future modifications, the owner should have selected a contract and procurement system best suited for these strategies.

3. The owner needed to convey the project objectives and strategies to all project participants so everyone could understand and focus on the same issues.

4. The authority and responsibility of all participants should be established before construction begins.

5. The owner should identify the scope of work at the beginning of the project, so it will conform to the contract. The outline of a typical scope of work may include the following:

- Official Identification of the Project
- A Brief Description of the Project
- Pertinent Contract Data Affecting the Work
- Licensing Information/ Conditions/ Constraints

- Responsibilities
- Available Descriptive Material Defining the Work
- Decisions that Have Been Made

Recommendations for Minor Problems Originating from the Owner

This part emphasizes the minor problems occurred during construction. The recommendations can help the owner avoid several problems that could occur during construction.

1. The owner should select project participants who can complete the project based on the project objectives and strategies.

2. The organization structure within the company should be well-established to support the project management and cooperate with participants outside the company.

3. The construction management company should be brought into the project during the design phase.

4. The owner should improve communication between construction participants by incorporating the following components in the project progress report:

- Executive Summary
- Project Cost Report

- Project Status Report
- Project Master Schedule
- Subcontracts Report
- Trend Report

Contract

Preparing the contract is a primary step in a construction project. The type and procedures for construction indicated in the contract have a significant impact on the construction process. In the case study, there were many contract documents which covered the responsibility of all parties. However, certain clauses were not properly clarified. This caused difficulties between the construction parties and sales representatives. Well established contract documents could reduce problems with responsibilities and communication on the construction site. The following recommendations are expected to reduce contract problems which were found in the case study.

Clarifying Objectives of Contracts

The objectives of contracts must be clear. In the case study, there were many contracts between the owner and construction parties; but some contracts did not completely identify the scope of work and responsibility of each party. In addition, the contract did not cover the complete responsibilities of some parties which consequently led to incomplete drawings and construction delays. It is important for the contract administration and management to reduce project risks, increase cost savings, reduce construction claims, and improve economic returns. Well-prepared contracts can effectively manage contract risks through incorporating fair terms, implementing negotiating practices, and using effective communication skills.

Preparing Contract Documents

Contract preparation should cover the following:

- Contract Conditions
- Commercial Terms and Pricing Arrangements
- Scope of Work
- Project Execution Plan

The well-prepared contract document must identify the responsibilities of parties involved with the construction. Separate responsibilities between the project manager and the contract department can cause inefficiencies, disagreements, and delays and result in a negative impact on the project cost and schedule. As noted in the case study, the contractor could not coordinate with the sales representative effectively because responsibility of the sales representatives was not indicated in the scope of work.

An important decision in execution strategy is whether to contract and to what extent. The scope of work must be established before the project develops an execution plan.

Selecting an Appropriate Contract Format

In order to select the appropriate format for contract documents the owner should know the advantages and disadvantages of format selection. Owner-approved plans, specifications, and contract documents define the construction work and clarify the scope of work. Conflicts among construction parties due to repetitive work can be avoided if the owner is aware of the importance of contract types and formats.

Recommendations for the Thai Construction Industry

The following part provides recommendations for problems in the Thai construction industry. As discussed in the Conclusion, certain problems in the Thai construction industry were apparent in the case study – mainly problems with construction procedures and management. In this part, the major recommendations focus on the construction procedures which can be applied to those problems discussed previously. As can be seen in the case study, the construction personnel played a critical role during construction. Even though they did not have opportunity to apply successful measures, they implemented some procedure to reduce problems occurred during construction. Because project success depends on construction personnel controlling and managing the construction, the recommendations also emphasize the general contractor and construction management company. These recommendations specifically focus on cost control procedures performed by both the general contractor and construction management company.

Project Planning and Project Control

As indicated in the case study analysis, the project planning and control procedures were not implemented properly. Although some measures were applied, construction delays and cost overruns occurred throughout the construction period. The general contractor could not control the schedule due to certain factors, including changing owner requirements. The following recommendations are proposed to assist the project managers for the general contractor and construction management companies in establishing effective project planning and project control procedures. The recommendations will be proposed based on the problems found in the case study. The proposed recommendations will be subcategorized into smaller issues regarding the major problems found in the case study and the Thai construction industry.

A project control system should start with the establishment of project standards. In this case study, the documents regarding the project standards were not found in the archives or reports. The components that will be used to control the project are estimate and measurement of actual performance on the project. The project estimate will identify the overall budget for the project and milestone costs for specific phases of work. In addition, purchase orders, delivery documents, and receipts will indicate actual costs for actual performance on the project. In the case study, the milestones costs were not established as a significant goal. In order to control the project effectively, the project objectives should have been established before construction started.

1. Area of Control

The areas of control which should be stated in the control process include the following:

- The money plan (the project budget)
- The time plan (the project schedule)
- Quality standards
- Material resources and delivery
- Labor supply and productivity
- Cash flow projection

2. Communication

Open communication between the owner and contractor's project manager during the development stage is essential to successful implementation of the design. This procedure should be implemented in all condominium projects because the design changes are expected during the construction to improve the project design in order to compete with other projects.

3. Components of Control

An effective project control technique should help management personnel accomplish project goals. Effective project control for condominiums should accomplish the following:

- Identify potential uncertainties well in advance of their occurrence.

- Evaluate the impact of hazards and, where possible, proposes actions to alleviate the situation.

- Provide constant surveillance of project.

4. Steps of Control

Control of project consists of the following three steps:

- Determining the level to which progress toward objectives is being made by analyzing the project reports.

- Identifying cause of and potential methods to correct critical deviations from planned performance.

- Taking control action to correct an adverse trend or to taking advantage of an unusually positive trend.

5. Project Directing

Besides controlling, project directing implements and carries out the approved plans necessary to accomplish the project objectives. These include the following:

- Staffing to ensure that a qualified person is selected for each position.

- Training to teach construction personnel how to accomplish their duties and responsibilities.

- Supervising to provide day-to-day instruction, guidance, and discipline as required so that the personnel can fulfill their duties and responsibilities.

- Delegating work, responsibility, and authority so all personnel can maximize their abilities.

- Motivating construction personnel to perform by responding to their needs.

- Counseling personnel about improving work or solving personal problems.

- Coordinating activities so they are performed in accordance with their importance with a minimum of conflict.

The project needs to integrate the following systems: financial and accounting, cost and schedule control, marketing, personnel, communications, computing, and production.

In order to forecast and control project costs for the contractor, a project control training manual should be developed to help the project manager redefine parallel work progress that allows for timely input to create a range of forecast which will allow for potential deviations. The project manager should continually check the schedule, perform a risk analysis on the remaining schedule, and promote an awareness regarding the importance of time. It should be noted that increased changes on a project decrease productivity depending upon the timing of the changes.

Work Breakdown Structure

Work Breakdown Structure (WBS) is one of the tools that can be used for controlling projects. The construction work must be categorized into smaller items to provide a highly accurate estimate. Work Breakdown Structure provides a guideline to accomplish the project objectives by including the following:

- All tasks to be performed can be identified and resources allocated to them.
- Once resource levels have been allocated to tasks, estimates of task duration can be made.
- All costs and resource allocations can be totaled to develop the overall project budget.
- Task durations can then be used to develop a working schedule for the project.
- Performance can be tracked against identified cost, schedule and resource allocations.
- Assignments of responsibility for each element can be made

Project Cost Estimate

Cost estimate was another concern in the case study. Since the estimate is the heart of construction, certain procedures for estimating are proposed to improve the performance of estimators working for both the contractor and construction management company.

The following are the key components of a quality project estimate:

- Direct Field Labor
- Indirect Field Labor
- Field Staff
- Temporary Facilities
- Construction Equipment
- Small Tools and Consumables
- Field Office Expenses
- Escalation and Contingency

The system indicating project costs should identify the following:

- Specification Changes
- Design Errors
- Field Errors
- Supplier Errors
- Owner Changes

- Changed or Unusual Site Conditions

The accuracy of an estimate is dependent on the quality of the estimating program and the experience of estimators. Insignificant improvement in estimate quality can be made after preparation of estimates together with incorporation of actual design and cost information as the work develops.

The design cost of a project is usually estimated two times to enable the owner to check the feasibility of the project, and to develop a more detailed estimate during the design phase to enable the architect to design the project within an agreed budget.

Cost Control

In the case study, many factors caused problems with cost control. The proposed cost control procedures discussed in the following recommendations can be used as a framework for improving project cost control in condominium projects which are sensitive to the market and requirements of purchasers.

The ability to control and anticipate construction costs will begin with the quality of the field budget. The following are required for a cost control system:

- A simple but comprehensive code of accounts.

- Assignment of specific responsibilities for controlling costs within the field organization.

- Use of standard forms and formats based on a standard code of accounts throughout the estimating, procurement, design, construction, and cost-control.
- A sound budget (based on a sound estimate).
- A mechanized system for handling the data on medium-size and large projects.

Change Orders

In order to control the change orders on condominium projects, the following should be implemented by both the project owner and construction parties:

- Well-prepared construction documents.
- Implementation of a process to establish appropriate project objectives.
- Implementation of effective cost control procedures.

Future Research

Because this is a pilot study based on a single case, certain issues will need to be studied further. This part suggests possible future research to explore the issues associated with cost overrun problems occurring in Thai condominium projects.

Owner Characteristics

This study did not analyze the characteristics which could impact cost overrun problems. The study of owner characteristics should include the impact of project objectives and strategies initiated by the owner on the construction management and cost overruns. Another issue that should be included in this study is the relationship between the owner and construction participants involved with the project. In the case study, the general contractor was an affiliate of the owner's company. This research did not examine the specific impact of this relationship. Future research may focus on this specific relationship which could also be between the owner and the general contractor, subcontractor, or other participants.

Management System

Other potential causes of cost overruns include the management system that was used by some construction parties involved with the project which had an impact on the preparation of cost estimates due to design changes resulting from unit modifications. Since the owner in the case study wanted flexibility for modifications, a management system will need to be developed to help achieve such a project objective. Future research is needed to identify an appropriate system and techniques for this situation.

External Factors Affecting Condominium Project Cost Control

Because the research focused on a condominium project that was developed before the Thai economic crisis of 1997, some factors associated with the economic recession were not explored. Future research should explore the condominium projects that were developed during the economic crisis to examine factors that influenced cost overruns on these projects. These factors include inflation rates, interest rates and the Thai government policy regarding the development of residential projects.

Risk Analysis

According to the study, risk analysis was not found in project or construction management. Neither the construction participants nor the owner discussed procedures to analyze possible risks during the construction. Future research can focus on the advantage of using risk analysis in developing condominium projects.

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APPENDIX A

CSI FORMAT

CSI Master Format

Division 1	General Requirements
Division 2	Site Construction
Division 3	Concrete
Division 4	Masonry
Division 5	Metals
Division 6	Wood and Plastics
Division 7	Thermal and Moisture Protection
Division 8	Doors and Windows
Division 9	Finishes
Division 10	Specialties
Division 11	Equipment
Division 12	Furnishings
Division 13	Special Construction
Division 14	Conveying Systems
Division 15	Mechanical
Division 16	Electrical

Figure 16: CSI Format Table.

APPENDIX B

ORGANIZATION CHART

Structure of Organization (For the Case Study)

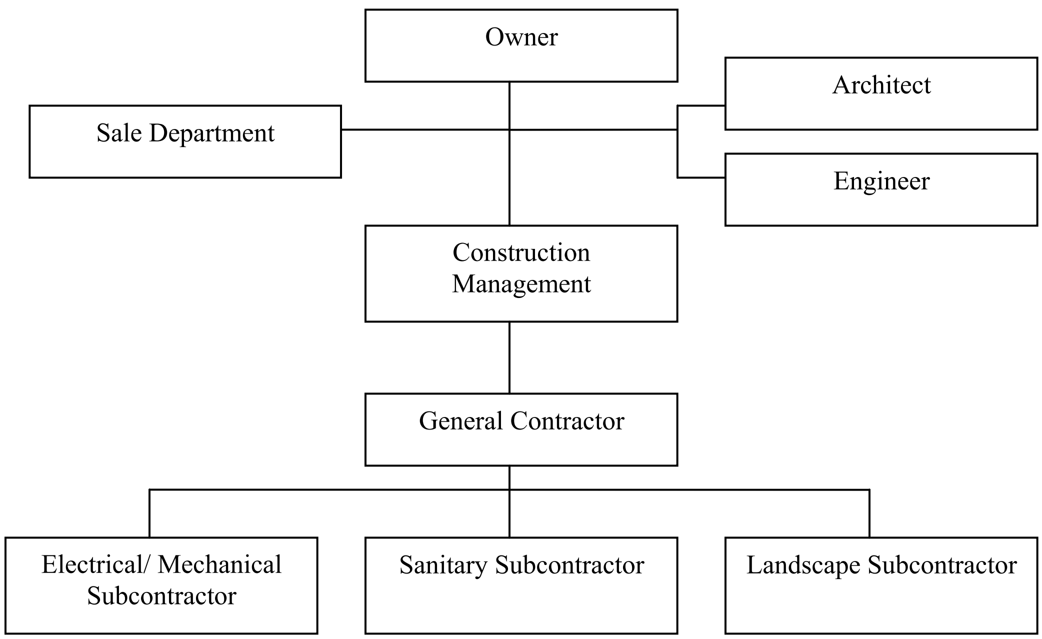


Figure 17: Organization Chart.

Project Participant Diagram

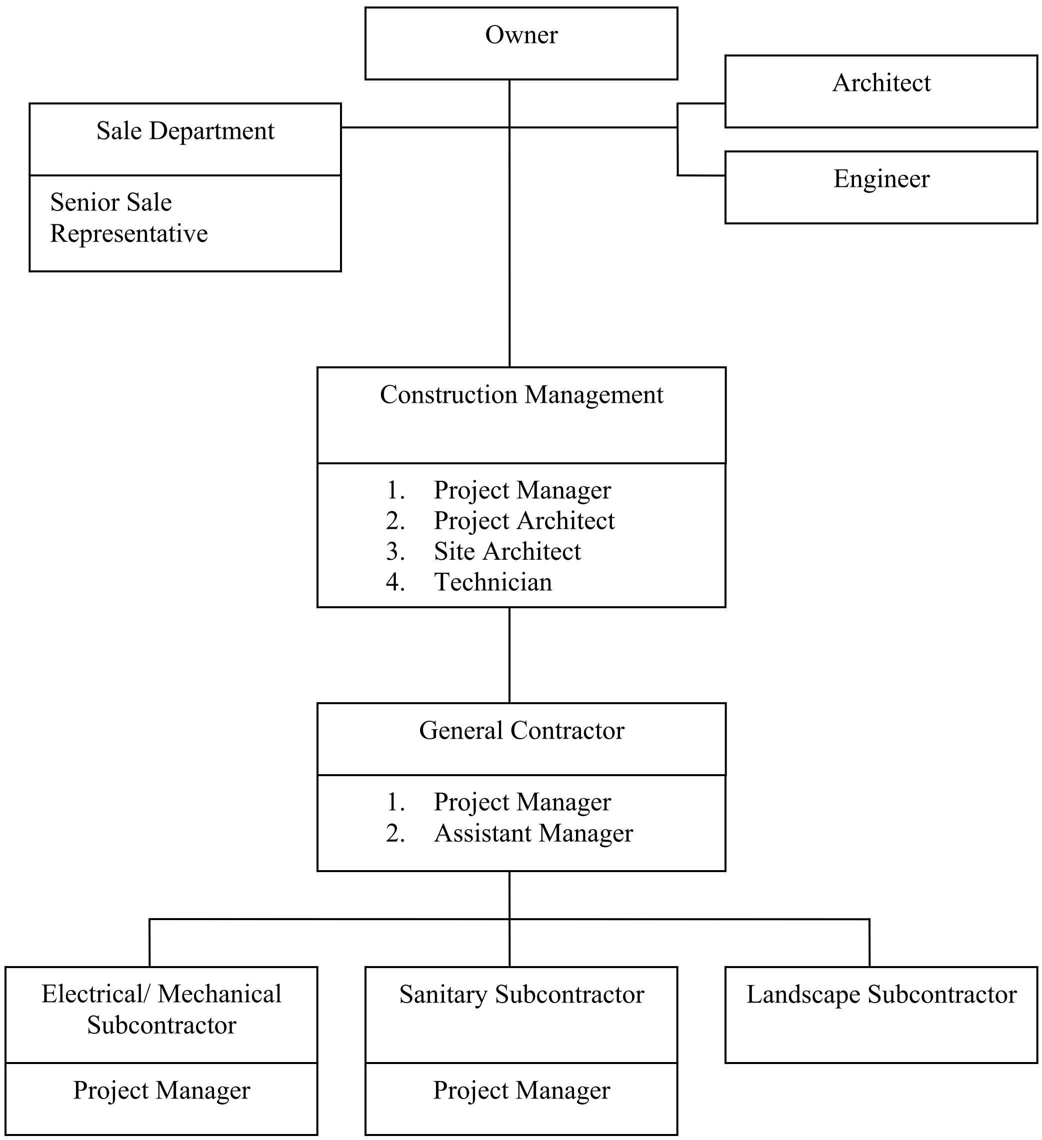


Figure 18: Structure of Project Partipants for the Condominium Project.

APPENDIX C

SCHEMATIC DRAWINGS

Schematic Drawings

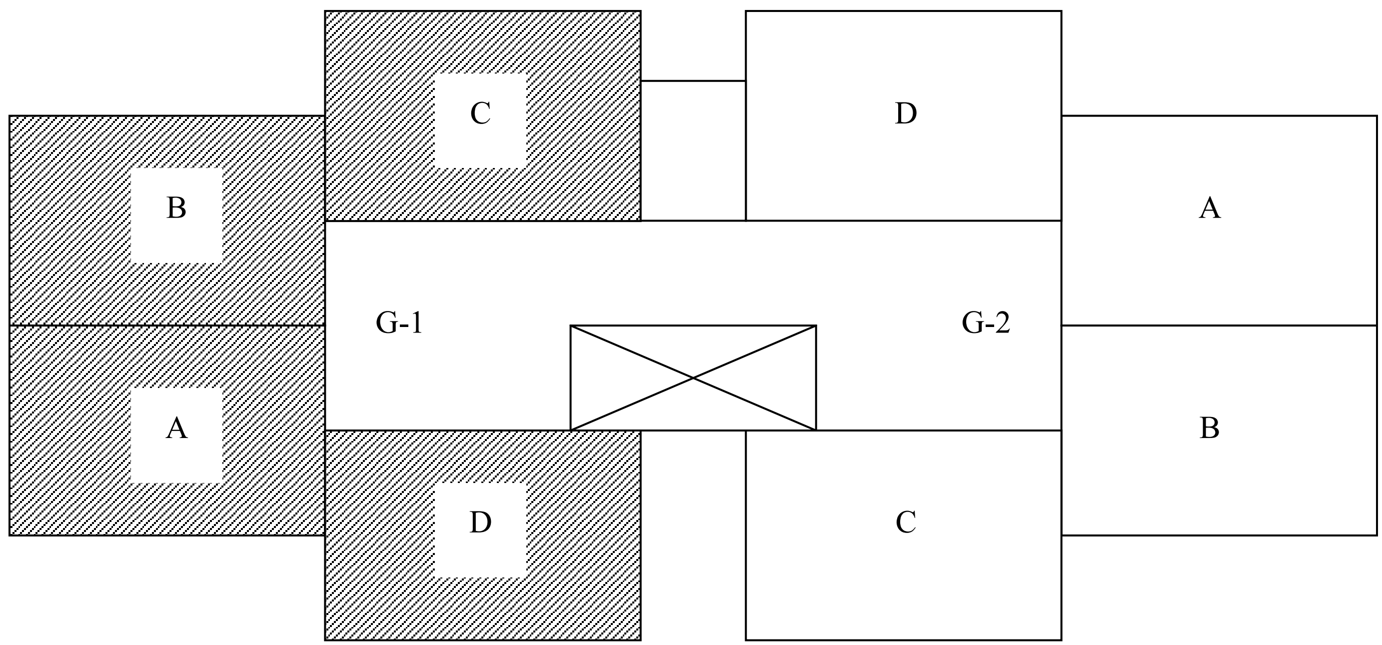


Figure 19: Sequences of Working Area-G1 and G2.

