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Construction Management Dep.

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كلية الهندسة
قسم إدارة التشييد

م/

A Cost Control System for Local Contracting Companies (CCS)

Eng. Hashem Arafa Skaik

B.Sc. Civil Engineering, Bir Zeit University

Supervised by

Dr. Kamalain Sha'at

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نتيجة الحكم على أطروحة ماجستير

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د. رفعت رستم	مناقشاً داخلياً	.....
د. هاني الشوا	مناقشاً خارجياً	.....

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واللجنة إذ تمنحه هذه الدرجة فإنها توصيه بتقوى الله ولزوم طاعته وأن يسخر علمه في خدمة دينه ووطنه.

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أ.د. أحمد يوسف أبوحلبية

P.O.Box 108, Rimal,Gaza, Palestine Tel:(+970/8)286 3554-2823311هاتف Fax: (+970/8)2863552 فاكس ص.ب108 الرمال- غزة-فلسطين
Web Site:www.iugaza.edu e-mail: public@mail.iugaza.edu

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ما لم تكن تعلم وكان فضل الله عليك عظيما"

صدق الله العظيم

Dedication

To my wife and family

for their unlimited

patience and support

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Abstract

In recent years, the construction management has recognized more and more the need for controlling project costs. A cost control system enables the contracting company to observe the project expenditures, compare it with cost standards and initiate corrective actions to keep cost within acceptable levels. It enables recognition of problems before they become unsolvable.

The aim of this thesis is to develop a computerized cost control system which suits local contractors in order to help them in managing and controlling the costs of their construction projects. A field survey based on a questionnaire and supported by personal interviews is conducted to investigate the cost control practice of Gaza Strip contracting companies. The survey results show that most contracting companies do not use many cost control tools and techniques. The main two obstacles for not using cost control in managing construction projects are the lack of cost control software suitable for local use and the unavailability of technical staff to support the cost control process. However, contractors show their desire and conviction to use cost control systems that consider the local circumstances.

A cost control software is developed to satisfy local contractor needs in cost control. This software is named "Cost Control Software" (**CCS**). Visual Basic language has been used to develop it. Detailed description of the software has been given with step-by-step implementation procedures. **CCS** relies on two types of input data; the first is the estimated data which is entered once at the project start. The second is the actual input cost and quantity data which is entered weekly. **CCS** provides many reports including item material, labor, equipment, and subcontract reports and item summery report. Also, **CCS** covers indirect cost and cost at completion reports. Reports show weekly and up-to-date status.

CCS has been evaluated and tested to explore the extent of its suitability to local contractors. The evaluation process is conducted by professional contractors. Overall, they are satisfied with **CCS** performance. In general, local contractors do not find difficulties in preparing the input data entry needed for operating **CCS**. Of course, they provide few comments and suggestions. The researcher benefited from some of these comments to modify **CCS**. Other comments are left for further researches. The researcher main recommendation is addressed to all parties involved in the construction sector to give more attention to cost control including holding training courses to explain its concepts and benefits

ملخص البحث

خلال السنوات الراهنة يتزايد إدراك العاملين في إدارة التشييد للحاجة لضبط تكلفة المشاريع، فنظام ضبط التكلفة يمكن شركة المقاولات من مراقبة تكاليف المشروع ومقارنتها بالتكلفة القياسية التي تم إعدادها وقت تسعير العطاء، ومن ثم يمكنها من اتخاذ إجراءات تصحيحية للمحافظة على التكلفة ضمن الحدود المقبول بها، إن نظام ضبط التكلفة يمكن من معرفة المشاكل قبل أن تتفاقم.

غرض هذه الدراسة هو تطوير برنامج حاسوب لضبط التكلفة يناسب المقاولين المحليين من أجل مساعدتهم في إدارة وضبط التكلفة لمشاريع التشييد، وقد تم إجراء مسح ميداني شمل توزيع استبانه مدعمة بمقابلة شخصية لمعرفة الواقع المحلي لمقاولي قطاع غزة في موضوع ضبط التكلفة، وقد بينت الدراسة أن معظم شركات المقاولات لا تستخدم الكثير من تقنيات وأساليب ضبط التكلفة، وكان السبب الرئيسي في ذلك كما بينت الدراسة هو عدم توفر برامج حاسوب لضبط التكلفة تلائم الواقع المحلي بالإضافة لعدم توفر الطاقم الفني اللازم لدعم عمليات ضبط التكلفة، إلا أن معظم الشركات أبدت قناعة ورغبة لاستخدام نظام ضبط تكلفة يلائم الظروف المحلية.

لقد تم تطوير برنامج محوسب لضبط التكلفة باستخدام لغة البرمجة المرئية الأساسية "Visual Basic" حيث يلبي احتياجات المقاولين المحليين وقد تم تسميته "برنامج ضبط التكلفة" (CCS) "Cost Control Software".
ويشمل البحث عرض مفصل للبرنامج مع طريقة تطبيقه، وجرى تصميم البرنامج ليستقبل نوعين من المدخلات: النوع الأول يمثل البيانات المقدرة والتي يتم إدخالها مرة واحدة في بداية المشروع، والنوع الثاني يمثل البيانات الخاصة بالكميات المنفذة والتكلفة الفعلية والتي يتم إدخالها أسبوعيا، هذا ويوفر البرنامج عدة تقارير للبنود ككل ومكوناتها من المواد والعمالة والمعدات ومقاولي الباطن كما يوفر تقرير للتكلفة الغير مباشرة وتقرير للتكلفة المتوقعة عند الانتهاء من المشروع، وتغطي هذه التقارير وضع المشروع أسبوعيا وحتى تاريخه.

لقد تم اختبار وتقييم البرنامج لمعرفة مدى ملاءمته للمقاولين المحليين وتم ذلك من خلال مقاولين ذوي خبرة أبدوا رضاهم عن أداء البرنامج بشكل عام، كما أوضحوا أنهم لم يجدوا صعوبات في إعداد البيانات المطلوب إدخالها لتشغيل البرنامج، وطبيعي كانت لديهم ملاحظات واقتراحات عن البرنامج، وقد قام الباحث بالاستفادة من بعضها في تعديل البرنامج في صورته النهائية وترك البعض الأخر لأبحاث مستقبلية، وكانت التوصية الأساسية للباحث موجهة لجميع الجهات المشاركة في قطاع التشييد لإبداء اهتمام أكبر بموضوع ضبط التكلفة وخاصة عقد دورات تدريبية للعاملين في قطاع التشييد لبيان المفاهيم الأساسية لعملية ضبط التكلفة والفوائد الناتجة عنها على صناعة التشييد.

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List of Abbreviations

AACE	Association for the Advancement of Cost Engineering
ANOVA	Analysis of variance
BOQ	Bill of Quantities
CCS	Cost Control Software
CSI	Construction Specification Institute
CVI	Index of Content Validity
DF	Degree of Freedom
EAC	Estimate at Completion
GDP	Gross Domestic Product
GNP	Gross National Product
IDE	Integrated Development Environment
ISO	International Standards Organization
PCBS	Palestinian Central Bureau of Statistics
PCU	Palestinian Contractors Union
PERT	Program Evaluation and Review Technique
PNA	Palestinian National Authority
PMI	Project Management Institute
SS	Sample Size
SPSS	Statistical Package for Social Sciences

CHAPTER 1

INTRODUCTION

1.1 General

Construction industry is a major element in the Palestinian economy. Any improvement in the construction industry will probably lead to a clear improvement in the Palestinian economy. An improvement in the construction industry can be achieved by improving the construction project management functions. One of the most important construction management functions to construction contractors is project cost control.

This chapter includes historical information about the construction industry and Palestinian economy. Also, it includes research rationale, research objectives, limitations of the research, and research organization.

1.2 The Construction Industry

The construction industry represents the largest single production activity in an economy. The construction industry is customer-oriented. It is different from mass production that it has slow response to the benefits of mass production. Every project is unique. The construction industry has suffered in recent decades in terms of low productivity compared with other industries (Hinze, 2001).

The construction industry is defined as a risky industry with uncertainties that management has to deal with. These uncertainties arise from the nature of the industry itself. In addition, Froese et al. (1997) state that construction industry is characterized by having many players of multiple disciplines who are brought together at various stages throughout a single project.

The importance of the construction industry to the economy can be measured by its contribution to the Gross Domestic Product (GDP), its contribution to investment, and the amount of manpower employed. Internationally, the construction industry contribution to the GDP is about 10 %.

1.3 The Palestinian Economy

The Palestinian economy may be characterized by its limited size. It is dependent on the economy of Israel for trade and employment opportunities. In 1999, GDP accounted for approximately US $4.15 billion and the total population was approximately 2.8 million. Thus, GDP per capita reached nearly $1500. The GNP per capita was higher, around $1800, given the large inflow of remittances from Palestinian workers in Israel and international aids. By using GDP or GNP criteria, Palestine is ranked in the group of lower middle-income countries, while the demographic growth rate is among the highest growth rate in the world (World Bank, 2001). Recent studies show that GDP is reduced to US $ 3.1 billion in 2002. This leads to a decrease in GDP and GNP per capita. GDP and GNP per capita reach to $904 and $998 respectively. These values represent 60 % and 55 % of the values at 1999 respectively (Center of Private Sector Development, 2003). Table 1.1 shows some of key economic indicators in Palestine in the years 1995 -2002.

The construction sector share of GDP is about 8 % of the value added to the Palestinian economy. Figure 1.1 summarizes the distribution of GDP in 2001. The construction industry in Palestine is considered one of the main industries. It has grown significantly since the birth of Palestinian National Authority. Table 1.2 illustrates some of the characteristics of the construction industry in the Palestinian Territories as reported by Palestinian Central Bureau of Statistics (PCBS, 2000).

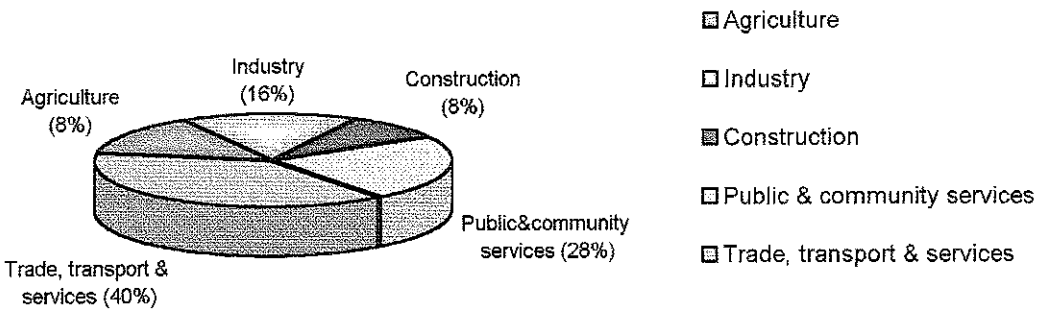

Figure 1.1 GDP Distribution in 2001

Table 1.1 Key Economic Indicators in Palestine (from 1994 to 2002)

Indicators	1994	1995	1996	1997	1998	1999	2000	2001	2002
Estimate of Population (in thousands)	2,361.0	2,454.0	2,554.0	2,840.3	2,958.6	3,084.9	3,224.5	3,381.8	3,549.5
GDP per Capita (US $)	1,331.6	1,456.7	1,461.1	1,564.9	1,564.7	1,495.7	1,535.0	1,235.7	920.6
GNP per Capita (US $)	1,525.0	1,701.2	1,680.8	1,798.9	1,857.9	1,806.1	1,797.3	1,380.3	1,015.9
Unemployment Rate (%)	24.7	18.2	23.8	20.3	14.4	11.8	14.1	25.5	31.3
Inflation Rate (%)	14.00	10.80	7.90	7.62	5.50	5.54	2.80	1.22	5.71
Public Revenues	399.8	549.1	927.9	953.6	1,083.8	1,136.2	1,364.0	1,053.0	977.4
Public Expenditures	382.8	635.1	927.9	1,113.1	1,193.5	1,194.4	1,364.0	1,239.3	1,227.8
Total Deficit (-) or Surplus	17.0	- 86.0	0.0	- 159.5	- 109.8	- 58.2	0.0	- 186.3	- 250.4
Workers in Israel (in thousands)	53.0	67.2	58.2	83.1	120.6	138.6	119.4	65.9	50.0
Workers in Palestine (in thousands)	328.9	347.7	354.4	402.8	435.1	461.9	489.8	481.0	485.7

Source: Palestine Monetary Authority

Table 1.2 Main Economic Indicators for Construction Contractors Activities, (1996 – 2000) Values in US $ 1000 (PCBS, 2000)

Indicator	Year				
	1996	**1997**	**1998**	**1999**	**2000**
Number of Enterprises	447	488	408	337	430
Number of persons engaged	5169	5538	5911	4153	5864
Compensation of employees	24 910	27 987	30 427	27 005	32 230
Output	196 659	216 738	225 663	199 326	178 834
Intermediate consumption	120 371	136 364	123 874	99 540	110 314
Value adds	76 288	80 374	101 789	99 786	68 520

1.4 Rationale

The construction industry in Palestine has been noticeably developed since the establishment of Palestinian National Authority (PNA). This is obvious from the relatively large projects which have been executed in the last decade. These projects are progressively larger in terms of their physical size and cost. As the projects become more complex than before, the need for more project management is essential. One of the main processes of project management is a comprehensive control system applied to the major elements affecting the project performance which are: Quality, Time, and Cost.