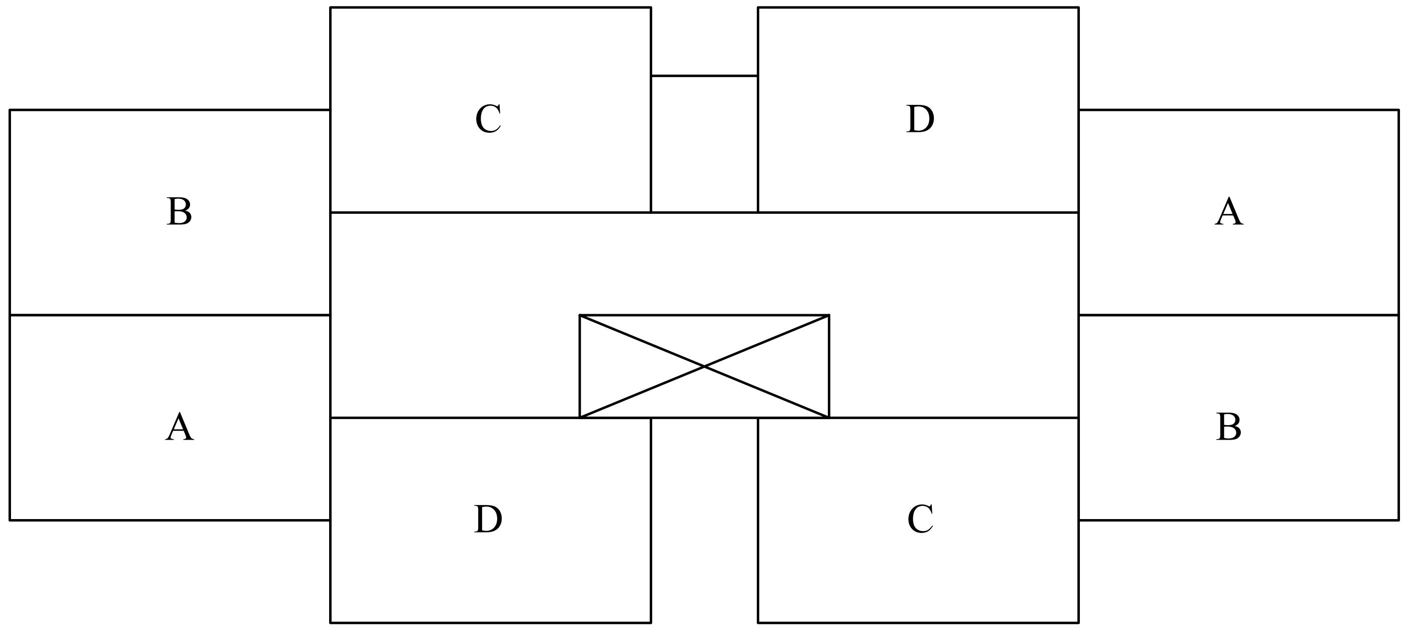


Figure 20: Schematic Floor Plan.

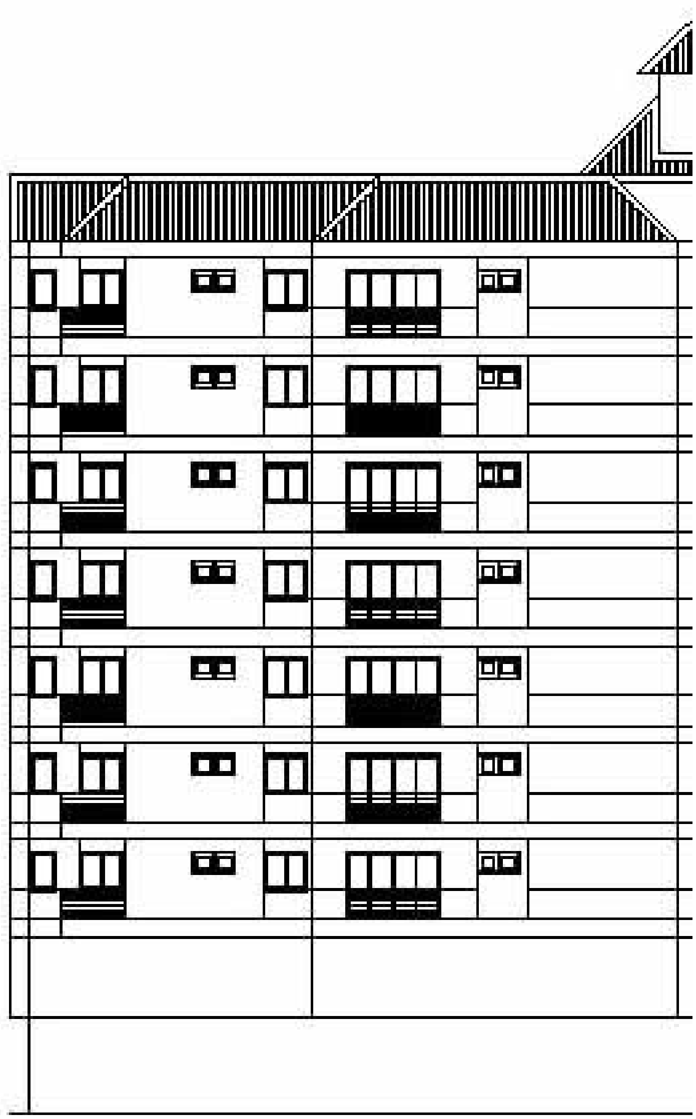


Figure 21: Elevation-01.

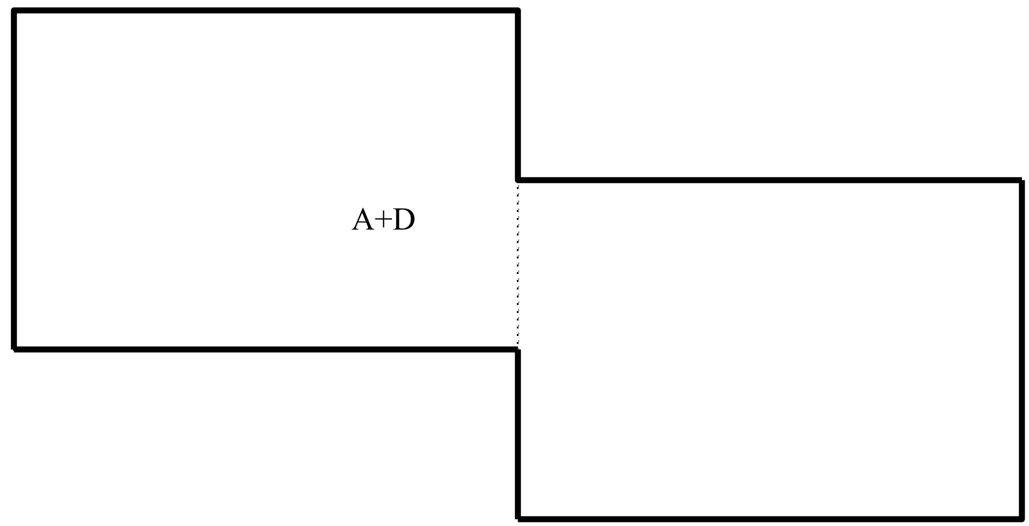


Figure 22: Combination Unit-A-D.

APPENDIX D

SCOPE OF WORK

Diagram of Scope and Responsibilities of Construction Parties

No	Participant	Scope-Responsibility
1	General Contractor	• Constructing the structure of the entire building and all architectural work as specified in the architectural drawings. • Preparing shop drawings for the owners, the construction management company and other parties. • Monitoring all of the work performed by the subcontractors. • Cooperating with the architects, engineers and the construction management company • Installing security system by coordinating with the electrical subcontractor • Providing the security cards for construction personnel during construction period and for the condominium management personnel who would provide these cards to the purchasers
2	Construction Management Company	• Monitoring the work performed by the general contractor and other subcontractors. • Preparing architectural drawings and specifications for the general contractor and subcontractors. • Coordinating between all parties involved with the construction. • Assisting the owner to make decisions regarding the construction techniques and materials
3	Mechanical Subcontractor	• Preparing mechanical shop drawings • Cooperating with the general contractor and other subcontractors • Constructing and installing mechanical system and related system • Preparing the necessary mechanical system for swimming pool such as water pump and treatment system • Coordinating with mechanical suppliers such as elevator manufacturer, swimming pool equipment suppliers

Figure 23: Scope and Responsibilities.

4	Electrical Subcontractor	• Preparing electrical shop drawings • Cooperating with the general contractor and other subcontractors • Constructing and installing electrical system and related system such as communication, telephone, television system • Coordinating with electrical instrument suppliers such as electrical generator and the electricity provider
5	Sanitary Subcontractor	• Preparing sanitary shop drawings and clean and waste water supply system • Cooperating with the general contractor and other subcontractors • Constructing and installing sanitary system and related system such as sanitary ware, and fixtures • Coordinating with electrical suppliers when electrical equipment is needed to be installed such as boiler in bathrooms • Preparing equipment and system for fire protection system

Figure 23: (Continued).

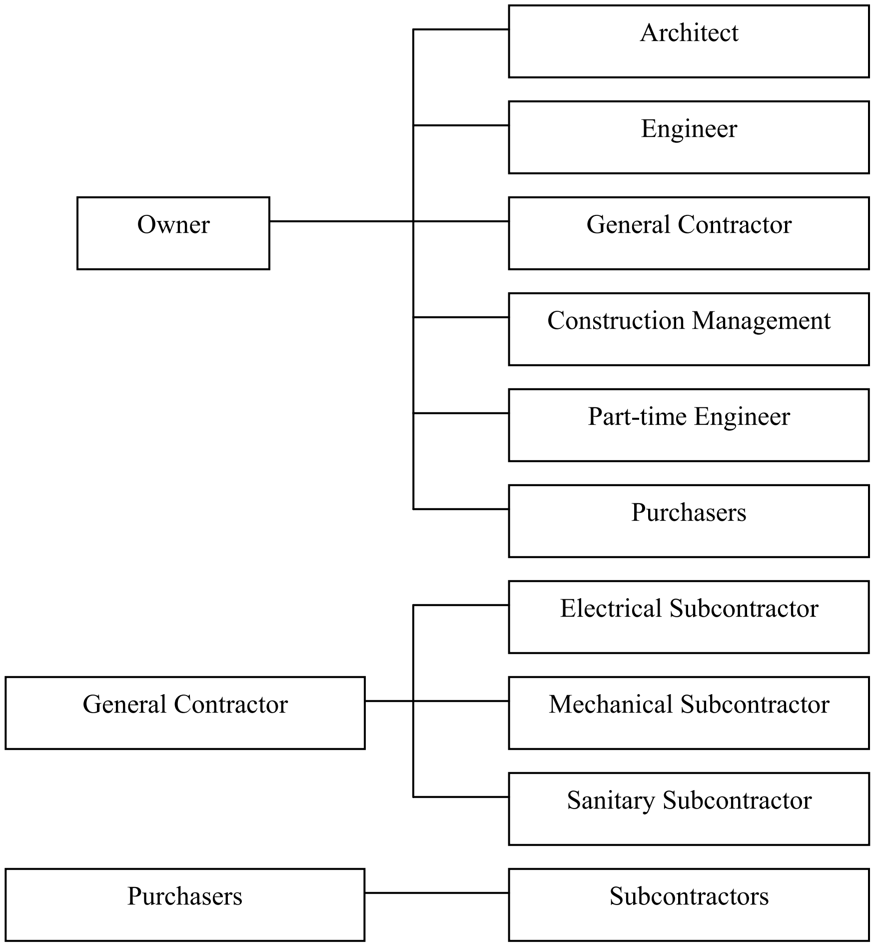


Figure 24: Diagram of Contracts.

APPENDIX E

CONSTRUCTION SCHEDULES

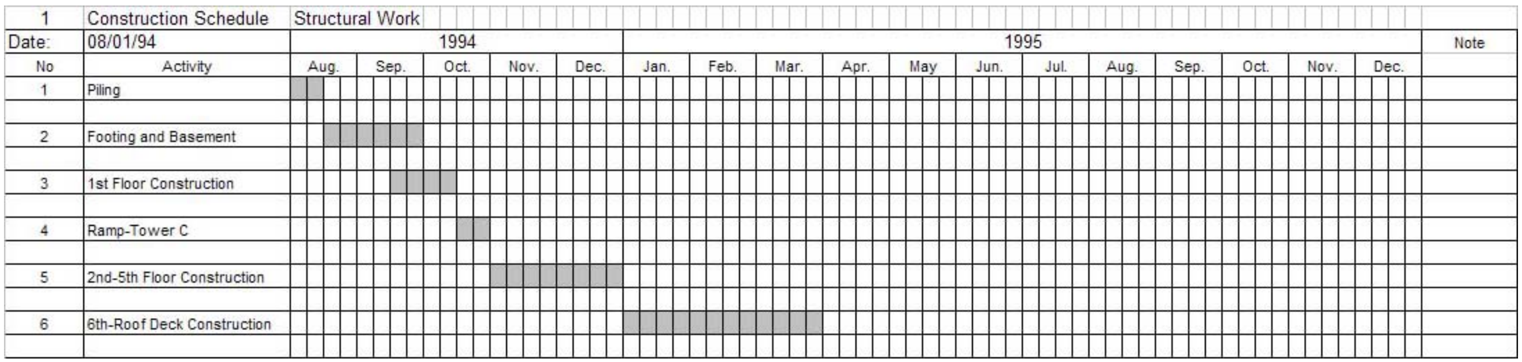


Figure 25: Structural Work Schedule-Update I.

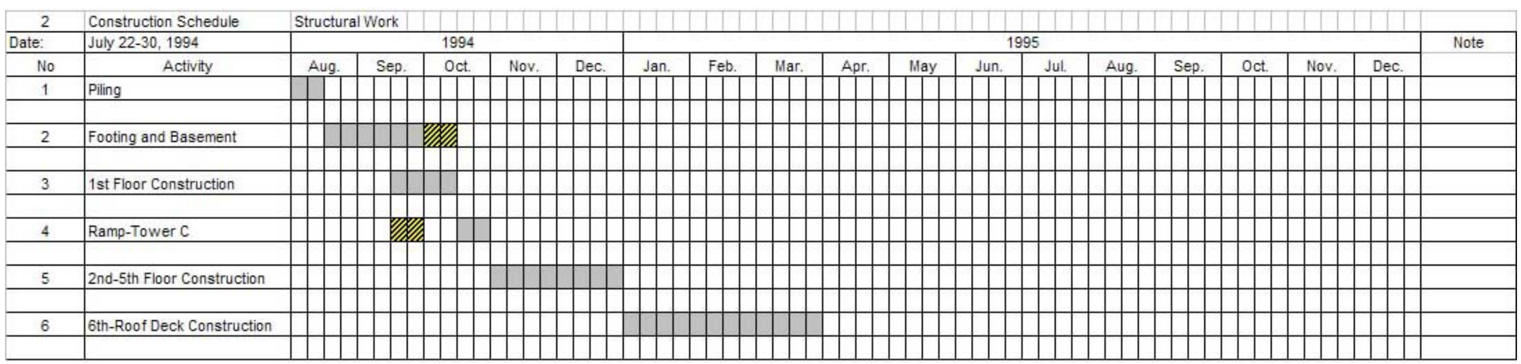


Figure 26: Structural Work Schedule-Update II.

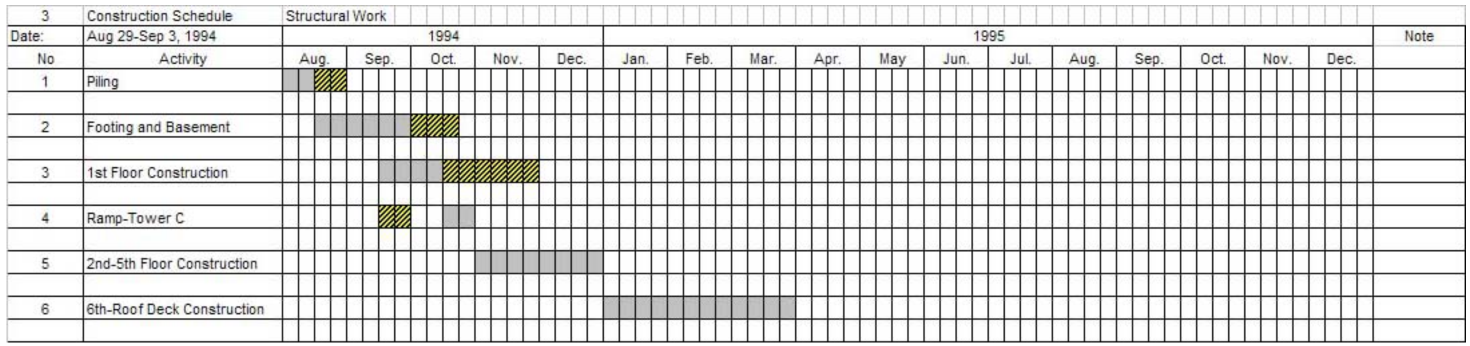


Figure 27: Structural Work Schedule-Update III.

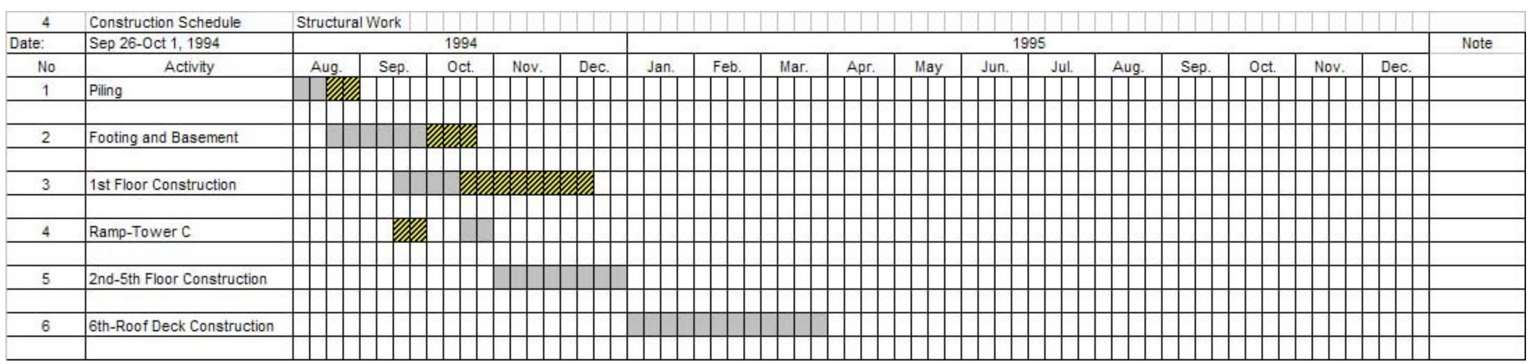


Figure 28: Structural Work Schedule-Update IV.

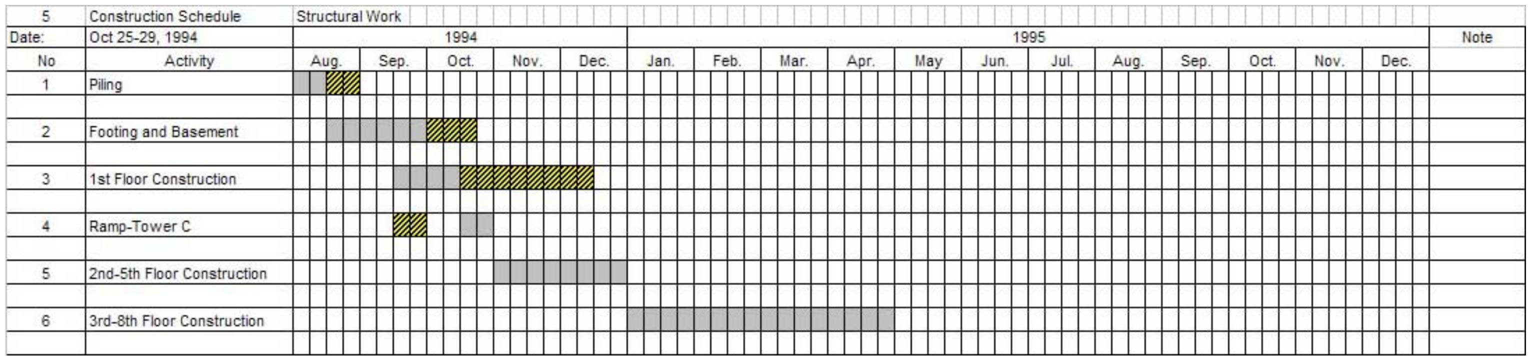


Figure 29: Structural Work Schedule-Update V.