In local practice, there is an obvious trend among contractors to implement quality control through their inclination to attain ISO 9000 Quality Assurance Certificate. Also, quality is controlled by the client and supervision through project specifications. The second factor which is time, local contractors have considerable tools to control it. This is obvious from the wide use of *MS Project* software and similar ones. Also, clients share the contractors in controlling time by encouraging them to finish the project in time. Otherwise, liquidated damages clauses will be applied. The final factor in the success of any project is cost, which is solely the contractor's responsibility. In local practice, cost control of the projects is generally either misunderstood, misused, or ignored.

In addition, Borland (1999) states that probably no business needs an effective cost control system more than the construction business. This is because construction companies operate on a small margin profit. Every dollar wasted on a job lowers earning by one dollar.

In local practice, the contracting companies usually wait until a project is finished to find out the project's gross profit or loss. There must be an ongoing system to measure and control the expenditures incurred during construction and to report the findings to management. Managers must have access to accurate cost data so that the trend of the cost can be determined as soon as possible. Subsequently, corrective action can be taken when needed. Project cost control is both strategic and value added process. It should be carried out throughout the life of a project, from the start of the project up to its final completion.

To the researcher knowledge, there are no previous researches that deal with this subject in Palestine. Yet, there are many researches studying this subject in other countries. In addition, many cost control software packages have been developed and used in these countries to fulfill their contractors' needs in project cost control.

In this research, due to the importance of cost control function in successfully managing the construction projects, the researcher focuses on this topic and aims to develop a computerized cost control system for local contractors. Exploring the local cost control practice of contracting companies is essential to develop such software to be useful for local use.

1.5 Research Objectives

The objective of this research is to develop a computerized cost control system for Gaza Strip contractors in order to assist them in managing and controlling their project costs.

To achieve this objective, it has been broken down into the following sub-objectives:

1. Review the literature related to construction cost control.
2. Review the current software packages related to construction cost control.
3. Investigate the local practice of the construction companies in controlling the cost of their projects.

4. Identify the limitations and difficulties which are facing the local contractors to implement a cost control system.
5. Develop a computerized cost control system suitable for local practice.
6. Perform evaluation for the suitability of the software.

1.6 Limitations of the Research

Considering the scope of the research, the limitations of the study are the followings:

1. The target population covers the "First" and "Second" classes of contractors in Gaza Strip.
2. The software is designed for "Unit Price" contracts, as it is the most common used contract.
3. The software is designed to control cost on weekly basis.
4. The software is designed to deal with equipment as if they are rented.

1.7 Research Organization

Besides this chapter, there are five chapters distributed as follows:

Chapter two: Literature Review, which focuses on the most important cost control aspects available through literature to explain the main concepts of the cost control system.

Chapter three: Methodology, which discusses the methodology adopted in this research, the sample population, the method of data gathering, and the method of data analysis.

Chapter four: Analysis and results, which presents the results of the questionnaire and the discussion of these results.

Chapter five: Software description, which describes the developed computerized cost control system. It describes the software components, and the method of use. Also, this chapter contains a section about software evaluation.

Chapter six: Conclusions and Recommendations, which presents the conclusions of this research, practical recommendations, and recommendations for further studies.

Also, there are eleven annexes which supplement these chapters distributed as follows:

Annex 1: A list of the surveyed companies.

Annex 2: The questionnaire (in Arabic).

Annex 3: The English version of the questionnaire.

Annex 4: An overview of software packages related to cost control.

Annex 5: The evaluation questionnaire (in Arabic).

Annex 6: The English version of the evaluation questionnaire.

Annex7: An illustrating example for the developed cost control software with relevant reports.

Annex 8: The critical value of t at various level of significance.

Annex 9: Main features of the developed cost control software.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter focuses on the most important cost control practices available through literature to explain the main concepts of cost control. Also, it discusses the main types of cost control systems, the cost control process, and the control of the elements comprising project cost such as material, labor, plant, subcontract and indirect costs.

2.2 Project Management

The project management institute (PMI) defines project management as "the application of knowledge, skills, tools, and techniques to project activities to meet project requirements. Project management is accomplished through the use of the processes such as: initiating, planning, executing, controlling, and closing" (PMI, 2000).

Also, project management is defined as "the process of applying management techniques and systems to direct and control suitable resources in order to successfully deliver the intended scope of the project" (Atkinson, 1999).

Cleland (1999) defines project management as a "series of activities embodied in a process of getting things done on a project by working with members of the project team in order to reach the project schedule, cost, and quality".

A project management process as shown in Figure 2.1 provides a paradigm for how the management functions of planning, organizing, motivation, directing, and control will be carried out in the commitment of the project resources.

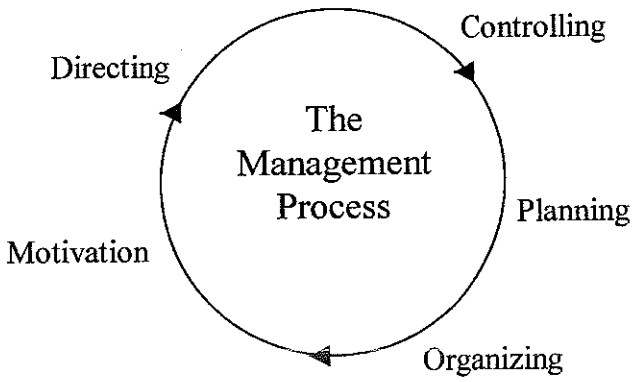

Figure 2.1 The management process

From the above definitions, it is shown that planning and control are the most significant functions of management at all levels of project stages. The control means to control against what was planned. This gives a special importance for the control function.

2.3 Project Control

Effective management of any construction project during its entire lifecycle requires that a well-organized control system be designed, developed, and implemented so that effective and efficient feedback on the project progress can be obtained. Project control is the final management function carried out by the project team. Control is the process of monitoring, evaluating, and comparing planned results with actual results to determine the progress toward the project cost, schedule, and quality. A simple explanation of the control system is shown in Figure 2.2.

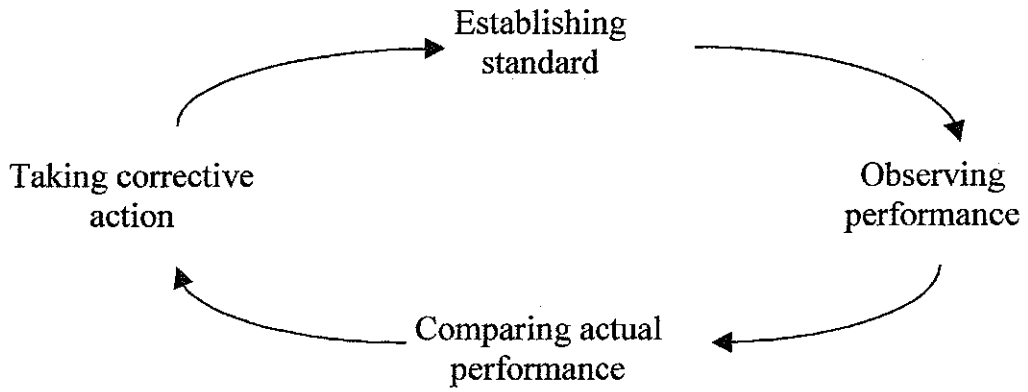

Figure 2.2 The control process

In the control process, the primary purpose is not to determine what has happened (although this is important information), but rather to predict what may happen in the future if present conditions continue, and if there are no changes in the management of the project (Cleland, 1999). In most control systems, project control is concerned with cost, schedule, and quality control. These areas are extremely interrelated, and therefore the system must be designed to assure full accountability for their interrelationships.

Martin (1992) defines project control as "an orderly, systematic, effective approach to identify potential problem areas and to provide sufficient informational detail upon which to base rational courses of remedial actions".

In addition, Hamilton (2001) states that project control systems are designed to give management the assurance that the project is proceeding according to plan. The primary function of a system is to monitor progress and detect deviations between what was planned and the current situation and, with forecasted trends, predict future deviations. For the important parameters, the control limits are established (and fixed); deviations outside these limits need to be highlighted by the system. Corrective action is normally taken when the deviations are considered to be significant.

To be effective, a project control system must be simple to administer and easily understood by all participants in a project. A control system must be developed so information can be routinely collected, verified, evaluated, and communicated to all participants in a project, so it will serve as a tool for project improvement rather than reporting flaws that irritate people (Oberlender, 1993).

The importance of project control is that project control system enables recognition of problems before they become unsolvable. The need for control will vary from one project to another, just as project contexts vary. On large and complex projects, any of the control aspects could form a separate activity for some person or organizational unit. On smaller jobs it may simply be one aspect amongst many for the project manager or management team (Hughes, 2001).

Iyer & Kohli (1996) define some of the requirements of a good project control system such as:

1. A comprehensive plan of the work to be performed to complete the project.
2. Precise estimation of time, labor, and cost.
3. Clear communication of scope of the required task.
4. Timely accounting of physical progress and cost expenditures.
5. Periodic re-estimation of time and cost to complete remaining work.
6. Frequent comparison of actual progress and expenditures to the schedule and budget.

2.4 Cost Engineering

Cost engineering is an area of engineering which is concerned with problems of cost estimation, cost control, and business planning and management science, including problems of project management, planning, scheduling, and profitability analysis of engineering projects and processes.

Another definition of cost engineering is as given by the Association for the Advancement of Cost Engineering (AACE) which is: "that area of engineering practice where judgement and experience are applied to solve problems of cost estimating; cost control; business planning and management science, profitability analysis; project management; and planning and scheduling."

2.5 Cost Control

Cost control is defined by Stewart et al. (1995) as "the application of procedures that result in early illumination of potential changes in resource requirements and in the timely surveillance of the usage of funds to permit action that will keep cost within a predetermined range." This definition implies that active efforts to control cost are achievable.

Ritz (1994) defines cost control as a procedure which highlights problem cost areas as soon as possible, thereby permitting corrective action to be taken and which allows for the earliest prediction of the final cost of the project. Pilcher (1992) defines cost control as a "process that should be carried out throughout the life of a project, from the inception of an idea in the client's mind to the final completion of the project and the final payment to the contractor who has constructed the work at site".

Another definition of cost control is as given by the American Association of Cost Engineers, which is "the application of procedures to monitor expenditures and performance against progress of projects with projected completion to measure variances and allow effective action to be taken to achieve minimal costs." (Martin, 1992). Also, Clough (1986) defines project cost control as a company information system designed to assist the project manager in controlling construction costs. It is a monitoring process that provides feedback to the manager concerning project expenses and how they compare to the established budget.

Cost control can be divided into two major areas:

i. The control of cost by the owner to ensure that the project fall within the original estimate.

In this area, cost control can be classified according to project stages into the following stages:

1. Cost control during proposal stage.
2. Cost control during the engineering (design) stage.
3. Cost control in the procurement stage.
4. Cost control during field construction.

   At this stage, the client's cost engineer will monitor the extra work to not exceed the approved budget.
5. Cost Control during Plant Start-up (Patrascu, 1978).

ii. The control of cost by the contractor. This is an attempt by the contractor to keep the cost of carrying out the work within the moneys that will be paid by the client.

In this study, the researcher concentrates on the second area, which is controlling cost by the contractor during the execution of work.

The cost control system can be expressed graphically as shown in Figure 2.3. In this system, first the cost standards or cost estimates are established before the project begins. These standards remain fixed during project execution. During execution, costs data are obtained by monitoring costs of project items throughout collecting the costs of labor, materials, equipment, and subcontract of project items. The collection of data should be done daily associated with measuring of quantities performed for the same period.

These costs are compared with the standard costs of the project. If there is no variance, i.e. the item is implemented according to the cost standard, then the objectives established by management are well within control of the firm. If there is a significant variance i.e. unfavorable performance, then the causes leading to this variance are identified, and corrective action is promptly required.