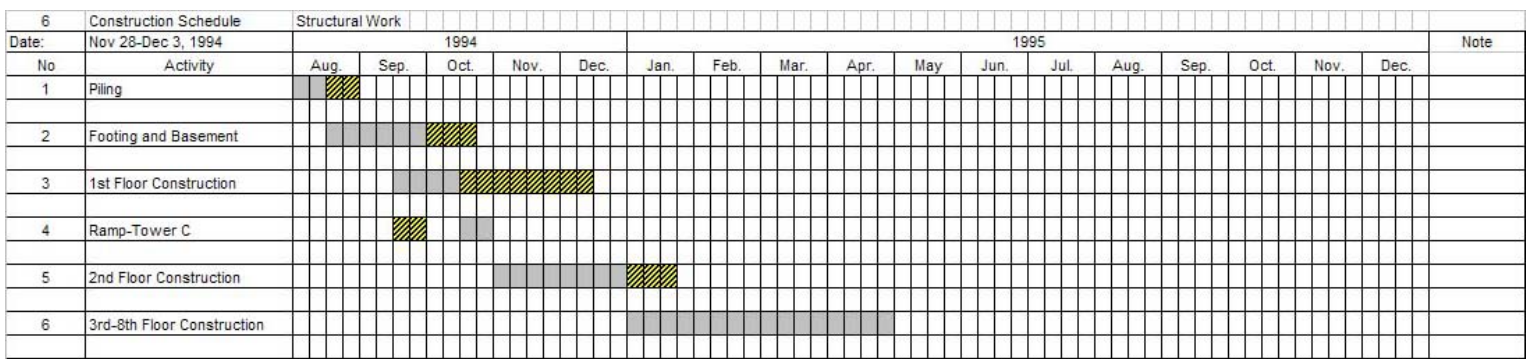


Figure 30: Structural Work Schedule-Update VI.

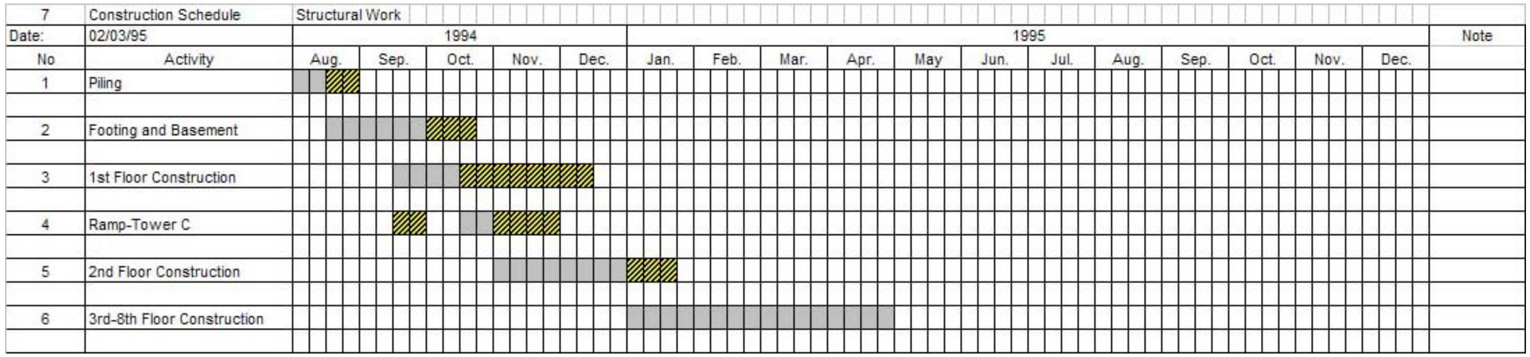


Figure 31: Structural Work Schedule-Update VII.

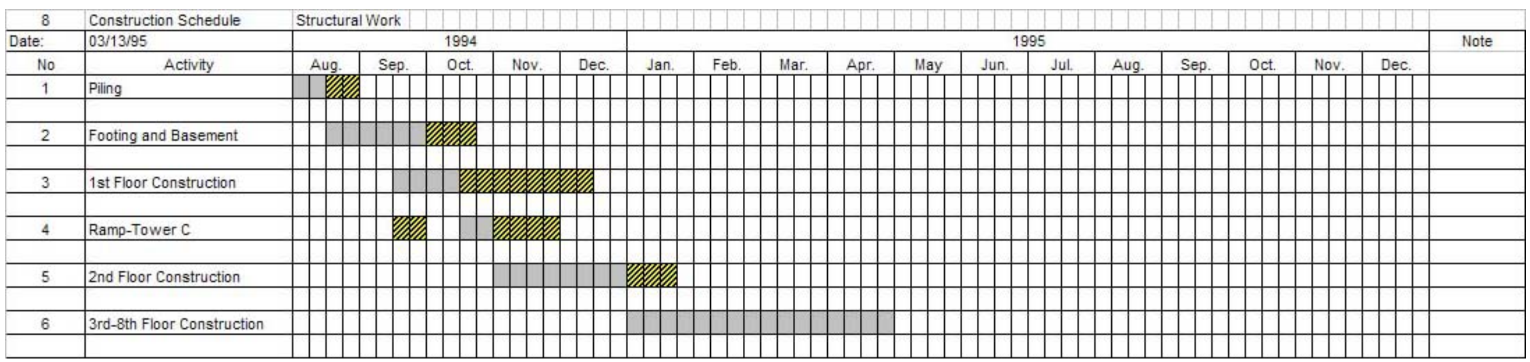


Figure 32: Structural Work Schedule-Update VIII.

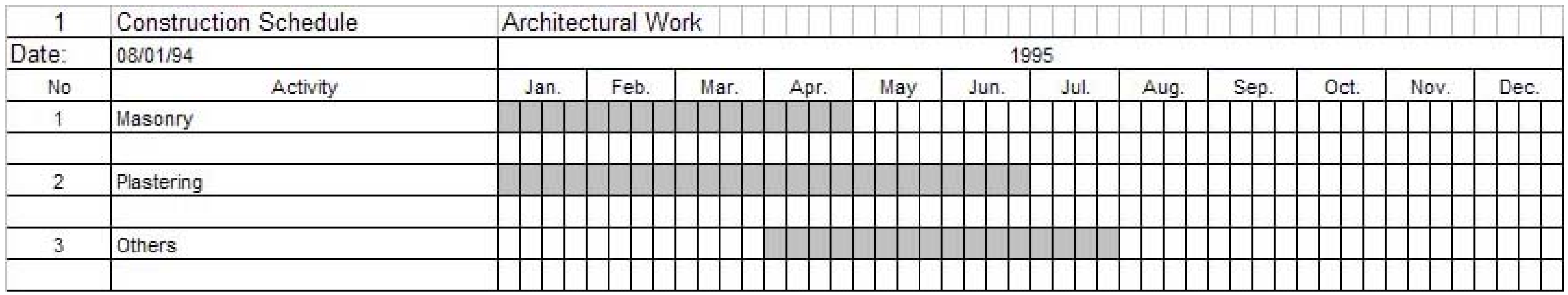


Figure 33: Architectural Work Schedule-Update I.

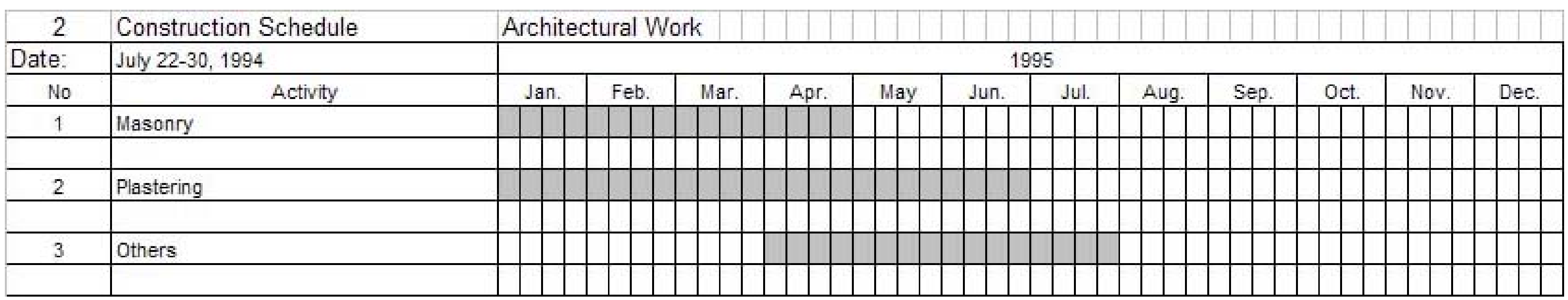


Figure 34: Architectural Work Schedule-Update II.

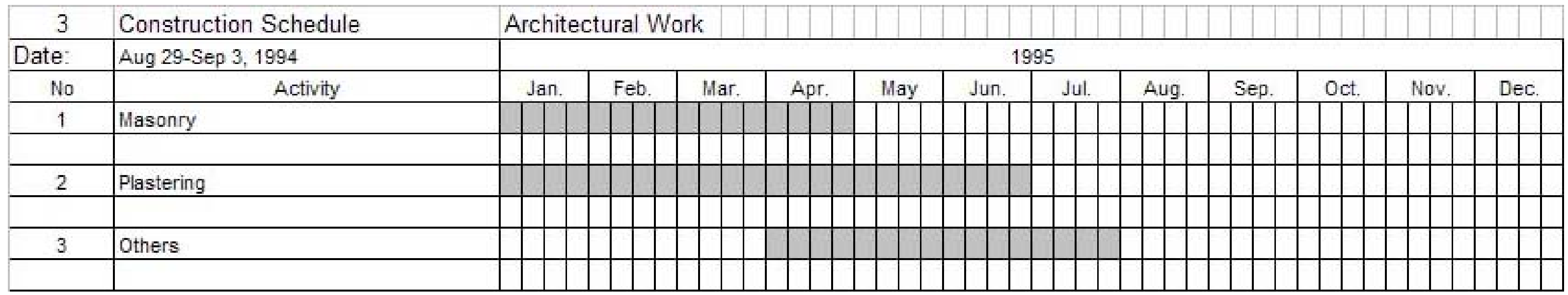


Figure 35: Architectural Work Schedule-Update III.

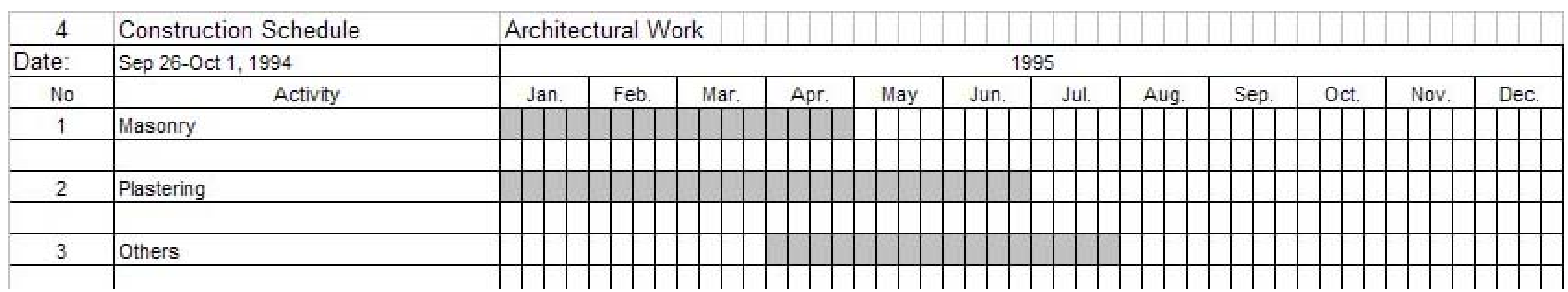


Figure 36: Architectural Work Schedule-Update IV.

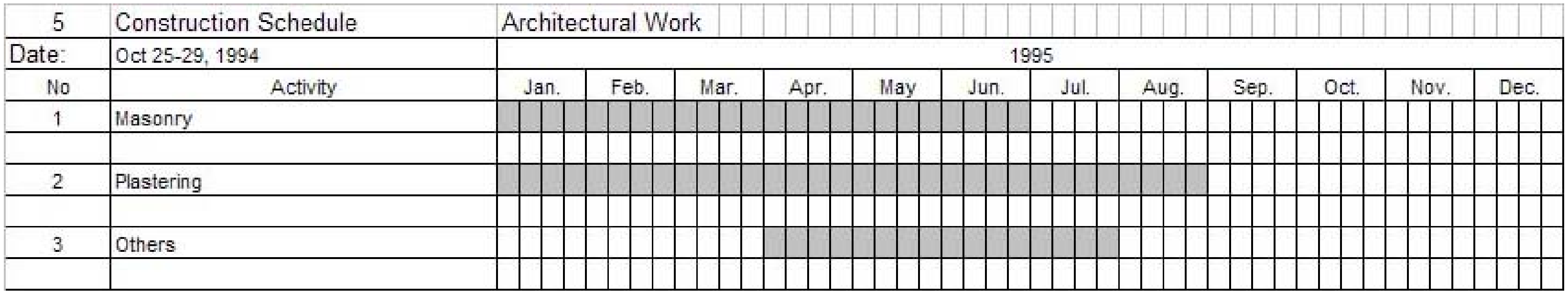


Figure 37: Architectural Work Schedule-Update V.

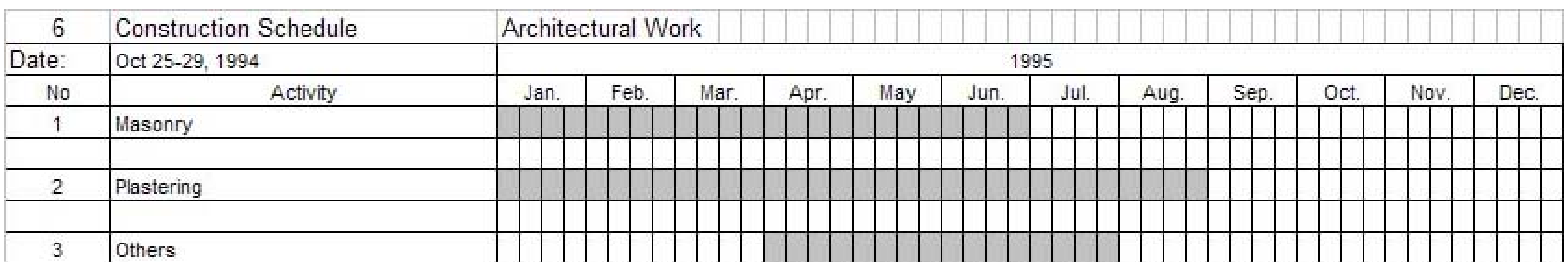


Figure 38: Architectural Work Schedule-Update VI.

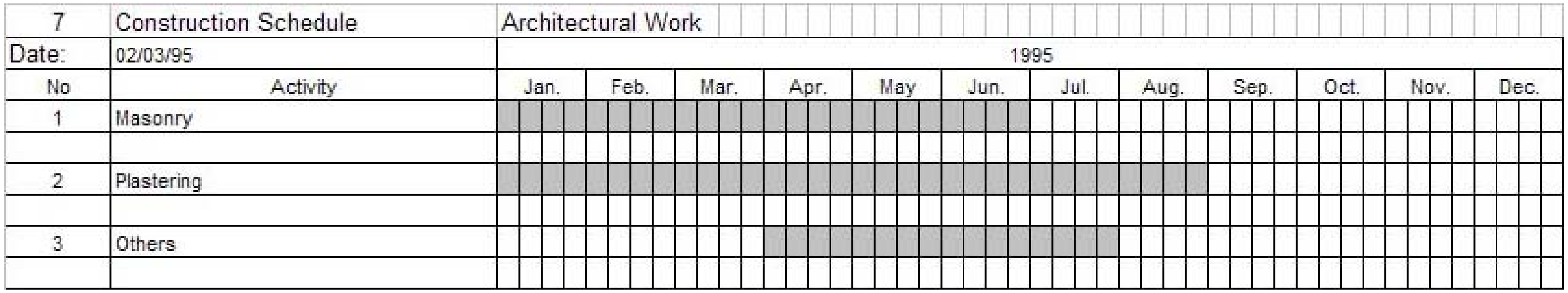


Figure 39: Architectural Work Schedule-Update VII.

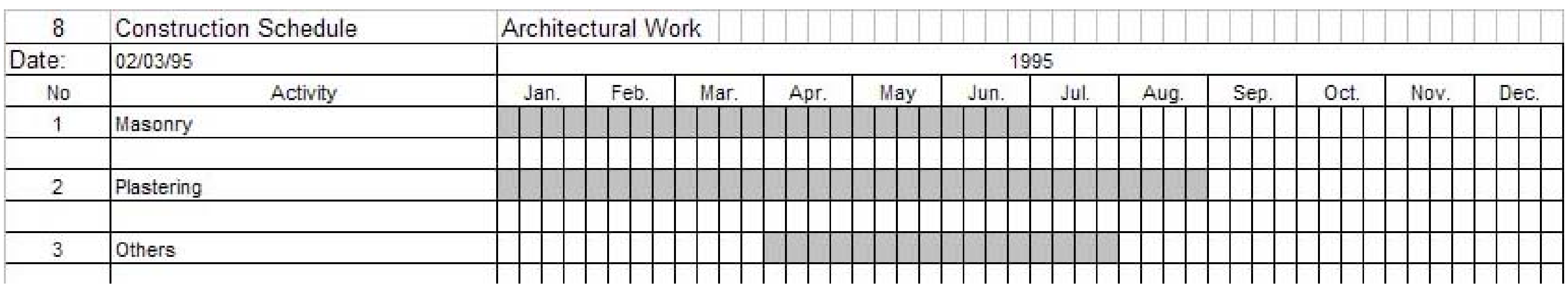


Figure 40: Architectural Work Schedule-Update VIII.

Construction Schedule prepared by the Electrical Subcontractor

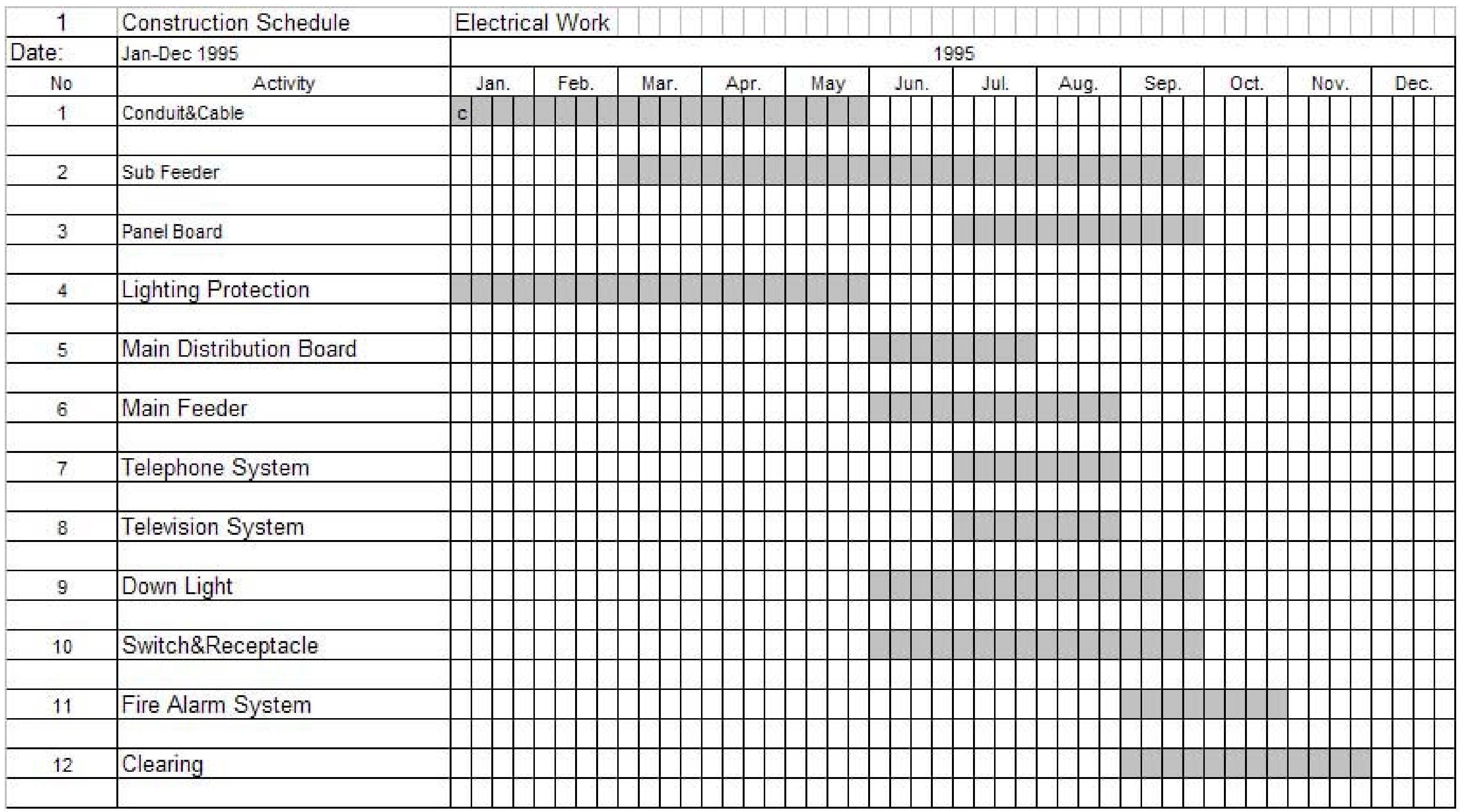


Figure 41: Electrical Work Schedule.

Construction Schedule prepared by the Sanitary Subcontractor

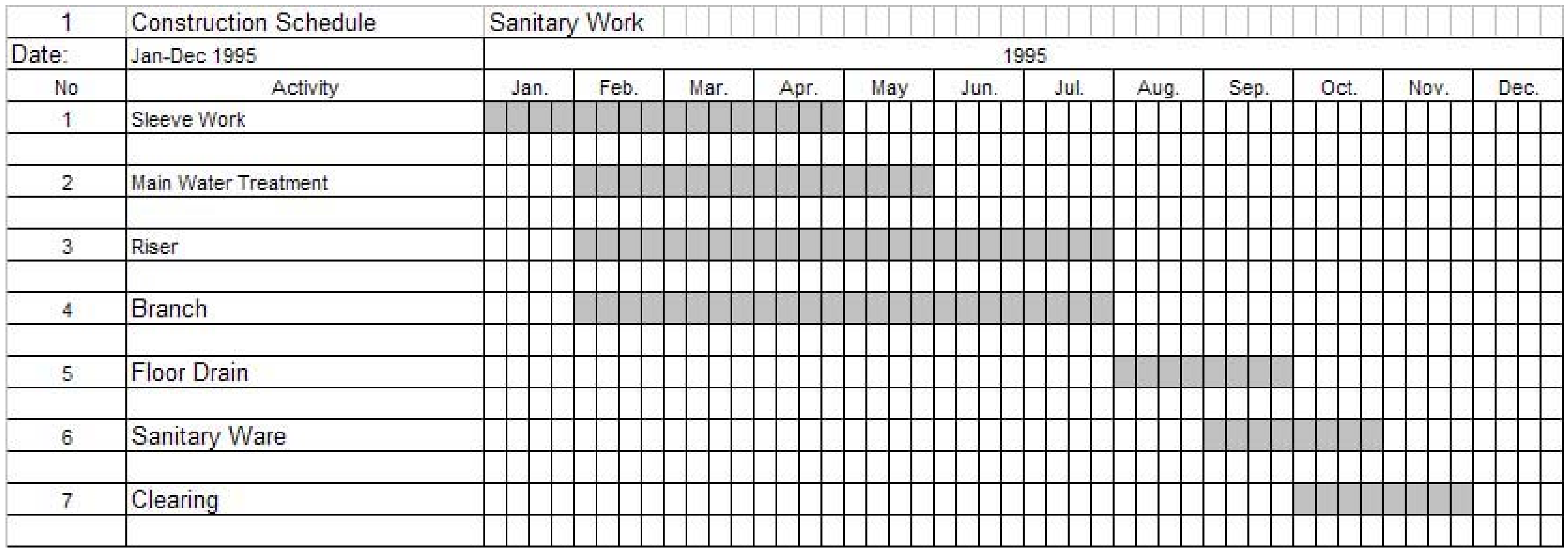


Figure 42: Sanitary Work Schedule.

APPENDIX F

PROJECT MEETINGS

Diagram of Project Meetings

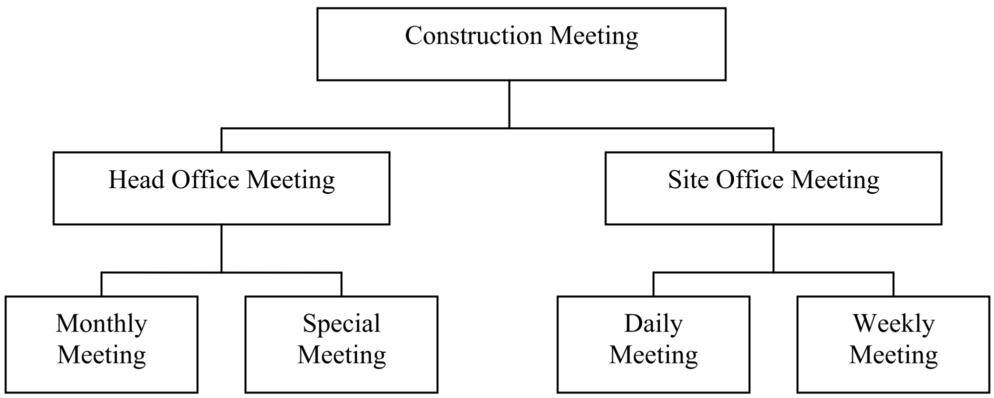


Figure 43: Diagram of Meeting Types.

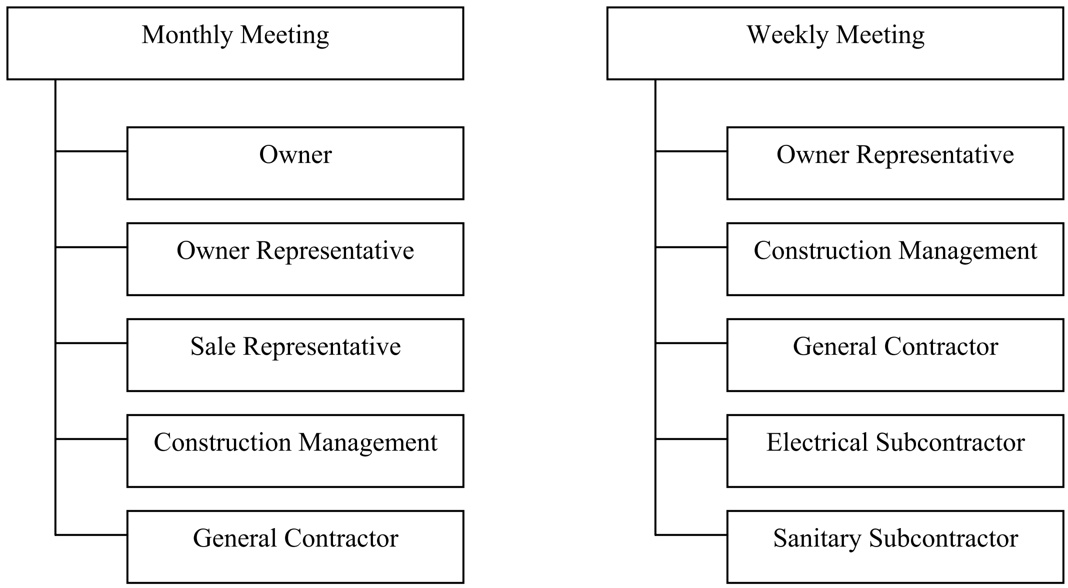


Figure 44: Meeting Participants Diagram.

APPENDIX G

BILLS OF QUANTITIES

Building: Tower G
Floor: 8
Floor Area: 698.00 sq.m.
Floor Height: 2.90 m.

Item	Description	Amount	Unit	Amount	Unit	Cost Material	Unit	Labor	Unit	Total	Cost for 8 floors	Note (USD)
1	Column (Reinforced Concrete)	30.00	Column	15.66	cu.m.	3,800.00	Baht	760.00	Baht	71,409.60	571,276.80	$22,851.07
2	Beam (Reinforced Concrete)	588.10	m.	105.86	cu.m.	3,800.00	Baht	760.00	Baht	482,712.48	3,861,699.84	$154,467.99
3	Floor (Reinforced Concrete)	676.00	sq.m.	101.40	cu.m.	2,800.00	Baht	560.00	Baht	340,704.00	2,725,632.00	$109,025.28
4	Wall (2.50 m.Concrete Post@2.50 m.)	408.60	m.	473.98	m.	750.00	Baht	150.00	Baht	426,578.40	3,412,627.20	$136,505.09
	Total									1,321,404.48	10,571,235.84	$422,849.43

Figure 45: Bill of Quantities-Structural Work.

Parking Garage

Description				Cost per Unit (Baht)		Total Cost (baht)		Grand Total (baht)	Note
		Amount	Unit	Material	Labor	Material	Labor		(USD)
Parking area		698.00	Sq.m.	3,000.00	600.00	2,094,000.00	418,800.00	2,512,800.00	$100,512.00
Total								**2,512,800.00**	$100,512.00
Overhead & Profit	7%							175,896.00	$7,035.84
VAT	7%							188,208.72	$7,528.35
Grand Total								**2,876,904.72**	$115,076.19

Figure 46: Bill of Quantities-Underground Parking Garage.

Building: Tower G
Floor: 8
Floor Area: 698.00 sq.m.
Floor Height: 2.90 m.

Item	Description					Cost per Unit (Baht)		Total Cost (baht)		Grand Total (baht)	Cost of 8 floors	Note
		Amount	Unit	Amount	Unit	Material	Labor	Material	Labor			(USD)
1	Floor Slab			698.00	sq.m.	1,860.00	415.00	1,298,280.00	289,670.00	1,587,950.00	12,703,600.00	$508,144.00
2	Masonry Wall	408.60	m.	1,184.94	sq.m.	400.00	302.00	473,976.00	357,851.88	831,827.88	6,654,623.04	$266,184.92
3	Ceiling		Sq.m.	676.00	sq.m.	335.00	137.00	226,460.00	92,612.00	319,072.00	2,552,576.00	$102,103.04
4	Steel Door-D1 (SD-01)			1.00	set	8,000.00	2,000.00	8,000.00	2,000.00	10,000.00	80,000.00	$3,200.00
5	Wood Door-D2 (WD-01)			4.00	set	12,000.00	2,400.00	48,000.00	9,600.00	57,600.00	460,800.00	$18,432.00
6	Wood Door-D3 (WD-02)			16.00	set	3,800.00	500.00	60,800.00	8,000.00	68,800.00	550,400.00	$22,016.00
7	Wood Door-D4 (WD-03)			16.00	set	3,200.00	500.00	51,200.00	8,000.00	59,200.00	473,600.00	$18,944.00
8	Wood Door-D5 (WD-04)			8.00	set	3,500.00	350.00	28,000.00	2,800.00	30,800.00	246,400.00	$9,856.00
9	Window W-1 (SW-01)			8.00	set	3,200.00	350.00	25,600.00	2,800.00	28,400.00	227,200.00	$9,088.00
10	Window W-2 (SW-02)			12.00	set	4,000.00	600.00	48,000.00	7,200.00	55,200.00	441,600.00	$17,664.00
11	Window W-3 (SW-03)			8.00	set	4,706.25	346.88	37,650.00	2,775.00	40,425.00	323,400.00	$12,936.00
12	Window W-4 (SW-04)			0.00	set	0.00	0.00	0.00	0.00	0.00	0.00	$0.00
13	Sanitary Ware			12.00	set	9,335.00	1,300.00	112,020.00	15,600.00	127,620.00	1,020,960.00	$40,838.40
14	Painting (Wall)			3,436.33	sq.m.	63.50	17.00	218,206.70	58,417.54	276,624.24	2,212,993.94	$88,519.76
15	Stair			1.00	LS							$0.00
16	Miscellaneous											$0.00
	Total						**9,217.88**	**2,636,192.70**	**857,326.42**	**3,493,519.12**	27,948,152.98	$1,117,926.12

Figure 47: Bill of Quantities- Architectural Work.

Swimming Pool and Deck

Description			Cost per Unit (Baht)		Total Cost (baht)		Grand Total (baht)	Note
	Amount	Unit	Material	Labor	Material	Labor		(USD)
Swimming Pool (8.00 x 40.00 m.)	320.00	Sq.m.	8,000.00	1,600.00	2,560,000.00	512,000.00	3,072,000.00	$122,880.00
Pool deck	150.00	Sq.m.	4,000.00	800.00	600,000.00	120,000.00	720,000.00	$28,800.00
Surge tank	15.00	Sq.m.	5,000.00	1,000.00	75,000.00	15,000.00	90,000.00	$3,600.00
Mechanical room	15.00	Sq.m.	8,000.00	1,600.00	120,000.00	24,000.00	144,000.00	$5,760.00
Softscape	200.00	Sq.m.	600.00	120.00	120,000.00	24,000.00	144,000.00	$5,760.00
Hardscape	150.00	Sq.m.	4,000.00	800.00	600,000.00	120,000.00	720,000.00	$28,800.00
Total							**4,890,000.00**	$195,600.00
Overhead & Profit 7%							342,300.00	$13,692.00
VAT 7%							366,261.00	$14,650.44
Grand Total							**5,598,561.00**	$223,942.44

Figure 48: Bill of Quantities- Swimming Pool.

APPENDIX H

PERSONNEL AND EQUIPMENT REPORTS

Construction Personnel Reports

From:	11/14/94	To:	11/19/94									
No	Description	Personnel		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Position	Number	Date		11/14/94	11/15/94	11/16/94	11/17/94	11/18/94	11/19/94	
1	Office	Engineer				1	1	1	1	1	1	
		Architect				0	0	0	0	0	0	
		Foreman				0	0	0	0	0	0	
		Surveyor				4	4	4	4	4	4	
		Draftman				1	1	1	1	1	1	
		Secretary				2	2	2	2	2	2	
		Storage				2	2	2	2	2	2	
2	Structural Work	Plaster				0	0	0	0	0	0	
		Iron Worker				24	24	24	24	24	24	
		Welder				6	6	6	6	6	6	
		Carpenter				34	34	34	34	34	34	
		Foreman				7	7	7	7	7	7	
		Labor				46	46	46	46	46	46	
3	Masonry Work	Carpenter				0	0	0	0	0	0	
		Plaster				36	36	36	36	36	36	
		Labor				0	0	0	0	0	0	
4	Topping-Furnishing	Plaster				0	0	0	0	0	0	
		Labor				0	0	0	0	0	0	
5	Electrical System	Foreman				5	5	5	5	5	5	
		Electrician				14	14	14	14	14	14	
		Labor				0	0	0	0	0	0	
6	Sanitary System	Foreman				0	0	0	0	0	0	
		Plumber				15	15	15	15	15	15	
		Labor				0	0	0	0	0	0	
7	Others	Maintenance				4	4	4	4	4	4	
		Driver				2	2	2	2	2	2	
		Tower Crane Op.				4	4	4	4	4	4	
		Housekeeper				2	2	2	2	2	2	
		Guard				2	2	2	2	2	2	

Figure 49: Construction Personnel Report- Update I.

From:	11/21/1994	To:	11/26/1994									
No	Description	Personnel		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Position	Number	Date		11/21/94	11/22/94	11/23/94	11/24/94	11/25/94	11/26/94	
1	Office	Engineer				1	1	1	1	1	1	
		Architect				0	0	0	0	0	0	
		Foreman				0	0	0	0	0	0	
		Surveyor				4	4	4	4	4	4	
		Draftman				1	1	1	1	1	1	
		Secretary				2	2	2	2	2	2	
		Storage				2	2	2	2	2	2	
2	Structural Work	Plaster				0	0	0	0	0	0	
		Iron Worker				24	24	24	24	24	24	
		Welder				6	6	6	6	6	6	
		Carpenter				34	34	34	34	34	34	
		Foreman				7	7	7	7	7	7	
		Labor				46	46	46	46	46	46	
3	Masonry Work	Carpenter				0	0	0	0	0	0	
		Plaster				36	36	36	36	36	36	
		Labor				0	0	0	0	0	0	
4	Topping-Furnishing	Plaster				0	0	0	0	0	0	
		Labor				0	0	0	0	0	0	
5	Electrical System	Foreman				5	5	5	5	5	5	
		Electrician				14	14	14	14	14	14	
		Labor				0	0	0	0	0	0	
6	Sanitary System	Foreman				0	0	0	0	0	0	
		Plumber				15	15	15	15	15	15	
		Labor				0	0	0	0	0	0	
7	Others	Maintenance				4	4	4	4	4	4	
		Driver				2	2	2	2	2	2	
		Tower Crane Op.				4	4	4	4	4	4	
		Housekeeper				2	2	2	2	2	2	
		Guard				2	2	2	2	2	2	

Figure 50: Construction Personnel Report- Update II.

From:	11/28/1994	To:	12/3/1994									
No	Description	Personnel		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Position	Number	Date		11/28/94	11/29/94	11/30/94	12/01/94	12/02/94	12/03/94	
1	Office	Engineer				1	1	1	1	1	1	
		Architect				0	0	0	0	0	0	
		Foreman				0	0	0	0	0	0	
		Surveyor				4	4	4	4	4	4	
		Draftman				1	1	1	1	1	1	
		Secretary				2	2	2	2	2	2	
		Storage				2	2	2	2	2	2	
2	Structural Work	Plaster				0	0	0	0	0	0	
		Iron Worker				24	24	24	24	24	24	
		Welder				6	6	6	6	6	6	
		Carpenter				45	45	45	45	45	45	
		Foreman				7	7	7	7	7	7	
		Labor				46	46	46	46	46	46	
3	Masonry Work	Carpenter				0	0	0	0	0	0	
		Plaster				38	38	38	38	38	38	
		Labor				0	0	0	0	0	0	
4	Topping-Furnishing	Plaster				0	0	0	0	0	0	
		Labor				0	0	0	0	0	0	
5	Electrical System	Foreman				5	5	5	5	5	5	
		Electrician				14	14	14	14	14	14	
		Labor				0	0	0	0	0	0	
6	Sanitary System	Foreman				0	0	0	0	0	0	
		Plumber				15	15	15	15	15	15	
		Labor				0	0	0	0	0	0	
7	Others	Maintenance				4	4	4	4	4	4	
		Driver				2	2	2	2	2	2	
		Tower Crane Op.				4	4	4	4	4	4	
		Housekeeper				2	2	2	2	2	2	
		Guard				2	2	2	2	2	2	

Figure 51: Construction Personnel Report- Update III.

From:	12/5/1994	To:	12/10/1994									
No	Description	Personnel		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Position	Number	Date		12/05/94	12/06/94	12/07/94	12/08/94	12/09/94	12/10/94	
1	Office	Engineer					1	1	1	1		
		Architect					0	0	0	0		
		Foreman					0	0	0	0		
		Surveyor					4	4	4	4		
		Draftman					1	1	1	1		
		Secretary					2	2	2	2		
		Storage					2	2	2	2		
2	Structural Work	Plaster					0	0	0	0		
		Iron Worker					24	24	24	24		
		Welder					6	6	6	6		
		Carpenter					45	45	45	45		
		Foreman					7	7	7	7		
		Labor					46	46	46	46		
3	Masonry Work	Carpenter					0	0	0	0		
		Plaster					38	38	38	38		
		Labor					0	0	0	0		
4	Topping-Furnishing	Plaster					0	0	0	0		
		Labor					0	0	0	0		
5	Electrical System	Foreman					5	5	5	5		
		Electrician					14	14	14	14		
		Labor					0	0	0	0		
6	Sanitary System	Foreman					0	0	0	0		
		Plumber					15	15	15	15		
		Labor					0	0	0	0		
7	Others	Maintenance					4	4	4	4		
		Driver					2	2	2	2		
		Tower Crane Op.					4	4	4	4		
		Housekeeper					2	2	2	2		
		Guard					2	2	2	2		

Figure 52: Construction Personnel Report- Update IV.