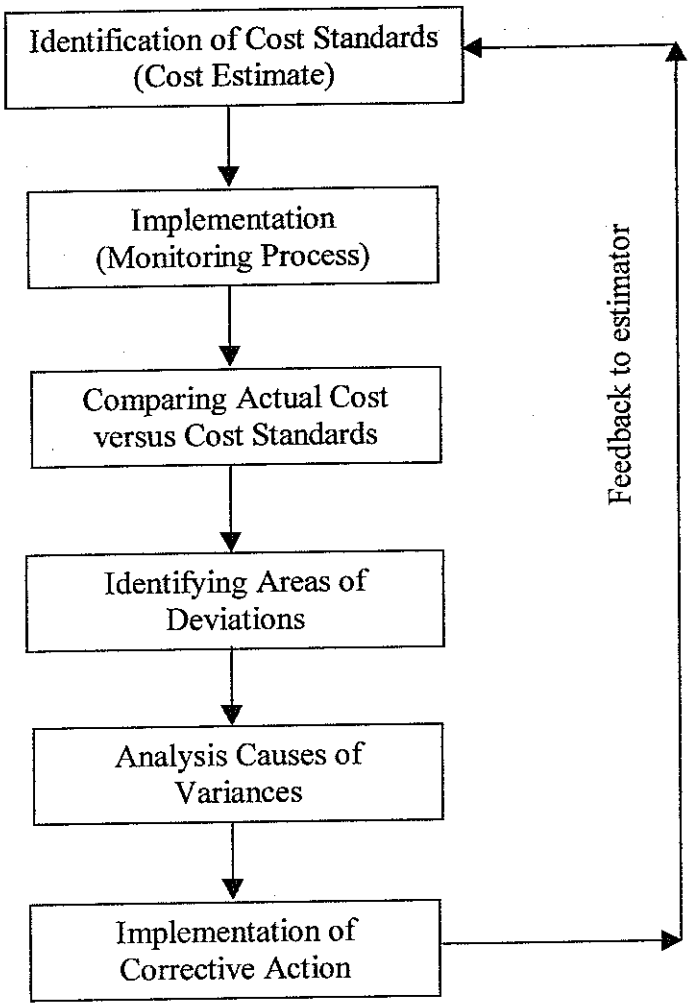

Figure 2.3 The Cost Control Process

2.6 Importance of Cost Control

Cost control is an important aspect of construction project management for both the owner who has to bear the cost of the work, and for the contractor who has to earn a profit. Everyone can agree that all major projects need good cost control. If the contractor dose not pay sufficient attention to cost control, not only would the profit margin be severely eroded but it could result in heavy losses (Singh, 1999). Cost control is needed to ensure that a project will have the correct quality, remain within budget, and finish on time (Bender, 2000).

In construction projects, there are always many causes for cost overrun. How does the project engineer know where the problem lies? With a cost control system, the project manager can find where cost overrun is, and where corrective action is necessary. This will benefit similar works currently in progress (El-Samadony and Tawfik, 1997).

From the above, it appears that cost control is important because it provides the contractor with accurate and timely data about project cost status. Also, it highlights the unfavorable project items which have significant cost overrun. This will lead to taking of prompt and effective corrective action.

2.7 Purposes of Cost Control

Singh (1999) summarizes the main purposes for cost control as the followings:

- *To determine whether the estimated profit is being made or not.* The cost control data provides the total expenditure incurred on the work at any given instance or at regular intervals. The contractor can find out his profit or loss by comparing the likely payments to him from the measurements of the completed portion of the work with the actual expenditure incurred on it as indicated by the cost control data.
- *To locate areas of inefficient functioning and provide data for reducing costs.* During construction, cost control data is used to draw attention to any part of the work that is being carried out in an uneconomical manner so that remedial action can be taken well in time. If the methods of cost control are not used, it would be known only at the end of the construction whether or not the work has resulted in a loss and would not be possible to pinpoint the exact reason for the loss. It would then be too late to do anything but to accept the loss.
- *To provide realistic and accurate information for future estimates.* The cost control data of a work provides feedback to the estimator for updating the knowledge of output data of men and machines. The value of such feedback is often of a limited nature, owing to the fact that in construction work, conditions tend to vary very widely from one contract to another. Any feedback of this nature provided by a cost control system must be accompanied by a full and complete description of the conditions pertaining to the particular costs.
- *To provide data for the valuation of variations that may occur during the course of contract.* Frequently, during a construction contract, rates have to be calculated for operations that differ in one way or another from those originally conceived. The maintenance of proper cost records enables the contractor to strengthen the case for the build up of a new rate.

- *To help in the evaluation the cost of delays, acceleration, changes of plan and possible claims.* During construction, the contractor may be requested to accelerate the work, or the project plan may be changed due to client and supervisors requirements which could lead to project delays. In this case, the cost control system would probably help in the evaluation of the subsequent costs.

2.8 Requirements of Cost Control System

Dansker (1992) lists the key documents that should be issued before any system of project cost control can proceed. These documents are:

- A detailed estimate of the Material costs.
- A detailed estimate of the Sub-contract costs.
- A detailed estimate of the Equipment costs.
- A detailed estimate of the Labor costs.
- A detailed estimate of the Overhead costs.

These documents are the basis of any project control procedure.

In order for the cost control procedure to be effective, the collection of data and the analyzing of performance must be a daily task. The earliest recognition that an activity is not performing well, is the best tool for initiating corrective action. If it is too late to affect the work already completed, it can assist the work in progress, and it can be a guide for other projects (Dansker, 1992).

Also, the cost control system must include these basic features:

- A simple but comprehensive code of accounts.
- Use of standard forms and formats on a standard code of accounts throughout the estimating, procurement, construction, and cost control groups (Ritz, 1994).
- Management Support: The basic requirement for a successful cost control system is a top management that sincerely wants it. Without this basic requirement proper cost control is not possible (Patrascu, 1978).

In addition, it is necessary that a cost control system should be simple and easy to install. Its accurate operation will depend upon a large number of individuals in the organization playing their part, and many of them will be individuals who have not been trained to make their living by the allocation of costs. It is important, too, that any system that is installed should be readily reconcilable with standard forms used within the company for other purposes (Pilcher, 1992).

2.9 Types of Cost Control Systems

The cost control system that may be used for a particular work depends upon the degree of details in which control is required to be exercised. The cost of operating a cost control system increases with the increase in detail in which the costs of various operations are recorded. Due to the high cost of operating a detailed cost control system, it may be desirable to use simpler systems of cost control. A good system must be quick acting, besides being simple (Singh, 1999).

Cost control systems can vary from those which control the work on a section or stage basis to those which control it on a unit basis. Some contractors are using cost control for certain sections of the project to be selected for control (Oxely and Poskitt, 1992).

The cost control systems can be classified into the following types:

2.9.1 Overall profit or loss

The contractor waits until the contract is complete, then he compares the sums of the money that have been paid with the monies incurred in purchasing materials, payments for labor, subcontractors, equipment, and overheads. Such a system is useful only on very small contracts of short duration involving few men and little construction equipment (Harris and Macaffer, 1989).

This is inexpensive but extremely risky operation, which involves little or no control of cost (Pilcher, 1992). In this technique, the contractor can not know which activities are doing well and those which are losing money (Oxely and Poskitt, 1992).

2.9.2 Profit or loss with reference to payments.

The total costs to date are compared with the valuation gross of retention. In this case, the valuation or the amount of money claimed by the contractor is compared with the amount of money that has expended for carrying out the work over a similar period (Pilcher, 1992). Care has to be taken to include the cost of materials delivered but not yet invoiced and to exclude materials on site not yet built into the payment work (Harris and McCaffer, 1989).

This system suffers from the disadvantage that there is no breakup of the cost figures for different items of work. It therefore, only indicates that the management of a job showing losses needs attention, but does not pinpoint the area needing such attention. It is however, better than the previous one, since at least it is carried out regularly and for a shorter interval of time.

2.9.3 Unit costing

In this system, costs of various types of work are recorded separately. The cumulative costs are divided by the quantity of work of each type that has been done. This provides unit costs that can be compared with those estimated. Considerable care must be taken to ensure that all costs are accounted for and are fairly distributed on activities, especially activities using the same materials and labor at the same period (Harris and McCaffer, 1989). By comparing the rate of cost with the rates in the cost estimate, the efficiency of work can be assessed. It gives a clear picture of the items which are proving uneconomical and need attention. However, it will not be clear from the limited detail of cost records whether the poor performance is on account of labor, material or machinery. Anyhow, it is sufficient indication for the field staff to take care of the item so that the losses can be reduced, if possible (Singh, 1999).

2.9.4 Pert/cost

This system requires that each contract to be networked by PERT (PERT = Performance Evaluation and Review Technique). The values of work packages, which in essence are groups of activities, are assessed in advance. The value can be divided by cost code, provided that the work package information is similarly divided. Thus, when incurred costs are recorded against the same code, variances can be calculated for management information.

This system cannot be applied directly where the work is valued by a bill of quantities which relates to the completed work rather than the operation. For this reason the system is seldom applied unless the work is the subject of an activity bill or operational bill (Harris and McCaffer, 1989).

2.9.5 Comparing with cost standards

It is a system by which all the cost inputs to a process are recorded on a week-by-week basis and then any trends can be identified and acted upon. Such unit costs would be separated into materials, labor, equipment, and so on.

In this method, the cost record consists of details of the rate of cost of labor, materials and machinery separately. These are then compared with the rates of those items known as "cost standards" or "cost estimates" as worked out when estimating costs. It is then possible to know at a glance the area of work in which there is inefficiency

and scope for improvement. The method is ideal, but since great details pertaining to labor, materials and equipment costs separately for each items of work are required to be maintained, it is a laborious and costly method (Singh, 1999).

2.9.6 Earned value

The earned value technique integrates cost and schedule for control purposes. In this technique, planned values are compared with earned values and any differences are called a variance. Earned value can be displayed as curves for a graphical representation of quantifiable data, such as cumulative cost versus time. These curves clearly highlight any problems and provide an early warning if a project will be behind in schedule or cost (Bender, 2000).

2.10 Cost Control Tools

Besides the above methods, Bender (2000) establishes some tools for project cost control. The most notable tools are cost trend analysis, management exception reporting, and range estimating. Each of these tools identifies cost problems once they have manifested to avoid potential cost problems.

2.10.1 Cost trend analysis

Cost trend analysis (or tracking curves) is a tool of cost control that compares budgeted costs with actual reported costs along with an estimate of the percent of project completion. The trend analysis tool of cost control recognizes that most projects develop an S curve when cumulative costs are charted with time or progress. An example of this trend curve is shown in Figure 2.4.

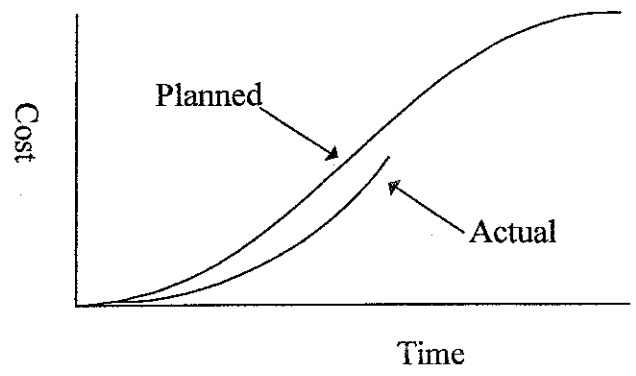

Figure 2.4 Cost trend analysis

The process begins by stating objectives and developing a plan to meet the objectives. As the project progresses, cost data is collected and plotted along with the planned cost data to form two S curves. A forecast of the final cost is projected using the original estimate trend curve as a guide. This forecasting method takes a significant amount of judgement and the data must be extrapolated to the completion of the project. If the estimate completion or future performance indicates a problem, management must take corrective action to correct variances occur. One limitation of cost trend analysis is that it does not consider which activities are cumulatively accounted for in determining actual values of cost expended.

2.10.2 Management exception reporting

Management exception reporting is a tool of cost control that focuses attention on cost variances by comparing actual to budgeted costs. Those items that show a variance between expected and actual costs are highlighted for management review. This method is routinely used because of simplicity. It can be used for the smallest to largest projects by simply using the preexisting estimate to develop a budget, tracking all cost against the budget, and focusing attention of the variances in cost.

Although a simple and easy to use method, the analysis of cost variances once they have occurred may provide information to decision-makers too late to be of significant value.

2.10.3 Range estimating

Range estimating is a cost control tool that combines Pareto's law and a modified Monte Carlo simulation. Pareto's law states that only a few of the critical elements account for the largest percentage of the cost variances. In other words, "20% of the elements effect 80% of the outcome". Critical elements are identified, quantified, and ranked according to their ability to effect the overall project cost. The range estimating uses ranges of cost and probability factors instead of the traditional probability density functions that are used in a typical Monte Carlo simulation.

During construction, the identified critical elements are closely monitored for any cost variances. This allows management to focus actions on areas that will have the largest cost impacts.

One limitation to this method is that this method highlights areas for management to focus attention on, but it does not provide any real parameters to gage a project cost effectiveness during the construction process.

2.11 Cost Control Personnel

Cost control should be the responsibility of the cost construction engineer. He is the person with the feeling for the value of the work and who is most likely intimate with the very details of the work. The accountant, who might also be expected to make a contribution in this field, has responsibilities that are largely historical as far as the money is involved. Historical information from accounts is of little use in construction cost control, because it is invariably available at too late a date to be effective as a control tool (Pilcher, 1992).

In construction projects, the duties of the cost engineer should be:

- To estimate how much the total cost of any project will be.
- To keep track of costs on a daily or weekly basis.
- To make timely evaluations of cost and scheduling status.
- To forecast costs based on present trends and remaining works.

These functions permit management to take corrective action before overruns and expenses mount uncontrollably (Patrascu, 1978).

2.12 Timing of Cost Control

The first rule of good management is to "minimize surprise". The early detection of actual cost overrun in construction activities is vital to management. It provides the opportunity to initiate remedial action and increases the chance of eliminating such overruns and minimizing their impact. Since cost overruns increase project costs and diminish profit, project management and upper management must become sensitive to the costs of all project activities (Wearn, 1989). A decision taken too early may turn out to have wrong when more data are later available. While late decisions are untimely since they lead to more costly site work than is necessary (Halpin and Woodhead, 1998).

2.13 The Cost Control Process

In general, construction cost control process consists basically of monitoring actual performance against cost estimate and identifying variances. According to Ballard (2000), the traditional control method based on the detection of variances appears to assume that the causes of deviation will be apparent and the appropriate corrective action obvious.

2.13.1 Cost estimate

The heart of any cost control system is the detailed estimate. Cost estimating is a main and crucial component of any contractor's work. It is a well-known and established function in contracting (Sha'at, 1993). Project cost control actually begins with the preparation of the original cost estimate. For each project, the contractor prepares a detailed estimate of prices, which serve as the basis of its contract. This estimate serves as a budget for cost control during the construction process (Clough, 1986). It is desirable; therefore, that the figures prepared by the estimator before submitting the tender should be in a form suitable for use in cost control at a subsequent date (Pilcher, 1992).