From:	12/12/1994	To:	12/17/1994									
No	Description	Personnel		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Position	Number	Date		12/12/94	12/13/94	12/14/94	12/15/94	12/16/94	12/17/94	
1	Office	Engineer				1	1	1	1	1	1	
		Architect				0	0	0	0	0	0	
		Foreman				0	0	0	0	0	0	
		Surveyor				4	4	4	4	4	4	
		Draftman				1	1	1	1	1	1	
		Secretary				2	2	2	2	2	2	
		Storage				2	2	2	2	2	2	
2	Structural Work	Plaster				0	0	0	0	0	0	
		Iron Worker				24	24	24	24	24	24	
		Welder				6	6	6	6	6	6	
		Carpenter				45	45	45	45	45	45	
		Foreman				7	7	7	7	7	7	
		Labor				46	46	46	46	46	46	
3	Masonry Work	Carpenter				0	0	0	0	0	0	
		Plaster				38	38	38	38	38	38	
		Labor				0	0	0	0	0	0	
4	Topping-Furnishing	Plaster				0	0	0	0	0	0	
		Labor				0	0	0	0	0	0	
5	Electrical System	Foreman				5	5	5	5	5	5	
		Electrician				14	14	14	14	14	14	
		Labor				0	0	0	0	0	0	
6	Sanitary System	Foreman				0	0	0	0	0	0	
		Plumber				15	15	15	15	15	15	
		Labor				0	0	0	0	0	0	
7	Others	Maintenance				4	4	4	4	4	4	
		Driver				2	2	2	2	2	2	
		Tower Crane Op.				4	4	4	4	4	4	
		Housekeeper				2	2	2	2	2	2	
		Guard				2	2	2	2	2	2	

Figure 53: Construction Personnel Report- Update V.

From:	12/19/1994	To:	12/24/1994									
No	Description	Personnel		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Position	Number	Date		12/19/94	12/20/94	12/21/94	12/22/94	12/23/94	12/24/94	
1	Office	Engineer				1	1	1				
		Architect				0	0	0				
		Foreman				0	0	0				
		Surveyor				4	4	4				
		Draftman				1	1	1				
		Secretary				2	2	2				
		Storage				2	2	2				
2	Structural Work	Plaster				0	0	0				
		Iron Worker				24	24	24				
		Welder				6	6	6				
		Carpenter				45	45	45				
		Foreman				7	7	7				
		Labor				46	46	46				
3	Masonry Work	Carpenter				0	0	0				
		Plaster				38	38	38				
		Labor				0	0	0				
4	Topping-Furnishing	Plaster				0	0	0				
		Labor				0	0	0				
5	Electrical System	Foreman				5	5	5				
		Electrician				14	14	14				
		Labor				0	0	0				
6	Sanitary System	Foreman				0	0	0				
		Plumber				15	15	15				
		Labor				0	0	0				
7	Others	Maintenance				4	4	4				
		Driver				2	2	2				
		Tower Crane Op.				4	4	4				
		Housekeeper				2	2	2				
		Guard				2	2	2				

Figure 54: Construction Personnel Report- Update VI.

From:	1/30/1995	To:	2/4/1995									
No	Description	Personnel		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Position	Number	Date		01/30/95	01/31/95	02/01/95	02/02/95	02/03/95	02/04/95	
1	Office	Engineer				1	1	1	1	1	1	
		Architect				0	0	0	0	0	0	
		Foreman				9	9	9	9	9	9	
		Surveyor				4	4	4	4	4	4	
		Draftman				1	1	1	1	1	1	
		Secretary				2	2	2	2	2	2	
		Storage				2	2	2	2	2	2	
2	Structural Work	Plaster				5	5	5	5	5	5	
		Iron Worker				25	25	25	25	25	25	
		Welder				2	2	2	2	2	2	
		Carpenter				35	35	35	35	35	35	
		Foreman				2	2	2	2	2	2	
		Labor				18	18	18	18	18	18	
3	Masonry Work	Carpenter				5	5	5	5	5	5	
		Plaster				10	10	10	10	10	10	
		Labor				15	15	15	15	15	15	
4	Topping-Furnishing	Plaster				0	0	0	0	0	0	
		Labor				0	0	0	0	0	0	
5	Electrical System	Foreman				1	1	1	1	1	1	
		Electrician				10	10	10	10	10	10	
		Labor				0	0	0	0	0	0	
6	Sanitary System	Foreman				2	2	2	2	2	2	
		Plumber				12	12	12	12	12	12	
		Labor				0	0	0	0	0	0	
7	Others	Maintenance				4	4	4	4	4	4	
		Driver				2	2	2	2	2	2	
		Tower Crane Op.				4	4	4	4	4	4	
		Housekeeper				2	2	2	2	2	2	
		Guard				2	2	2	2	2	2	

Figure 55: Construction Personnel Report- Update VII.

From:	2/6/1995	To:	2/11/1995									
No	Description	Personnel		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Position	Number	Date		02/06/95	02/07/95	02/08/95	02/09/95	02/10/95	02/11/95	
1	Office	Engineer				1	1	1	1	1	1	
		Architect				0	0	0	0	0	0	
		Foreman				9	9	9	9	9	9	
		Surveyor				4	4	4	4	4	4	
		Draftman				1	1	1	1	1	1	
		Secretary				2	2	2	2	2	2	
		Storage				2	2	2	2	2	2	
2	Structural Work	Plaster				5	5	5	5	5	5	
		Iron Worker				25	25	25	25	25	25	
		Welder				2	2	2	2	2	2	
		Carpenter				35	35	35	35	35	35	
		Foreman				2	2	2	2	2	2	
		Labor				18	18	18	18	18	18	
3	Masonry Work	Carpenter				5	5	5	5	5	5	
		Plaster				10	10	10	10	10	10	
		Labor				15	15	15	15	15	15	
4	Topping-Furnishing	Plaster				0	0	0	0	0	0	
		Labor				0	0	0	0	0	0	
5	Electrical System	Foreman				1	1	1	1	1	1	
		Electrician				10	10	10	10	10	10	
		Labor				0	0	0	0	0	0	
6	Sanitary System	Foreman				2	2	2	2	2	2	
		Plumber				12	12	12	12	12	12	
		Labor				0	0	0	0	0	0	
7	Others	Maintenance				4	4	4	4	4	4	
		Driver				2	2	2	2	2	2	
		Tower Crane Op.				4	4	4	4	4	4	
		Housekeeper				2	2	2	2	2	2	
		Guard				2	2	2	2	2	2	

Figure 56: Construction Personnel Report- Update VIII.

From:	2/13/1995	To:		2/18/1995								
No	Description	Personnel		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Position	Number	Date		02/13/95	02/14/95	02/15/95	02/16/95	02/17/95	02/18/95	
1	Office	Engineer				1	1	1	1	1	1	
		Architect				0	0	0	0	0	0	
		Foreman				9	9	9	9	9	9	
		Surveyor				4	4	4	4	4	4	
		Draftman				1	1	1	1	1	1	
		Secretary				2	2	2	2	2	2	
		Storage				2	2	2	2	2	2	
2	Structural Work	Plaster				5	5	5	5	5	5	
		Iron Worker				25	25	25	25	25	25	
		Welder				2	2	2	2	2	2	
		Carpenter				35	35	35	35	35	35	
		Foreman				2	2	2	2	2	2	
		Labor				18	18	18	18	18	18	
3	Masonry Work	Carpenter				5	5	5	5	5	5	
		Plaster				10	10	10	10	10	10	
		Labor				15	15	15	15	15	15	
4	Topping-Furnishing	Plaster				0	0	0	0	0	0	
		Labor				0	0	0	0	0	0	
5	Electrical System	Foreman				1	1	1	1	1	1	
		Electrician				10	10	10	10	10	10	
		Labor				0	0	0	0	0	0	
6	Sanitary System	Foreman				2	2	2	2	2	2	
		Plumber				12	12	12	12	12	12	
		Labor				0	0	0	0	0	0	
7	Others	Maintenance				4	4	4	4	4	4	
		Driver				2	2	2	2	2	2	
		Tower Crane Op.				4	4	4	4	4	4	
		Housekeeper				2	2	2	2	2	2	
		Guard				2	2	2	2	2	2	

Figure 57: Construction Personnel Report- Update IX.

From:	2/20/1995	To:	2/25/1995									
No	Description	Personnel		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Position	Number	Date		02/20/95	02/21/95	02/22/95	02/23/95	02/24/95	02/25/95	
1	Office	Engineer				1	1	1	1	1	1	
		Architect				0	0	0	0	0	0	
		Foreman				9	9	9	9	9	9	
		Surveyor				4	4	4	4	4	4	
		Draftman				1	1	1	1	1	1	
		Secretary				2	2	2	2	2	2	
		Storage				2	2	2	2	2	2	
2	Structural Work	Plaster				5	5	5	5	5	5	
		Iron Worker				25	25	25	25	25	25	
		Welder				2	2	2	2	2	2	
		Carpenter				35	35	35	35	35	35	
		Foreman				2	2	2	2	2	2	
		Labor				18	18	18	18	18	18	
3	Masonry Work	Carpenter				5	5	5	5	5	5	
		Plaster				10	10	10	10	10	10	
		Labor				15	15	15	15	15	15	
4	Topping-Furnishing	Plaster				0	0	0	0	0	0	
		Labor				0	0	0	0	0	0	
5	Electrical System	Foreman				1	1	1	1	1	1	
		Electrician				10	10	10	10	10	10	
		Labor				0	0	0	0	0	0	
6	Sanitary System	Foreman				2	2	2	2	2	2	
		Plumber				12	12	12	12	12	12	
		Labor				0	0	0	0	0	0	
7	Others	Maintenance				4	4	4	4	4	4	
		Driver				2	2	2	2	2	2	
		Tower Crane Op.				4	4	4	4	4	4	
		Housekeeper				2	2	2	2	2	2	
		Guard				2	2	2	2	2	2	

Figure 58: Construction Personnel Report- Update X.

From:	2/27/1995	To:		3/4/1995								
No	Description	Personnel		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Position	Number	Date		02/27/95	02/28/95	03/01/95	03/02/95	03/03/95	03/04/95	
1	Office	Engineer				1	1	1	1	1	1	
		Architect				0	0	0	0	0	0	
		Foreman				9	9	9	9	9	9	
		Surveyor				4	4	4	4	4	4	
		Draftman				1	1	1	1	1	1	
		Secretary				2	2	2	2	2	2	
		Storage				2	2	2	2	2	2	
2	Structural Work	Plaster				5	5	5	5	5	5	
		Iron Worker				25	25	25	25	25	25	
		Welder				2	2	2	2	2	2	
		Carpenter				35	35	35	35	35	35	
		Foreman				2	2	2	2	2	2	
		Labor				18	18	18	18	18	18	
3	Masonry Work	Carpenter				5	5	5	5	5	5	
		Plaster				10	10	10	10	10	10	
		Labor				15	15	15	15	15	15	
4	Topping-Furnishing	Plaster				0	0	0	0	0	0	
		Labor				0	0	0	0	0	0	
5	Electrical System	Foreman				1	1	1	1	1	1	
		Electrician				10	10	10	10	10	10	
		Labor				0	0	0	0	0	0	
6	Sanitary System	Foreman				1	1	1	1	1	1	
		Plumber				12	12	12	12	12	12	
		Labor				0	0	0	0	0	0	
7	Others	Maintenance				4	4	4	4	4	4	
		Driver				2	2	2	2	2	2	
		Tower Crane Op.				4	4	4	4	4	4	
		Housekeeper				2	2	2	2	2	2	
		Guard				2	2	2	2	2	2	

Figure 59: Construction Personnel Report- Update XI.

Construction Equipment Reports

From:	11/14/94	To:		11/19/94								
No	Description	Equipment, Tools		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Number	Unit	Date		11/14/94	11/15/94	11/16/94	11/17/94	11/18/94	11/19/94	
1	Hoist					0	0	0	0	0	0	
2	Truck					0	0	0	0	0	0	
3	Pick-up Truck					0	0	0	0	0	0	
4	Concrete Cart					0	0	0	0	0	0	
5	Vibrator					2	2	2	2	2	2	
6	Concrete Mixer					2	2	2	2	2	2	
7	Steel Cutter					2	2	2	2	2	2	
8	Steel Bender					2	2	2	2	2	2	
9	Electrical Saw					0	0	0	0	0	0	
10	Wood Saw					0	0	0	0	0	0	
11	Surveyor Camera					2	2	2	2	2	2	
12	Water Pump					2	2	2	2	2	2	
13	Welding Machine					2	2	2	2	2	2	
14	Soil Compactor					0	0	0	0	0	0	
15	Backhoe					2	2	2	2	2	2	
16	Tower Crane					2	2	2	2	2	2	

Figure 60: Construction Equipment Report- Update I.

From:	11/21/1994	To:	11/26/1994									
No	Description	Equipment, Tools		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Number	Unit	Date		11/21/94	11/22/94	11/23/94	11/24/94	11/25/94	11/26/94	
1	Hoist					0	0	0	0	0	0	
2	Truck					0	0	0	0	0	0	
3	Pick-up Truck					0	0	0	0	0	0	
4	Concrete Cart					0	0	0	0	0	0	
5	Vibrator					2	2	2	2	2	2	
6	Concrete Mixer					2	2	2	2	2	2	
7	Steel Cutter					2	2	2	2	2	2	
8	Steel Bender					2	2	2	2	2	2	
9	Electrical Saw					0	0	0	0	0	0	
10	Wood Saw					0	0	0	0	0	0	
11	Surveyor Camera					2	2	2	2	2	2	
12	Water Pump					2	2	2	2	2	2	
13	Welding Machine					2	2	2	2	2	2	
14	Soil Compactor					0	0	0	0	0	0	
15	Backhoe					2	2	2	2	2	2	
16	Tower Crane					2	2	2	2	2	2	

Figure 61: Construction Equipment Report- Update II.

From:	11/28/1994	To:	12/3/1994									
No	Description	Equipment, Tools		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Number	Unit	Date		11/28/94	11/29/94	11/30/94	12/01/94	12/02/94	12/03/94	
1	Hoist					0	0	0	0	0	0	
2	Truck					0	0	0	0	0	0	
3	Pick-up Truck					0	0	0	0	0	0	
4	Concrete Cart					0	0	0	0	0	0	
5	Vibrator					2	2	2	2	2	2	
6	Concrete Mixer					2	2	2	2	2	2	
7	Steel Cutter					2	2	2	2	2	2	
8	Steel Bender					2	2	2	2	2	2	
9	Electrical Saw					0	0	0	0	0	0	
10	Wood Saw					0	0	0	0	0	0	
11	Surveyor Camera					2	2	2	2	2	2	
12	Water Pump					2	2	2	2	2	2	
13	Welding Machine					2	2	2	2	2	2	
14	Soil Compactor					0	0	0	0	0	0	
15	Backhoe					2	2	2	2	2	2	
16	Tower Crane					2	2	2	2	2	2	

Figure 62: Construction Equipment Report- Update III.

From:	12/5/1994	To:	12/10/1994									
No	Description	Equipment, Tools		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Number	Unit	Date		12/05/94	12/06/94	12/07/94	12/08/94	12/09/94	12/10/94	
1	Hoist						0	0	0	0		
2	Truck						0	0	0	0		
3	Pick-up Truck						0	0	0	0		
4	Concrete Cart						0	0	0	0		
5	Vibrator						2	2	2	2		
6	Concrete Mixer						2	2	2	2		
7	Steel Cutter						2	2	2	2		
8	Steel Bender						2	2	2	2		
9	Electrical Saw						0	0	0	0		
10	Wood Saw						0	0	0	0		
11	Surveyor Camera						2	2	2	2		
12	Water Pump						2	2	2	2		
13	Welding Machine						2	2	2	2		
14	Soil Compactor						0	0	0	0		
15	Backhoe						2	2	2	2		
16	Tower Crane						2	2	2	2		

Figure 63: Construction Equipment Report- Update IV.

From:	12/12/1994	To:	12/17/1994									
No	Description	Equipment, Tools		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Number	Unit	Date		12/12/94	12/13/94	12/14/94	12/15/94	12/16/94	12/17/94	
1	Hoist					0	0	0	0	0	0	
2	Truck					0	0	0	0	0	0	
3	Pick-up Truck					0	0	0	0	0	0	
4	Concrete Cart					0	0	0	0	0	0	
5	Vibrator					2	2	2	2	2	2	
6	Concrete Mixer					2	2	2	2	2	2	
7	Steel Cutter					2	2	2	2	2	2	
8	Steel Bender					2	2	2	2	2	2	
9	Electrical Saw					0	0	0	0	0	0	
10	Wood Saw					0	0	0	0	0	0	
11	Surveyor Camera					2	2	2	2	2	2	
12	Water Pump					2	2	2	2	2	2	
13	Welding Machine					2	2	2	2	2	2	
14	Soil Compactor					0	0	0	0	0	0	
15	Backhoe					2	2	2	2	2	2	
16	Tower Crane					2	2	2	2	2	2	

Figure 64: Construction Equipment Report- Update V.

From:	12/19/1994	To:	12/24/1994									
No	Description	Equipment, Tools		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Number	Unit	Date		12/19/94	12/20/94	12/21/94	12/22/94	12/23/94	12/24/94	
1	Hoist					0	0	0				
2	Truck					0	0	0				
3	Pick-up Truck					0	0	0				
4	Concrete Cart					0	0	0				
5	Vibrator					2	2	2				
6	Concrete Mixer					2	2	2				
7	Steel Cutter					2	2	2				
8	Steel Bender					2	2	2				
9	Electrical Saw					0	0	0				
10	Wood Saw					0	0	0				
11	Surveyor Camera					2	2	2				
12	Water Pump					2	2	2				
13	Welding Machine					2	2	2				
14	Soil Compactor					0	0	0				
15	Backhoe					2	2	2				
16	Tower Crane					2	2	2				

Figure 65: Construction Equipment Report- Update VI.

From:	1/30/1995	To:	2/4/1995									
No	Description	Equipment, Tools		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Number	Unit	Date		01/30/95	01/31/95	02/01/95	02/02/95	02/03/95	02/04/95	
1	Hoist					0	0	0	0	0	0	
2	Truck					2	2	2	2	2	2	
3	Pick-up Truck					0	0	0	0	0	0	
4	Concrete Cart					0	0	0	0	0	0	
5	Vibrator					2	2	2	2	2	2	
6	Concrete Mixer					2	2	2	2	2	2	
7	Steel Cutter					2	2	2	2	2	2	
8	Steel Bender					2	2	2	2	2	2	
9	Electrical Saw					0	0	0	0	0	0	
10	Wood Saw					0	0	0	0	0	0	
11	Surveyor Camera					2	2	2	2	2	2	
12	Water Pump					2	2	2	2	2	2	
13	Welding Machine					2	2	2	2	2	2	
14	Soil Compactor					0	0	0	0	0	0	
15	Backhoe					2	2	2	2	2	2	
16	Tower Crane					2	2	2	2	2	2	

Figure 66: Construction Equipment Report- Update VII.

From:	2/6/1995	To:	2/11/1995									
No	Description	Equipment, Tools		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Number	Unit	Date		02/06/95	02/07/95	02/08/95	02/09/95	02/10/95	02/11/95	
1	Hoist					0	0	0	0	0	0	
2	Truck					2	2	2	2	2	2	
3	Pick-up Truck					0	0	0	0	0	0	
4	Concrete Cart					0	0	0	0	0	0	
5	Vibrator					2	2	2	2	2	2	
6	Concrete Mixer					2	2	2	2	2	2	
7	Steel Cutter					2	2	2	2	2	2	
8	Steel Bender					2	2	2	2	2	2	
9	Electrical Saw					0	0	0	0	0	0	
10	Wood Saw					0	0	0	0	0	0	
11	Surveyor Camera					2	2	2	2	2	2	
12	Water Pump					2	2	2	2	2	2	
13	Welding Machine					2	2	2	2	2	2	
14	Soil Compactor					0	0	0	0	0	0	
15	Backhoe					2	2	2	2	2	2	
16	Tower Crane					2	2	2	2	2	2	

Figure 67: Construction Equipment Report- Update VIII.

From:	2/13/1995	To:	2/18/1995									
No	Description	Equipment, Tools		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Number	Unit	Date		02/13/95	02/14/95	02/15/95	02/16/95	02/17/95	02/18/95	
1	Hoist					0	0	0	0	0	0	
2	Truck					2	2	2	2	2	2	
3	Pick-up Truck					0	0	0	0	0	0	
4	Concrete Cart					0	0	0	0	0	0	
5	Vibrator					2	2	2	2	2	2	
6	Concrete Mixer					2	2	2	2	2	2	
7	Steel Cutter					2	2	2	2	2	2	
8	Steel Bender					2	2	2	2	2	2	
9	Electrical Saw					0	0	0	0	0	0	
10	Wood Saw					0	0	0	0	0	0	
11	Surveyor Camera					2	2	2	2	2	2	
12	Water Pump					2	2	2	2	2	2	
13	Welding Machine					2	2	2	2	2	2	
14	Soil Compactor					0	0	0	0	0	0	
15	Backhoe					2	2	2	2	2	2	
16	Tower Crane					2	2	2	2	2	2	

Figure 68: Construction Equipment Report- Update IX.