One of the purposes of performing a cost estimate is to have a means by which the development costs can be monitored and controlled. Also, an important piece of information that is required from the estimate for the purpose of control is a precise statement showing the cost of every operation involved in the work. In making a comparison of the cost incurred with the priced bill of quantities or the estimator's analysis, a *cost standard* is being used. It must be remembered that this cost standard is one that is set by the estimator at the time of preparation of the estimate and one that falls within the estimator's judgment. In the light of further information which becomes available it may be necessary to use other judgments of a better-informed nature for the purpose of control (Pilcher, 1992). It should be noted that because the cost of gathering cost information is high, some form of estimation is usually necessary. Estimation leads to a loss of accuracy which results in uncertainty.

From the above, it is noted that the success of implementing any cost control system depends on the accuracy of the cost estimate. However, there are some uncertainties related to project cost estimate. Examples of these are equipment performance, material wastes, productivity of labor and others. All of these uncertainties can contribute to making an estimate uncertain.

2.13.2 Cost monitoring

Monitoring and control is the core activity of site management, and has to be done effectively and efficiently (Neale, 1989). It is important to distinguish between "monitoring" and "control". Monitoring involves measuring the actual incurred cost and comparing it with the planned cost. Control is achieved by management action triggered or influenced by the results of monitoring (El-Samadony and Tawfik, 1997). Also, cost monitoring should be made on a daily basis, but cost control should be done on weekly basis (Oxely and Poskitt, 1992). In the normal course of events, checking costs for a period of less than one week tends to be far too expensive operation, unless an operation on site is being carried out at an extremely fast rate and costs and quantities can be measured accurately (Pilcher, 1992).

The ability to have an effective cost control program relies on a process to provide timely, reliable, and appropriate data. Management depends on a reliable and quick exchange of information in order to successfully implement cost control strategies. How data is recorded, refined and organized effects its usefulness as a snapshot of the project. The data must be screened and corrected before management uses it (Bender, 2000).

There are three essential components in the monitoring process. These are:

- Collecting information about the actual achievement on the project.
- Processing this information into simple reports which compare planned and actual progress in a way which can be understood quickly.
- Taking necessary controlling action and re-planning as necessary (Neale, 1989).

The monitoring function needs to be such that all levels of management receive information of a sufficient level of detail and frequency to allow problem identification and corrective action at a time when the problems are still easily manageable (Hamilton, 2001). It should be noted that the accuracy of cost control system depends largely on the accuracy of data collection by the contractor's staff.

2.13.3 Cost variance

Once cost data are collected and analyzed, they should be compared with the cost estimate. The variance between the actual costs and the estimated costs should be calculated as absolute and/or relative (percentage) values.

Variance analysis involves comparing the actual cost with the planned cost to see if the amount spent was more or less than the budgeted. In the management of projects, variance analysis alone is inadequate because it indicates neither how much work has been completed nor what the future expenses are likely to be (Hamilton, 2001).

At this level of control, a straightforward variance between the estimated cost and the actual cost is established, and unfavorable or adverse variances are indicated. Where the variance either favorable or unfavorable, is significant, a variance analysis for a more detailed nature can be called for in order to establish the cause. The variance as a percentage of the value of the work so far completed is included so as to give a better idea of the trends which may have been established (Dansker, 1992).

Five Questions must be addressed during the variance analysis.

1) What is the problem causing the variance?
2) What is the impact on time, cost, and performance?
3) What is the impact on other efforts, if any?
4) What corrective action is planned or under way?
5) What are the expected results of corrective action?

If the variance is within the permitted deviations, then there will be no response, and the variance may be ignored. In some situations where the variance is not marginal, corrective action may be required (Kerzner, 1992).

2.13.4 Corrective action

Cost control and any other project control discipline is simply impossible without appropriate corrective action. The unfavorable trend must be isolated and examined before remedial action can be proposed and implemented. The best way to correct a problem is to identify who should do what and when (Patrascu, 1978).

The corrective action may take two forms: taking steps to change the performance of the activity to bring it closer to what was planned, or changing the plan so that it more closely reflects the changed situation brought about by the departure from the plan (Woodward, 1997).

It is important if possible to report the correct and necessary information in a form which can best be interpreted by management and at a level of detail most appropriate for the managers who will be using the information.

These reports focus on activities with variances exceeding certain predefined limits. The principle is to identify and isolate the most important and critical activities which need control, and to give it to the right person as quickly as possible for consideration, discussion, and action. This is called management by exception (Barrie and Paulson, 1992).

2.13.5 Trend analysis and forecasting

A project control system must routinely collect and record the information from the status of the project. At each reporting period, the actual status can be compared to the planned status, so that necessary corrective actions can be taken. As the information is accumulated, a trend analysis can be performed to evaluate the productivity and the variances in cost and schedule (Cleland, 1999).

Trends can be identified from the cost forecast. The total of the cost to date and the cost to complete is compared to the cost estimate. If the forecast for a particular activity or the entire facility increases than the estimate, then this is an upward trend that will need corrective measures. Accurate forecasting requires that you use actual costs to date and not costs used in the estimate. This is a basic requirement since future costs can be predicted with fairly high accuracy if you have a good record of costs to date (Patrascue, 1978). Kibler (1992) states that one can forecast the future based on events of the past.

How to develop forecast cost

Management's attention needs to focus on the future and how the project will finish with respect to completion on or below budget. This forecasted final completion cost is known as Estimate at Completion (EAC).

The EAC contains the similar uncertainties associated with estimating. New uncertainties of determining how much of the project is currently completed and extrapolating this to completion are the new uncertainties introduced. Other uncertainties introduced into estimating completion cost are selecting the appropriate calculation method, the accuracy of input information, and subjective judgement (Bender, 2000).

There are many methods for developing the cost forecast:

- One method is to assume that overrun or underrun at completion will remain the same as given at the report date. Under this assumption, it is presumed that the performance of the project team over the balance of the job will be close to or on target – that is within budget.
- A second forecasting method assumes that the past performance of the project team will continue at the same rate of efficiency or inefficiency for the balance of the project.
- The third forecasting method uses the information relative to actual cost to date incurred in labor, equipment, materials, subcontracts, and so on. The resources required for the work to be completed are estimated from the most recent productivity levels that consider the learning curve effect and are priced out at the prevailing prices taking into account the market fluctuations (Ahuja, 1980).

2.13.6 Feedback

Cost control information is invaluable for future estimating. Feedback must be accompanied by a full description of the conditions under which the work was carried out, as conditions can vary a great deal from one contract to another.