From:	2/20/1995	To:		2/25/1995								
No	Description	Equipment, Tools		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Number	Unit	Date		02/20/95	02/21/95	02/22/95	02/23/95	02/24/95	02/25/95	
1	Hoist					0	0	0	0	0	0	
2	Truck					2	2	2	2	2	2	
3	Pick-up Truck					0	0	0	0	0	0	
4	Concrete Cart					0	0	0	0	0	0	
5	Vibrator					2	2	2	2	2	2	
6	Concrete Mixer					2	2	2	2	2	2	
7	Steel Cutter					2	2	2	2	2	2	
8	Steel Bender					2	2	2	2	2	2	
9	Electrical Saw					0	0	0	0	0	0	
10	Wood Saw					0	0	0	0	0	0	
11	Surveyor Camera					2	2	2	2	2	2	
12	Water Pump					2	2	2	2	2	2	
13	Welding Machine					2	2	2	2	2	2	
14	Soil Compactor					0	0	0	0	0	0	
15	Backhoe					2	2	2	2	2	2	
16	Tower Crane					2	2	2	2	2	2	

Figure 69: Construction Equipment Report- Update X.

From:	2/27/1995	To:	3/4/1995									
No	Description	Equipment, Tools		Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Note
		Number	Unit	Date		02/27/95	02/28/95	03/01/95	03/02/95	03/03/95	03/04/95	
1	Hoist					0	0	0	0	0	0	
2	Truck					2	2	2	2	2	2	
3	Pick-up Truck					0	0	0	0	0	0	
4	Concrete Cart					0	0	0	0	0	0	
5	Vibrator					2	2	2	2	2	2	
6	Concrete Mixer					2	2	2	2	2	2	
7	Steel Cutter					2	2	2	2	2	2	
8	Steel Bender					2	2	2	2	2	2	
9	Electrical Saw					0	0	0	0	0	0	
10	Wood Saw					0	0	0	0	0	0	
11	Surveyor Camera					2	2	2	2	2	2	
12	Water Pump					2	2	2	2	2	2	
13	Welding Machine					2	2	2	2	2	2	
14	Soil Compactor					0	0	0	0	0	0	
15	Backhoe					2	2	2	2	2	2	
16	Tower Crane					2	2	2	2	2	2	

Figure 70: Construction Equipment Report- Update XI.

APPENDIX I

PROGRESS PAYMENT

Progress Payment Prepared by the General Contractor

Item	Description	Amount (USD)	Percent of Work
1	Mobilization	$84,986.67	6.31%
2	Piling Work	$101,600.00	7.54%
3	Foundation	$82,999.28	6.16%
4	Structural Work		
	Basement & 1st Floor	$131,249.85	9.74%
	2nd Floor-5th Floor	$142,229.57	10.55%
	6th Floor-7th Floor	$71,538.31	5.31%
	8th Floor	$36,815.08	2.73%
	Roof Deck	$33,283.71	2.47%
5	Finishing Work		
	Brick Walls & Plastering	$76,875.47	5.70%
	Tiling & Concrete	$27,287.20	2.02%
	Ceiling	$72,040.00	5.34%
	Door&Window	$98,320.00	7.29%
	Sanitary Ware	$35,840.00	2.66%
	Paining	$48,154.67	3.57%
	Carpet	$69,120.00	5.14%
	Miscellaneous	$14,018.67	1.04%
6	Waste Treatment Plant	$24,388.69	1.81%
7	Electrical Work	$144,554.67	10.72%
8	Plumbing Work	$52,565.33	3.90%
9	Overhead & Profit		
10	Tax		
	Grand Total	$1,347,867.16	100.00%

Figure 71: Payment of Material by the General Contractor.

Item	Description	Amount (USD)	Percent of Work
1	Mobilization	$90,666.67	20.67%
2	Piling Work	$9,144.00	2.09%
3	Foundation	$15,755.52	3.59%
4	Structural Work		
	Basement & 1st Floor	$28,016.07	6.39%
	2nd Floor-5th Floor	$31,815.95	7.26%
	6th Floor-7th Floor	$15,984.45	3.65%
	8th Floor	$8,240.71	1.88%
	Roof Deck	$8,294.29	1.89%
5	Finishing Work		
	Brick Walls & Plastering	$66,460.53	15.16%
	Tiling & Concrete	$12,487.20	2.85%
	Ceiling	$29,668.00	6.77%
	Door&Window	$13,816.00	3.15%
	Sanitary Ware	$5,120.00	1.17%
	Paining	$12,688.27	2.89%
	Carpet	$0.00	0.00%
	Miscellaneous	$6,008.00	1.37%
6	Waste Treatment Plant	$3,040.37	0.69%
7	Electrical Work	$39,424.00	8.99%
8	Plumbing Work	$13,141.33	3.00%
9	Overhead & Profit	$28,684.00	6.54%
10	Tax		
	Grand Total	$438,455.36	100.00%

Figure 72: Payment of Labor by the General Contractor.

Progress Payment Prepared by the Construction Management Company

Item	Description		Amount (USD)	Percent of Work
1	Mobilization		84,986.67	6.31%
2	Piling Work		101,600.00	7.54%
3	Foundation		82,999.28	6.16%
4	Structural Work			
	Basement & 1st Floor		131,249.85	9.74%
	2nd Floor-5th Floor		142,229.57	10.55%
	6th Floor-7th Floor		71,538.31	5.31%
	8th Floor		36,815.08	2.73%
	Roof Deck		33,283.71	2.47%
5	Finishing Work			
	Brick Walls & Plastering		76,875.47	5.70%
	Tiling & Concrete		27,287.20	2.02%
	Ceiling		72,040.00	5.34%
	Door&Window		98,320.00	7.29%
	Sanitary Ware		35,840.00	2.66%
	Paining		48,154.67	3.57%
	Carpet		69,120.00	5.13%
	Miscellaneous		14,018.67	1.04%
6	Waste Treatment Plant		24,388.69	1.81%
7	Electrical Work		144,554.67	10.72%
8	Plumbing Work		52,565.33	3.90%
			1,347,867.16	100.00%
9	Overhead&Profit	7%	94,350.70	
10	VAT	7%	100,955.25	
	Grand Total		**1,543,173.11**	

Figure 73: Payment of Material by the Construction Management Company.

Item	Description		Amount (USD	Percent of Work
1	Mobilization		90,666.67	22.13%
2	Piling Work		9,144.00	2.23%
3	Foundation		15,755.52	3.84%
4	Structural Work			
	Basement & 1st Floor		28,016.07	6.84%
	2nd Floor-5th Floor		31,815.95	7.76%
	6th Floor-7th Floor		15,984.45	3.90%
	8th Floor		8,240.71	2.01%
	Roof Deck		8,294.29	2.02%
5	Finishing Work			
	Brick Walls & Plastering		66,460.53	16.22%
	Tiling & Concrete		12,487.20	3.05%
	Ceiling		29,668.00	7.24%
	Door&Window		13,816.00	3.37%
	Sanitary Ware		5,120.00	1.25%
	Paining		12,688.27	3.10%
	Carpet		0.00	0.00%
	Miscellaneous		6,008.00	1.47%
6	Waste Treatment Plant		3,040.37	0.74%
7	Electrical Work		39,424.00	9.62%
8	Plumbing Work		13,141.33	3.21%
			409,771.36	**100.00%**
9	Overhead & Profit	7%	28,684.00	
10	VAT	7%	30,691.87	
	Grand Total		**469,147.23**	

Figure 74: Payment of Labor by the Construction Management Company.

Payment of Material As Attached to the Monthly Reports

Item	Description	Amount (USD)	Percent of Work	Work Complete	ACC	Last Time	This Time
1	Mobilization	$84,986.67	6.31%	9.98%	0.63%	0.00%	0.63%
2	Piling Work	$101,600.00	7.54%	100.00%	7.54%	0.00%	7.54%
3	Foundation	$82,999.28	6.16%	100.00%	6.16%	0.00%	6.16%
4	Structural Work						
	Basement & 1st Floor	$131,249.85	9.74%	50.00%	4.87%	0.00%	4.87%
	2nd Floor-5th Floor	$142,229.57	10.55%	0.00%	0.00%	0.00%	0.00%
	6th Floor-7th Floor	$71,538.31	5.31%	0.00%	0.00%	0.00%	0.00%
	8th Floor	$36,815.08	2.73%	0.00%	0.00%	0.00%	0.00%
	Roof Deck	$33,283.71	2.47%	0.00%	0.00%	0.00%	0.00%
5	Finishing Work						
	Brick Walls & Plastering	$76,875.47	5.70%	0.00%	0.00%	0.00%	0.00%
	Tiling & Concrete	$27,287.20	2.02%	0.00%	0.00%	0.00%	0.00%
	Ceiling	$72,040.00	5.34%	0.00%	0.00%	0.00%	0.00%
	Door&Window	$98,320.00	7.29%	0.00%	0.00%	0.00%	0.00%
	Sanitary Ware	$35,840.00	2.66%	0.00%	0.00%	0.00%	0.00%
	Paining	$48,154.67	3.57%	0.00%	0.00%	0.00%	0.00%
	Carpet	$69,120.00	5.14%	0.00%	0.00%	0.00%	0.00%
	Miscellaneous	$14,018.67	1.04%	0.00%	0.00%	0.00%	0.00%
6	Waste Treatment Plant	$24,388.69	1.81%	0.00%	0.00%	0.00%	0.00%
7	Electrical Work	$144,554.67	10.72%	0.00%	0.00%	0.00%	0.00%
8	Plumbing Work	$52,565.33	3.90%	0.00%	0.00%	0.00%	0.00%
9	Overhead & Profit						
10	Tax						
	Grand Total	$1,347,867.16	100.00%		19.20%	0.00%	19.20%

Figure 75: Payment of Material- Update I.

Item	Description	Amount (USD)	Percent of Work	Work Complete	ACC	Last Time	This Time
1	Mobilization	$84,986.67	6.31%	9.98%	0.63%	0.63%	0.00%
2	Piling Work	$101,600.00	7.54%	100.00%	7.54%	7.54%	0.00%
3	Foundation	$82,999.28	6.16%	100.00%	6.16%	6.16%	0.00%
4	Structural Work						
	Basement & 1st Floor	$131,249.85	9.74%	69.92%	6.81%	4.87%	1.94%
	2nd Floor-5th Floor	$142,229.57	10.55%	0.00%	0.00%	0.00%	0.00%
	6th Floor-7th Floor	$71,538.31	5.31%	0.00%	0.00%	0.00%	0.00%
	8th Floor	$36,815.08	2.73%	0.00%	0.00%	0.00%	0.00%
	Roof Deck	$33,283.71	2.47%	0.00%	0.00%	0.00%	0.00%
5	Finishing Work						
	Brick Walls & Plastering	$76,875.47	5.70%	0.00%	0.00%	0.00%	0.00%
	Tiling & Concrete	$27,287.20	2.02%	0.00%	0.00%	0.00%	0.00%
	Ceiling	$72,040.00	5.34%	0.00%	0.00%	0.00%	0.00%
	Door&Window	$98,320.00	7.29%	0.00%	0.00%	0.00%	0.00%
	Sanitary Ware	$35,840.00	2.66%	0.00%	0.00%	0.00%	0.00%
	Paining	$48,154.67	3.57%	0.00%	0.00%	0.00%	0.00%
	Carpet	$69,120.00	5.14%	0.00%	0.00%	0.00%	0.00%
	Miscellaneous	$14,018.67	1.04%	0.00%	0.00%	0.00%	0.00%
6	Waste Treatment Plant	$24,388.69	1.81%	0.00%	0.00%	0.00%	0.00%
7	Electrical Work	$144,554.67	10.72%	0.00%	0.00%	0.00%	0.00%
8	Plumbing Work	$52,565.33	3.90%	0.00%	0.00%	0.00%	0.00%
9	Overhead & Profit						
10	Tax						
	Grand Total	$1,347,867.16	100.00%		21.14%	19.20%	1.94%

Figure 76: Payment of Material- Update II.

Item	Description	Amount (USD)	Percent of Work	Work Complete	ACC	Last Time	This Time
1	Mobilization	$84,986.67	6.31%	9.98%	0.63%	0.63%	0.00%
2	Piling Work	$101,600.00	7.54%	100.00%	7.54%	7.54%	0.00%
3	Foundation	$82,999.28	6.16%	100.00%	6.16%	6.16%	0.00%
4	Structural Work						
	Basement & 1st Floor	$131,249.85	9.74%	100.00%	9.74%	6.81%	2.93%
	2nd Floor-5th Floor	$142,229.57	10.55%	10.05%	1.06%	0.00%	1.06%
	6th Floor-7th Floor	$71,538.31	5.31%	0.00%	0.00%	0.00%	0.00%
	8th Floor	$36,815.08	2.73%	0.00%	0.00%	0.00%	0.00%
	Roof Deck	$33,283.71	2.47%	0.00%	0.00%	0.00%	0.00%
5	Finishing Work						
	Brick Walls & Plastering	$76,875.47	5.70%	0.00%	0.00%	0.00%	0.00%
	Tiling & Concrete	$27,287.20	2.02%	0.00%	0.00%	0.00%	0.00%
	Ceiling	$72,040.00	5.34%	0.00%	0.00%	0.00%	0.00%
	Door&Window	$98,320.00	7.29%	0.00%	0.00%	0.00%	0.00%
	Sanitary Ware	$35,840.00	2.66%	0.00%	0.00%	0.00%	0.00%
	Paining	$48,154.67	3.57%	0.00%	0.00%	0.00%	0.00%
	Carpet	$69,120.00	5.14%	0.00%	0.00%	0.00%	0.00%
	Miscellaneous	$14,018.67	1.04%	0.00%	0.00%	0.00%	0.00%
6	Waste Treatment Plant	$24,388.69	1.81%	0.00%	0.00%	0.00%	0.00%
7	Electrical Work	$144,554.67	10.72%	0.00%	0.00%	0.00%	0.00%
8	Plumbing Work	$52,565.33	3.90%	0.00%	0.00%	0.00%	0.00%
9	Overhead & Profit						
10	Tax						
	Grand Total	$1,347,867.16	100.00%		25.13%	21.14%	3.99%

Figure 77: Payment of Material- Update III.

Item	Description	Amount (USD)	Percent of Work	Work Complete	ACC	Last Time	This Time
1	Mobilization	$84,986.67	6.31%	9.98%	0.63%	0.63%	0.00%
2	Piling Work	$101,600.00	7.54%	100.00%	7.54%	7.54%	0.00%
3	Foundation	$82,999.28	6.16%	100.00%	6.16%	6.16%	0.00%
4	Structural Work						
	Basement & 1st Floor	$131,249.85	9.74%	100.00%	9.74%	9.74%	0.00%
	2nd Floor-5th Floor	$142,229.57	10.55%	50.05%	5.28%	1.06%	4.22%
	6th Floor-7th Floor	$71,538.31	5.31%	0.00%	0.00%	0.00%	0.00%
	8th Floor	$36,815.08	2.73%	0.00%	0.00%	0.00%	0.00%
	Roof Deck	$33,283.71	2.47%	0.00%	0.00%	0.00%	0.00%
5	Finishing Work						
	Brick Walls & Plastering	$76,875.47	5.70%	0.00%	0.00%	0.00%	0.00%
	Tiling & Concrete	$27,287.20	2.02%	0.00%	0.00%	0.00%	0.00%
	Ceiling	$72,040.00	5.34%	0.00%	0.00%	0.00%	0.00%
	Door&Window	$98,320.00	7.29%	0.00%	0.00%	0.00%	0.00%
	Sanitary Ware	$35,840.00	2.66%	0.00%	0.00%	0.00%	0.00%
	Paining	$48,154.67	3.57%	0.00%	0.00%	0.00%	0.00%
	Carpet	$69,120.00	5.14%	0.00%	0.00%	0.00%	0.00%
	Miscellaneous	$14,018.67	1.04%	0.00%	0.00%	0.00%	0.00%
6	Waste Treatment Plant	$24,388.69	1.81%	0.00%	0.00%	0.00%	0.00%
7	Electrical Work	$144,554.67	10.72%	0.00%	0.00%	0.00%	0.00%
8	Plumbing Work	$52,565.33	3.90%	0.00%	0.00%	0.00%	0.00%
9	Overhead & Profit						
10	Tax						
	Grand Total	$1,347,867.16	100.00%		29.35%	25.13%	4.22%

Figure 78: Payment of Material- Update IV.

Item	Description	Amount (USD)	Percent of Work	Work Complete	ACC	Last Time	This Time
1	Mobilization	$84,986.67	6.31%	49.92%	3.15%	0.63%	2.52%
2	Piling Work	$101,600.00	7.54%	100.00%	7.54%	7.54%	0.00%
3	Foundation	$82,999.28	6.16%	100.00%	6.16%	6.16%	0.00%
4	Structural Work						
	Basement & 1st Floor	$131,249.85	9.74%	100.00%	9.74%	9.74%	0.00%
	2nd Floor-5th Floor	$142,229.57	10.55%	89.95%	9.49%	5.28%	4.21%
	6th Floor-7th Floor	$71,538.31	5.31%	0.00%	0.00%	0.00%	0.00%
	8th Floor	$36,815.08	2.73%	0.00%	0.00%	0.00%	0.00%
	Roof Deck	$33,283.71	2.47%	0.00%	0.00%	0.00%	0.00%
5	Finishing Work						
	Brick Walls & Plastering	$76,875.47	5.70%	0.00%	0.00%	0.00%	0.00%
	Tiling & Concrete	$27,287.20	2.02%	0.00%	0.00%	0.00%	0.00%
	Ceiling	$72,040.00	5.34%	0.00%	0.00%	0.00%	0.00%
	Door&Window	$98,320.00	7.29%	0.00%	0.00%	0.00%	0.00%
	Sanitary Ware	$35,840.00	2.66%	0.00%	0.00%	0.00%	0.00%
	Paining	$48,154.67	3.57%	0.00%	0.00%	0.00%	0.00%
	Carpet	$69,120.00	5.14%	0.00%	0.00%	0.00%	0.00%
	Miscellaneous	$14,018.67	1.04%	9.62%	0.10%	0.00%	0.10%
6	Waste Treatment Plant	$24,388.69	1.81%	0.00%	0.00%	0.00%	0.00%
7	Electrical Work	$144,554.67	10.72%	0.00%	0.00%	0.00%	0.00%
8	Plumbing Work	$52,565.33	3.90%	0.00%	0.00%	0.00%	0.00%
9	Overhead & Profit						
10	Tax						
	Grand Total	$1,347,867.16	100.00%		36.18%	29.35%	6.83%

Figure 79: Payment of Material- Update V.

Payment of Labor As Attached to the Monthly Reports

Item	Description	Amount (USD)	Percent of Work	Work Complete	ACC	Last Time	This Time
1	Mobilization	$90,666.67	20.67%	9.97%	2.06%	0.00%	2.06%
2	Piling Work	$9,144.00	2.09%	100.00%	2.09%	0.00%	2.09%
3	Foundation	$15,755.52	3.59%	100.00%	3.59%	0.00%	3.59%
4	Structural Work						
	Basement & 1st Floor	$28,016.07	6.39%	49.92%	3.19%	0.00%	3.19%
	2nd Floor-5th Floor	$31,815.95	7.26%	0.00%	0.00%	0.00%	0.00%
	6th Floor-7th Floor	$15,984.45	3.65%	0.00%	0.00%	0.00%	0.00%
	8th Floor	$8,240.71	1.88%	0.00%	0.00%	0.00%	0.00%
	Roof Deck	$8,294.29	1.89%	0.00%	0.00%	0.00%	0.00%
5	Finishing Work						
	Brick Walls & Plastering	$66,460.53	15.16%	0.00%	0.00%	0.00%	0.00%
	Tiling & Concrete	$12,487.20	2.85%	0.00%	0.00%	0.00%	0.00%
	Ceiling	$29,668.00	6.77%	0.00%	0.00%	0.00%	0.00%
	Door&Window	$13,816.00	3.15%	0.00%	0.00%	0.00%	0.00%
	Sanitary Ware	$5,120.00	1.17%	0.00%	0.00%	0.00%	0.00%
	Paining	$12,688.27	2.89%	0.00%	0.00%	0.00%	0.00%
	Carpet	$0.00	0.00%	0.00%	0.00%	0.00%	0.00%
	Miscellaneous	$6,008.00	1.37%	0.00%	0.00%	0.00%	0.00%
6	Waste Treatment Plant	$3,040.37	0.69%	0.00%	0.00%	0.00%	0.00%
7	Electrical Work	$39,424.00	8.99%	0.00%	0.00%	0.00%	0.00%
8	Plumbing Work	$13,141.33	3.00%	0.00%	0.00%	0.00%	0.00%
9	Overhead & Profit	$28,684.00	6.54%	10.86%	0.71%	0.00%	0.71%
10	Tax						
	Grand Total	$438,455.36	100.00%		11.64%	0.00%	11.64%

Figure 80: Payment of Labor- Update I.

Item	Description	Amount (USD)	Percent of Work	Work Complete	ACC	Last Time	This Time
1	Mobilization	$90,666.67	20.67%	9.97%	2.06%	2.06%	0.00%
2	Piling Work	$9,144.00	2.09%	100.00%	2.09%	2.09%	0.00%
3	Foundation	$15,755.52	3.59%	100.00%	3.59%	3.59%	0.00%
4	Structural Work						
	Basement & 1st Floor	$28,016.07	6.39%	69.95%	4.47%	3.19%	1.94%
	2nd Floor-5th Floor	$31,815.95	7.26%	0.00%	0.00%	0.00%	0.00%
	6th Floor-7th Floor	$15,984.45	3.65%	0.00%	0.00%	0.00%	0.00%
	8th Floor	$8,240.71	1.88%	0.00%	0.00%	0.00%	0.00%
	Roof Deck	$8,294.29	1.89%	0.00%	0.00%	0.00%	0.00%
5	Finishing Work						
	Brick Walls & Plastering	$66,460.53	15.16%	0.00%	0.00%	0.00%	0.00%
	Tiling & Concrete	$12,487.20	2.85%	0.00%	0.00%	0.00%	0.00%
	Ceiling	$29,668.00	6.77%	0.00%	0.00%	0.00%	0.00%
	Door&Window	$13,816.00	3.15%	0.00%	0.00%	0.00%	0.00%
	Sanitary Ware	$5,120.00	1.17%	0.00%	0.00%	0.00%	0.00%
	Paining	$12,688.27	2.89%	0.00%	0.00%	0.00%	0.00%
	Carpet	$0.00	0.00%	0.00%	0.00%	0.00%	0.00%
	Miscellaneous	$6,008.00	1.37%	0.00%	0.00%	0.00%	0.00%
6	Waste Treatment Plant	$3,040.37	0.69%	0.00%	0.00%	0.00%	0.00%
7	Electrical Work	$39,424.00	8.99%	0.00%	0.00%	0.00%	0.00%
8	Plumbing Work	$13,141.33	3.00%	0.00%	0.00%	0.00%	0.00%
9	Overhead & Profit	$28,684.00	6.54%	12.08%	0.79%	0.71%	0.08%
10	Tax						
	Grand Total	$438,455.36	100.00%		13.00%	11.64%	2.02%

Figure 81: Payment of Labor- Update II.

Item	Description	Amount (USD)	Percent of Work	Work Complete	ACC	Last Time	This Time
1	Mobilization	$90,666.67	20.67%	9.97%	2.06%	2.06%	0.00%
2	Piling Work	$9,144.00	2.09%	100.00%	2.09%	2.09%	0.00%
3	Foundation	$15,755.52	3.59%	100.00%	3.59%	3.59%	0.00%
4	Structural Work						
	Basement & 1st Floor	$28,016.07	6.39%	100.00%	6.39%	4.47%	1.92%
	2nd Floor-5th Floor	$31,815.95	7.26%	10.06%	0.73%	0.00%	0.73%
	6th Floor-7th Floor	$15,984.45	3.65%	0.00%	0.00%	0.00%	0.00%
	8th Floor	$8,240.71	1.88%	0.00%	0.00%	0.00%	0.00%
	Roof Deck	$8,294.29	1.89%	0.00%	0.00%	0.00%	0.00%
5	Finishing Work						
	Brick Walls & Plastering	$66,460.53	15.16%	0.00%	0.00%	0.00%	0.00%
	Tiling & Concrete	$12,487.20	2.85%	0.00%	0.00%	0.00%	0.00%
	Ceiling	$29,668.00	6.77%	0.00%	0.00%	0.00%	0.00%
	Door&Window	$13,816.00	3.15%	0.00%	0.00%	0.00%	0.00%
	Sanitary Ware	$5,120.00	1.17%	0.00%	0.00%	0.00%	0.00%
	Paining	$12,688.27	2.89%	0.00%	0.00%	0.00%	0.00%
	Carpet	$0.00	0.00%	0.00%	0.00%	0.00%	0.00%
	Miscellaneous	$6,008.00	1.37%	0.00%	0.00%	0.00%	0.00%
6	Waste Treatment Plant	$3,040.37	0.69%	0.00%	0.00%	0.00%	0.00%
7	Electrical Work	$39,424.00	8.99%	0.00%	0.00%	0.00%	0.00%
8	Plumbing Work	$13,141.33	3.00%	0.00%	0.00%	0.00%	0.00%
9	Overhead & Profit	$28,684.00	6.54%	14.83%	0.97%	0.79%	0.18%
10	Tax						
	Grand Total	$438,455.36	100.00%		15.83%	13.00%	2.83%

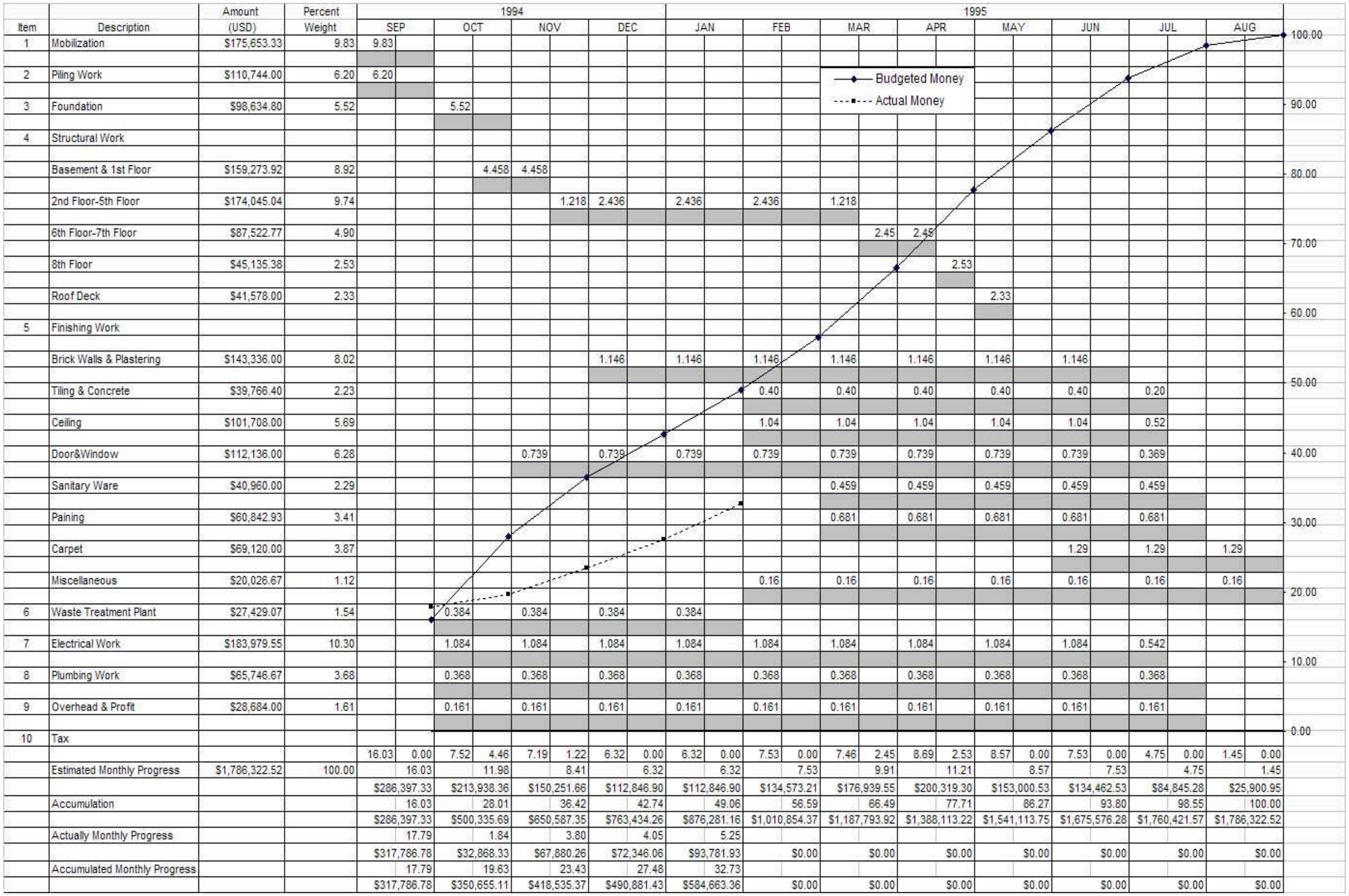
Figure 82:Payment of Labor- Update III.

Item	Description	Amount (USD)	Percent of Work	Work Complete	ACC	Last Time	This Time
1	Mobilization	$90,666.67	20.67%	9.97%	2.06%	2.06%	0.00%
2	Piling Work	$9,144.00	2.09%	100.00%	2.09%	2.09%	0.00%
3	Foundation	$15,755.52	3.59%	100.00%	3.59%	3.59%	0.00%
4	Structural Work						
	Basement & 1st Floor	$28,016.07	6.39%	100.00%	6.39%	6.39%	0.00%
	2nd Floor-5th Floor	$31,815.95	7.26%	50.00%	3.63%	0.73%	2.90%
	6th Floor-7th Floor	$15,984.45	3.65%	0.00%	0.00%	0.00%	0.00%
	8th Floor	$8,240.71	1.88%	0.00%	0.00%	0.00%	0.00%
	Roof Deck	$8,294.29	1.89%	0.00%	0.00%	0.00%	0.00%
5	Finishing Work						
	Brick Walls & Plastering	$66,460.53	15.16%	0.00%	0.00%	0.00%	0.00%
	Tiling & Concrete	$12,487.20	2.85%	0.00%	0.00%	0.00%	0.00%
	Ceiling	$29,668.00	6.77%	0.00%	0.00%	0.00%	0.00%
	Door&Window	$13,816.00	3.15%	0.00%	0.00%	0.00%	0.00%
	Sanitary Ware	$5,120.00	1.17%	0.00%	0.00%	0.00%	0.00%
	Paining	$12,688.27	2.89%	0.00%	0.00%	0.00%	0.00%
	Carpet	$0.00	0.00%	0.00%	0.00%	0.00%	0.00%
	Miscellaneous	$6,008.00	1.37%	0.00%	0.00%	0.00%	0.00%
6	Waste Treatment Plant	$3,040.37	0.69%	0.00%	0.00%	0.00%	0.00%
7	Electrical Work	$39,424.00	8.99%	0.00%	0.00%	0.00%	0.00%
8	Plumbing Work	$13,141.33	3.00%	0.00%	0.00%	0.00%	0.00%
9	Overhead & Profit	$28,684.00	6.54%	17.89%	1.17%	0.97%	0.20%
10	Tax						
	Grand Total	$438,455.36	100.00%		18.93%	15.83%	3.10%

Figure 83: Payment of Labor- Update IV.

Item	Description	Amount (USD)	Percent of Work	Work Complete	ACC	Last Time	This Time
1	Mobilization	$90,666.67	20.67%	49.98%	10.33%	2.06%	8.27%
2	Piling Work	$9,144.00	2.09%	100.00%	2.09%	2.09%	0.00%
3	Foundation	$15,755.52	3.59%	100.00%	3.59%	3.59%	0.00%
4	Structural Work						
	Basement & 1st Floor	$28,016.07	6.39%	100.00%	6.39%	6.39%	0.00%
	2nd Floor-5th Floor	$31,815.95	7.26%	89.94%	6.53%	3.63%	2.90%
	6th Floor-7th Floor	$15,984.45	3.65%	0.00%	0.00%	0.00%	0.00%
	8th Floor	$8,240.71	1.88%	0.00%	0.00%	0.00%	0.00%
	Roof Deck	$8,294.29	1.89%	0.00%	0.00%	0.00%	0.00%
5	Finishing Work						
	Brick Walls & Plastering	$66,460.53	15.16%	0.00%	0.00%	0.00%	0.00%
	Tiling & Concrete	$12,487.20	2.85%	0.00%	0.00%	0.00%	0.00%
	Ceiling	$29,668.00	6.77%	0.00%	0.00%	0.00%	0.00%
	Door&Window	$13,816.00	3.15%	0.00%	0.00%	0.00%	0.00%
	Sanitary Ware	$5,120.00	1.17%	0.00%	0.00%	0.00%	0.00%
	Paining	$12,688.27	2.89%	0.00%	0.00%	0.00%	0.00%
	Carpet	$0.00	0.00%	0.00%	0.00%	0.00%	0.00%
	Miscellaneous	$6,008.00	1.37%	10.22%	0.14%	0.00%	0.14%
6	Waste Treatment Plant	$3,040.37	0.69%	0.00%	0.00%	0.00%	0.00%
7	Electrical Work	$39,424.00	8.99%	0.00%	0.00%	0.00%	0.00%
8	Plumbing Work	$13,141.33	3.00%	0.00%	0.00%	0.00%	0.00%
9	Overhead & Profit	$28,684.00	6.54%	29.05%	1.90%	1.17%	0.73%
10	Tax						
	Grand Total	$438,455.36	100.00%		30.97%	18.93%	12.04%

Figure 84: Payment of Labor- Update V.



Item	Description	Amount (USD)	Percent Weight	1994 SEP	OCT	NOV	DEC	1995 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
1	Mobilization	$175,653.33	9.83	9.83											
2	Piling Work	$110,744.00	6.20	6.20											
3	Foundation	$98,634.80	5.52		5.52										
4	Structural Work														
	Basement & 1st Floor	$159,273.92	8.92		4.458	4.458									
	2nd Floor-5th Floor	$174,045.04	9.74			1.218	2.436	2.436	2.436	1.218					
	6th Floor-7th Floor	$87,522.77	4.90							2.45	2.45				
	8th Floor	$45,135.38	2.53								2.53				
	Roof Deck	$41,578.00	2.33									2.33			
5	Finishing Work														
	Brick Walls & Plastering	$143,336.00	8.02				1.146	1.146	1.146	1.146	1.146	1.146	1.146		
	Tiling & Concrete	$39,766.40	2.23						0.40	0.40	0.40	0.40	0.40	0.20	
	Ceiling	$101,708.00	5.69						1.04	1.04	1.04	1.04	1.04	0.52	
	Door&Window	$112,136.00	6.28			0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.369	
	Sanitary Ware	$40,960.00	2.29							0.459	0.459	0.459	0.459	0.459	
	Paining	$60,842.93	3.41							0.681	0.681	0.681	0.681	0.681	
	Carpet	$69,120.00	3.87										1.29	1.29	1.29
	Miscellaneous	$20,026.67	1.12						0.16	0.16	0.16	0.16	0.16	0.16	0.16
6	Waste Treatment Plant	$27,429.07	1.54		0.384	0.384	0.384	0.384							
7	Electrical Work	$183,979.55	10.30		1.084	1.084	1.084	1.084	1.084	1.084	1.084	1.084	1.084	0.542	
8	Plumbing Work	$65,746.67	3.68		0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	
9	Overhead & Profit	$28,684.00	1.61		0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.161	
10	Tax														
				16.03 0.00	7.52 4.46	7.19 1.22	6.32 0.00	6.32 0.00	7.53 0.00	7.46 2.45	8.69 2.53	8.57 0.00	7.53 0.00	4.75 0.00	1.45 0.00
	Estimated Monthly Progress	$1,786,322.52	100.00	16.03	11.98	8.41	6.32	6.32	7.53	9.91	11.21	8.57	7.53	4.75	1.45
				$286,397.33	$213,938.36	$150,251.66	$112,846.90	$112,846.90	$134,573.21	$176,939.55	$200,319.30	$153,000.53	$134,462.53	$84,845.28	$25,900.95
	Accumulation			16.03	28.01	36.42	42.74	49.06	56.59	66.49	77.71	86.27	93.80	98.55	100.00
				$286,397.33	$500,335.69	$650,587.35	$763,434.26	$876,281.16	$1,010,854.37	$1,187,793.92	$1,388,113.22	$1,541,113.75	$1,675,576.28	$1,760,421.57	$1,786,322.52
	Actually Monthly Progress			17.79	1.84	3.80	4.05	5.25							
				$317,786.78	$32,868.33	$67,880.26	$72,346.06	$93,781.93	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Accumulated Monthly Progress			17.79	19.63	23.43	27.48	32.73							
				$317,786.78	$350,655.11	$418,535.37	$490,881.43	$584,663.36	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Figure 85: Schedule and Payment (Original).

Item	Description	Amount (USD)	Percent Weight	1994 SEP	1994 OCT	1994 NOV	1994 DEC	1995 JAN	1995 FEB	1995 MAR	1995 APR	1995 MAY	1995 JUN	1995 JUL	1995 AUG	1995 SEP	1995 OCT
1	Mobilization	$175,653.33	9.83	9.83													
2	Piling Work	$110,744.00	6.20	6.20													
3	Foundation	$98,634.80	5.52		5.52												
4	Structural Work																
	Basement & 1st Floor	$159,273.92	8.92		4.458	4.458											
	2nd Floor-5th Floor	$174,045.04	9.74			1.218	2.436	2.436	2.436	1.218							
	6th Floor-7th Floor	$87,522.77	4.90							2.45	2.45						
	8th Floor	$45,135.38	2.53								2.53						
	Roof Deck	$41,578.00	2.33									2.33					
5	Finishing Work																
	Brick Walls & Plastering	$143,336.00	8.02				1.146	1.146	1.146	1.146	1.146	1.146	1.146				
	Tiling & Concrete	$39,766.40	2.23						0.40	0.40	0.40	0.40	0.40	0.20			
	Ceiling	$101,708.00	5.69						1.04	1.04	1.04	1.04	1.04	0.52			
	Door&Window	$112,136.00	6.28			0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.369			
	Sanitary Ware	$40,960.00	2.29							0.459	0.459	0.459	0.459	0.459			
	Paining	$60,842.93	3.41							0.681	0.681	0.681	0.681	0.681			
	Carpet	$69,120.00	3.87										1.29	1.29	1.29		
	Miscellaneous	$20,026.67	1.12						0.16	0.16	0.16	0.16	0.16	0.16	0.16		
6	Waste Treatment Plant	$27,429.07	1.54		0.384	0.384	0.384	0.384									
7	Electrical Work	$183,979.55	10.30		1.084	1.084	1.084	1.084	1.084	1.084	1.084	1.084	1.084	0.542			
8	Plumbing Work	$65,746.67	3.68		0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368			
9	Overhead & Profit	$28,684.00	1.61		0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.161			
10	Tax																
				16.03 0.00	7.52 4.46	7.19 1.22	6.32 0.00	6.32 0.00	7.53 0.00	7.46 2.45	8.69 2.53	8.57 0.00	7.53 0.00	4.75 0.00	1.45 0.00		
	Estimated Monthly Progress	$1,786,322.52	100.00	16.03	11.98	8.41	6.32	6.32	7.53	9.91	11.21	8.57	7.53	4.75	1.45		
	(Assumed increased costs)			$286,397.33	$213,938.36	$150,251.66	$112,846.90	$112,846.90	$134,573.21	$176,939.55	$200,319.30	$153,000.53	$134,462.53	$84,845.28	$25,900.95		
	Accumulation			16.03	28.01	36.42	42.74	49.06	56.59	66.49	77.71	86.27	93.80	98.55	100.00		
				$286,397.33	$500,335.69	$650,587.35	$763,434.26	$876,281.16	$1,010,854.37	$1,187,793.92	$1,388,113.22	$1,541,113.75	$1,675,576.28	$1,760,421.57	$1,786,322.52		
	Actually Monthly Progress			17.79	1.84	3.80	4.05	5.25	7.53	9.91	11.21	8.57	7.53	4.75	5.45	7.00	5.32
				$317,786.78	$32,868.33	$67,880.26	$72,346.06	$93,781.93	$134,573.21	$176,939.55	$200,319.30	$153,000.53	$134,462.53	$84,845.28	$97,354.58	$125,042.58	$95,032.36
	Accumulated Monthly Progress			17.79	19.63	23.43	27.48	32.73	40.26	50.17	61.38	69.95	77.48	82.23	87.68	94.68	100.00
				$317,786.78	$350,655.11	$418,535.37	$490,881.43	$584,663.36	$719,236.57	$896,176.12	$1,096,495.42	$1,249,495.95	$1,383,958.48	$1,468,803.77	$1,566,158.34	$1,691,200.92	$1,786,233.28

Estimated Work
Actual Work

Figure 86: Schedule and Payment-Scenario-1.

Item	Description	Amount (USD)	Percent Weight	1994 SEP	OCT	NOV	DEC	1995 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
1	Mobilization	$175,653.33	9.83	9.83													
2	Piling Work	$110,744.00	6.20	6.20													
3	Foundation	$98,634.80	5.52		5.52												
4	Structural Work																
	Basement & 1st Floor	$159,273.92	8.92		4.458	4.458											
	2nd Floor-5th Floor	$174,045.04	9.74			1.218	2.436	2.436	2.436	1.218							
	6th Floor-7th Floor	$87,522.77	4.90							2.45	2.45						
	8th Floor	$45,135.38	2.53								2.53						
	Roof Deck	$41,578.00	2.33									2.33					
5	Finishing Work																
	Brick Walls & Plastering	$143,336.00	8.02				1.146	1.146	1.146	1.146	1.146	1.146	1.146				
	Tiling & Concrete	$39,766.40	2.23						0.40	0.40	0.40	0.40	0.40	0.20			
	Ceiling	$101,708.00	5.69						1.04	1.04	1.04	1.04	1.04	0.52			
	Door&Window	$112,136.00	6.28			0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.369			
	Sanitary Ware	$40,960.00	2.29							0.459	0.459	0.459	0.459	0.459			
	Paining	$60,842.93	3.41							0.681	0.681	0.681	0.681	0.681			
	Carpet	$69,120.00	3.87										1.29	1.29	1.29		
	Miscellaneous	$20,026.67	1.12						0.16	0.16	0.16	0.16	0.16	0.16	0.16		
6	Waste Treatment Plant	$27,429.07	1.54		0.384	0.384	0.384	0.384									
7	Electrical Work	$183,979.55	10.30		1.084	1.084	1.084	1.084	1.084	1.084	1.084	1.084	1.084	0.542			
8	Plumbing Work	$65,746.67	3.68		0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368			
9	Overhead & Profit	$28,684.00	1.61		0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.161			
10	Tax																
				16.03 0.00	7.52 4.46	7.19 1.22	6.32 0.00	6.32 0.00	7.53 0.00	7.46 2.45	8.69 2.53	8.57 0.00	7.53 0.00	4.75 0.00	1.45 0.00		
	Estimated Monthly Progress	$1,786,322.52	100.00	16.03	11.98	8.41	6.32	6.32	7.53	9.91	11.21	8.57	7.53	4.75	1.45		
	(Assumed increased costs)	$2,054,270.90		$286,397.33	$213,938.36	$150,251.66	$112,846.90	$112,846.90	$134,573.21	$176,939.55	$200,319.30	$153,000.53	$134,462.53	$84,845.28	$25,900.95		
	Accumulation			16.03	28.01	36.42	42.74	49.06	56.59	66.49	77.71	86.27	93.80	98.55	100.00		
				$286,397.33	$500,335.69	$650,587.35	$763,434.26	$876,281.16	$1,010,854.37	$1,187,793.92	$1,388,113.22	$1,541,113.75	$1,675,576.28	$1,760,421.57	$1,786,322.52		
	Actually Monthly Progress			17.79	1.84	3.80	4.05	5.25	7.53	9.91	11.21	8.57	7.53	4.75	5.45	7.00	5.32
				$317,786.78	$32,868.33	$67,880.26	$72,346.06	$93,781.93	$154,759.19	$203,480.48	$230,367.19	$175,950.61	$154,631.91	$97,572.08	$111,957.76	$143,798.96	$109,287.21
	Accumulated Monthly Progress			17.79	19.63	23.43	27.48	32.73	40.26	50.17	61.38	69.95	77.48	82.23	87.68	94.68	100.00
				$317,786.78	$350,655.11	$418,535.37	$490,881.43	$584,663.36	$827,122.05	$1,030,602.53	$1,260,969.73	$1,436,920.34	$1,591,552.26	$1,689,124.33	$1,801,082.10	$1,944,881.06	$2,054,168.27

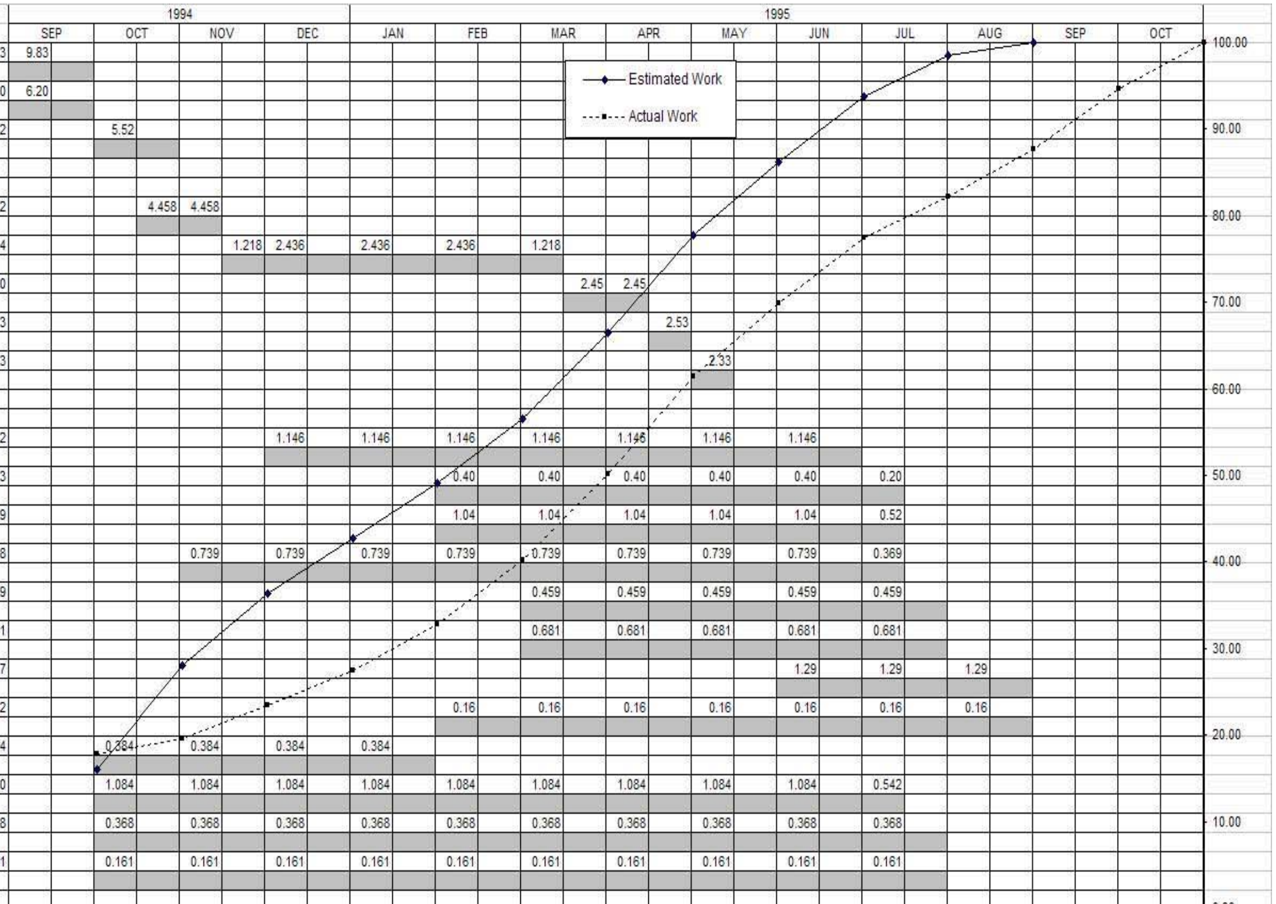


Figure 87: Schedule and Payment-Scenario-2.

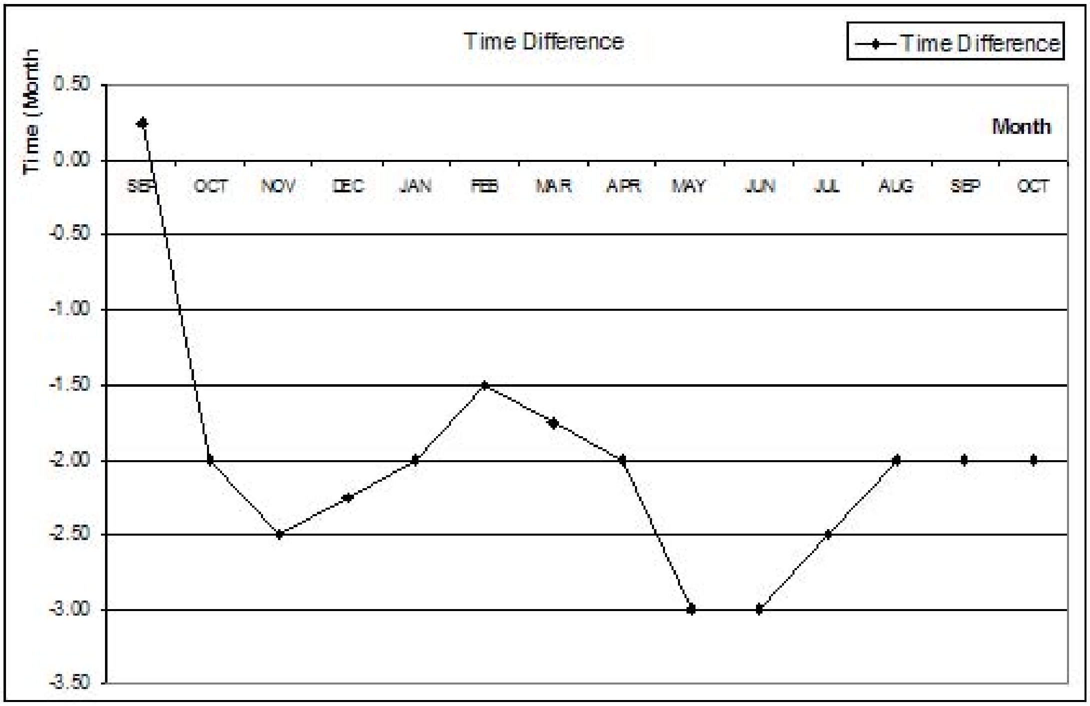


Figure 88: Time of Delays in the Project.

APPENDIX J

OBSERVATION LOG

Observation Log from July 1994 to July 1995

No	No of Meeting	Date	Day	Begin		Finish		Time	Note
1	1	07/11/94	Monday	4.00	p.m.	5.30	p.m.	1.30	
2	2	07/18/94	Monday	4.30	p.m.	5.30	p.m.	1.00	
3		07/25/94	Monday	0.00		0.00		0.00	NA
4	3	08/01/94	Monday	4.30	p.m.	5.45	p.m.	1.15	
5	4	08/08/94	Monday	4.30	p.m.	5.30	p.m.	1.00	
6	5	08/15/94	Monday	4.00	p.m.	5.30	p.m.	1.30	
7	6	08/22/94	Monday	3.30	p.m.	5.25	p.m.	1.95	Prepare plan of parking garage
8	7	08/29/94	Monday	3.45	p.m.	5.45	p.m.	2.00	
9	8	09/05/94	Monday	4.00	p.m.	5.30	p.m.	1.30	
10	9	09/12/94	Monday	5.00	p.m.	6.45	p.m.	1.45	
11	10	09/19/94	Monday	4.25	p.m.	5.25	p.m.	1.00	20 minutes site visit
12		09/22/94	Thursday	10.00	a.m.	12.00	p.m.	2.00	Observe Preparing Floor tile specification
13	11	09/26/94	Monday	3.30	p.m.	5.00	p.m.	1.30	
14	12	10/03/94	Monday	3.45	p.m.	5.10	p.m.	1.25	
15	13	10/10/94	Monday	3.45	p.m.	5.30	p.m.	1.45	
16	14	10/17/94	Monday	3.45	p.m.	5.30	p.m.	1.45	
17	15	10/24/94	Monday	0.00	p.m.	0.00	p.m.	0.00	Holiday
18	16	10/31/94	Monday	4.00	p.m.	5.20	p.m.	1.20	
19	17	11/07/94	Monday	4.00	p.m.	5.45	p.m.	1.45	
20	18	11/14/94	Monday	4.00	p.m.	5.40	p.m.	1.40	
21	19	11/21/94	Monday	3.45	p.m.	5.30	p.m.	1.45	
22	20	11/28/94	Monday	3.30	p.m.	5.45	p.m.	2.15	
23	21	12/05/94	Monday	0.00	p.m.	0.00	p.m.	0.00	Holiday
24	22	12/12/94	Monday	4.00	p.m.	5.45	p.m.	1.45	
25		12/14/94	Wednesday	1.00	p.m.	3.00	p.m.	2.00	Observe Preparing Floor Plan Tower G
26	23	12/19/94	Monday	4.00	p.m.	5.30	p.m.	1.30	
27	24	12/26/94	Monday	3.30	p.m.	5.50	p.m.	2.20	
28	25	01/02/95	Monday	0.00		0.00		0.00	Holiday
29	26	01/09/95	Monday	3.00	p.m.	5.00	p.m.	2.00	40 minutes site visit
30	27	01/16/95	Monday	3.30	p.m.	5.00	p.m.	1.30	
31	28	01/23/95	Monday	4.00	p.m.	5.00	p.m.	1.00	
32	29	01/30/95	Monday	0.00	p.m.	0.00	p.m.	0.00	NA
33		02/06/95	Monday	4.00	p.m.	5.25	p.m.	1.25	
34	30	02/13/95	Monday	4.30	p.m.	6.00	p.m.	1.30	
35	31	02/20/95	Monday	4.00	p.m.	5.30	p.m.	1.30	
36		02/21/95	Tuesday	10.00	a.m.	1.00	p.m.	3.00	3 Hours site visit-measuring site plan
37	32	02/27/95	Monday	4.00	p.m.	7.20	p.m.	3.20	
38		03/02/95	Thursday	2.00	p.m.	3.00	p.m.	1.00	Observe the meeting at CM office
39	33	03/06/95	Monday	4.00	p.m.	5.30	p.m.	1.30	Observe the meeting at the owner's head office
40	34	03/13/95	Monday	3.00	p.m.	4.30	p.m.	1.30	
41		03/14/95	Tuesday	10.30	a.m.	2.00	p.m.	3.30	Observe site inspection by CM
42	35	03/20/95	Monday	4.00	p.m.	5.35	p.m.	1.35	20 minutes site visit
43	36	03/27/95	Monday	4.00	p.m.	5.40	p.m.	1.40	
44	37	04/03/95	Monday	4.30	p.m.	5.45	p.m.	1.15	25 Minutes site visit
45	38	04/10/95	Monday	2.30	p.m.	4.00	p.m.	1.30	
46		04/17/95	Monday	0.00		0.00		0.00	NA
47	39	04/24/95	Monday	4.00	p.m.	5.30	p.m.	1.30	
48		05/01/95	Monday	0.00	p.m.	0.00	p.m.	0.00	Holiday
49	40	05/08/95	Monday	4.00	p.m.	5.30	p.m.	1.30	
50	41	05/12/95	Friday	2.30	p.m.	4.00	p.m.	1.30	Observe the meeting at the owner's head office

Figure 89: Observation Log.

51	42	05/15/95	Monday	4.30	p.m.	6.15	p.m.	1.45	
52	43	05/22/95	Monday	4.00	p.m.	5.40	p.m.	1.40	
53	44	05/29/95	Monday	4.45	p.m.	6.10	p.m.	1.25	
54	45	06/05/95	Monday	3.45	p.m.	5.00	p.m.	1.15	
55	46	06/12/95	Monday	4.00	p.m.	5.30	p.m.	1.30	
56	47	06/19/95	Monday	4.00	p.m.	5.30	p.m.	1.30	
57	48	06/26/95	Monday	4.00	p.m.	5.30	p.m.	1.30	
58	49	07/03/95	Monday	4.15	p.m.	5.35	p.m.	1.15	
59	50	07/07/95	Friday	4.30	p.m.	6.45	p.m.	2.15	Observe the meeting at the owner's head office
60		07/10/95	Monday	0.00		0.00		0.00	NA
61	51	07/13/95	Thursday	1.00	p.m.	2.00	p.m.	1.00	Observe the meeting at the owner's head office
62	52	07/17/95	Monday	4.00	p.m.	5.25	p.m.	1.25	
63		07/24/95	Monday	0.00	p.m.	0.00	p.m.	0.00	NA
64	53	07/31/95	Monday	3.45	p.m.	5.00	p.m.	1.15	

Figure 89: (Continued).

No	Code	Description	Note
1	01300-01-080194-En	The general contractor was waiting for structural drawings.	Incomplete Drawing and Design Change
2	02450-01-072294-Ot	The piling work disturbed the neighbor, the general contractor stopped working for one day.	Problem with Neighbor
3	02450-01-080694-Ma	One of pile was broken and misposition while it was driven into the ground during the piling work.	Problem with material
4	02450-01-081194-Ma	One of pile was broken and misposition while it was driven into the ground during the piling work.	Problem with material
5	02450-01-082794-Eq	The crane was malfunctioning.	Problem with equipment
6	01300-01-090394-Co	The project had to wait for a new subcontractor to mobilize to the site.	Problem with construction management
7	01300-02-090394-Ot	The owner wanted to change the design of unit C and D of Tower G.	problem with design change from the Sale Department
8	01300-01-090394-Ar	The general contractor was waiting for structural drawings.	Incomplete Drawing and Design Change
9	02450-01-091994-Ot	There was flooding on the site which caused the general contractor to stopped working.	Problem with action of god and caused a few days of delay
10	01300-02-100194-Ow	The design change of unit C and D of Tower G.	problem with design change from the Sale Department
11	01300-01-102994-En	The general contractor was waiting for structural drawings.	Incomplete Drawing and Design Change
12	01300-02-102994-Ow	The owner wanted to change the design of unit C and D of Tower G. The construction was 15 days behind schedule.	problem with design change from the Sale Department
13	01300-01-110594-En	The general contractor was waiting for structural drawings.	Incomplete Drawing
14	03100-01-111294-Ot	The general contractor stopped working for one week.	No result of stop working is indicated in the report.
15	03100-01-112694-La	The general contractor stopped working due to long vacation.	Long vacation
16	04050-02-120394-Ow	The design change of balcony of unit C and D.	Design change
17	04050-02-121094-La	The general contractor stopped working due to government holiday.	Government holiday
18	04050-02-122194-Co	The construction was stopped due to mobilization of new subcontractor. This caused the construction stop from Dec. 21, 1994 to Jan. 5, 1995.	Construction management problem
19	04050-02-121994-Ow	The design change of balcony of unit C and D.	Design change
20	03050-02-121994-Ot	The general contractor stopped working and the reason was not indicated in the reports.	No result of stop working is indicated in the report.
21	04050-02-051395-Ow	The design change of unit A and D. Two unit were combined to be single unit as required by a purchaser.	Design change from the Sale Department.

Figure 90: Observation Minute.

APPENDIX K

INTERVIEW QUESTIONS

Interview Questions

Interview Questions
Technical

1. What was your position in the project?
2. What was your responsibility in the project?
3. How long had you been in the project?
4. In your opinion, what are the factors that can affect the project cost control?
5. In your opinion, what are the factors that can affect the project cost estimates?
6. In your opinion, what are the reasons of cost overruns in this project?
7. Based on your experience, how the project manager can reduce cost overruns?
8. Did the project have problem with cost overrun?

Personnel Behaviors

9. How do you feel about the productivity of personnel in the project?
10. How do you feel about the participations of personnel in the project?
11. Did you attend all meetings?
12. Did you have problem about working with other project participants?
13. What is the role of the owner in managing cost control?
14. What is the role of the contractor in managing cost control?
15. What is the role of the CM in managing cost control?
16. Did the contractor have conflict with the sale department?

Figure 91: Interview Questions.

APPENDIX L

HOLIDAY CALENDAR

Calendar of November 1995-January 1995

November	1994					
Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			
December	1994					
Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31
January	1995					
Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				
Note:		indicates the holidays				

Figure 92: Holiday Calendar.

VITA

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