Another very important use of cost control information is in the pricing of variations. The contractor will have factual information to assist him in settling a rate for the work done. Any unit cost in excess of or below the target by more than a predetermined margin requires further investigation and should be brought to attention of management (Oxley and Poskitt, 1992).

Thus, project cost control data are important not only to project management in decision-making processes but also to the company's estimating and planning departments because these data provide feedback information essential for effective estimates and bids on new projects. In this case, a project cost control system should both serve current project management efforts and provide the field performance database for estimating future projects (Halpin and Woodhead, 1998). As a conclusion, once projects are completed, they can supply a wealth of information for future use (Levy, 2002).

2.13.7 Cost reports

After collecting the cost data, it is necessary to arrange them to be used by managers for control action. Consideration must be given to the amount of detail required in reports, which will vary according to the level of management for which they are prepared.

As well as preparing reports based upon the cost data already collected for a contract, it is necessary to project the costs into the future and to estimate or re-estimate the cost of the work yet to be completed. It is only in this way that the ultimate profit or loss for a contract can be estimated. The re-estimate must take into account any new information that has come to light since the commencement of the contract. An adequate reporting system is then an essential part of a cost control system (Pilcher, 1992). An important byproduct of an effective cost reporting system is the information that it can generate for management on the general cost performance of field construction activities. The information can be brought to bear on problems of great interest to project management (Halpin and Woodhead, 1998).

2.13.7.1 Reporting systems

Different reports with varying amounts of detail would be prepared for different individuals involved in a project. Reports to upper management would be summaries, reports to particular staff individuals would emphasize their responsibilities (e.g. purchasing, payroll, etc.), and detailed reports would be provided to the individual project managers (Hendrickson and Tung, 2000).

2.13.7.2 Forms of reports

One of the basic reports for the control of costs on site is the *weekly cost report*. This report gives a complete record of the quantities of work which have been carried out in the week previous to the date of the report, together with the lump sum total costs of materials, labor and equipment that have been incurred in respect of those operations. For the weekly cost report, only the major operations involving large quantities and considerable cost would be chosen because the preparation of cost records for all activities involves a great deal of time and cost. Items that are showing a unit cost in excess of the estimate will require further investigation into the plant and labor costs involved (Pilcher, 1992).

In general, the project cost report shows where overruns have occurred but does not provide any explanation about why they happened. Overruns may be caused by either labor, equipment, subcontract, or material costs. Hence, to isolate the source of excessive cost, reference must be made to the material unit cost report, equipment unit cost report, labor unit cost report, and the subcontract unit cost report (Levy, 2002).

2.13.7.3 Content of reports

In order to be effective for control purposes, a complete report should have five main components:

1) **Estimate**: total, to-date, or this period, that provide a reference standard against which to compare actual or forecast results.
2) **Actual**: what has already happened, either this period or to-date.
3) **Forecast**: based at the best knowledge at hand, it is expected to predict what will happen to the project and its elements in the future.
4) **Variance:** how far actual and forecast results differ from those which were planned or estimated.
5) **Reasons:** anticipated or unexpected circumstances that account for the actual and forecast behavior of the project and its operations, and especially that explain significant variances from the plan (Barrie and Paulson, 1992).

An important aspect of any cost control system is recognizing the causes of variances not just the symptoms. The symptoms of cost problems are easy to detect; they are variances on charts or management exception reports. What is needed is a method that also recognizes the root causes for any cost escalation. Without a clear understanding of the causes of cost escalation, management's actions may actually make the problem worse or at the very least waste time, energy, and result in missed opportunities (Bender, 2000).

There are possible explanations for cost overruns. These include:

1) Tasks are more complex than originally understood.
2) Estimates are too aggressive at the start of the project.
3) There are unexpected level of staff illness and/or turnover.

2.14 Cost Control Problems

There are some significant problems which arise when considering the particular form of a project cost control system to adopt. The followings are the main ones as indicated by Pilcher (1973), Patrascu (1978), Iyer and Kohli (1996), and Kerzner (1992):

1. The cost of installing and operating the system itself.
2. The cost of providing a means of collecting basic cost data, usually in the forms of the hours worked by individual men on a daily basis.
3. The absence of an adequate and timely feedback system.
4. Personal bias of the project staff.
5. Inaccurate or partly reported information.
6. Attitude of some project managers who believe that with time, problems will get automatically resolved. This may give the project staff the impression that the management does not really care about the control process.
7. Poor estimating techniques or standards result in unrealistic budgets.
8. Out of sequence starting and completion of activities and events.
9. No management policy on reporting and control practices.

Resistance to cost control can take many forms. The most common forms and reasons for subordinating the cost control function include the followings:

Killer Phrases: Killer phrases can have a devastating effect on any function. Some of these killer phrases are "the project will be late and the cost will overrun". "It will cost too much"; "we always did it this way and we are still in business"; "we should use it in the next project". Those phrases can without any further analysis "kill" an idea that a cost engineer or any other engineer tries to implement.

Idea Competition and Blockage: The business of the cost engineer is to monitor, compile, report and forecast the costs that are initiated and incurred by others. His ideas may be resisted, if not rejected, because the nature of the cost engineer's job is to mind some one else's business.

Human Factors: Human beings resist change and discipline imposed by others. Humans do not like to be criticized and are slow to recognize that there are other ways of doing things.

Ignorance of the Cost Aspect: Individuals working on the project often ignore the overall dollar consequence of their decision. They let this factor to top management in spite of the considerable effect of their decisions on the overall cost of the project.

Quality/Cost/Schedule Conflicts: During project execution, there may be conflict between those three requirements. Getting the right balance between quality, cost, and schedule is a fundamental requirement of a good engineering management (Patrascu, 1978).

To minimize these problems, it is necessary for project mangers to show project team members and others how control benefits them and the project (Hamilton, 2001).

2.15 Cost Control System

The five main generators of project costs are materials, labor, equipment, subcontract, and indirect costs. Those shall be taken separately when developing a cost control system.

2.15.1 Control of materials

Control systems for materials should be carried out in terms of both their unit costs and unit quantities. In cases of deficiency, one cannot be sure if cost is the basis, whether the cause is due to high wastage of materials, or whether the materials are bought at prices in excess of the estimate (Pilcher, 1992).

The control of the cost of materials on the site has some difficulties. One of the main difficulties of carrying out this control is the accurate assessment of the amount of materials on the site, in other words, the difference between the materials on delivery and those incorporated in the work.

2.15.1.1 Material cost control factors

In materials control, the following three factors need consideration:

i) Material purchase.

Material purchasing should be done according to a prepared list done by the project engineer from the bill of quantities. It is the responsibility of the project engineer to compare the requisition with the bill of materials.

Generally, the purchasing materials should follow these procedures:

- Receive the approved authorized purchase requisitions.
- Receive the estimated price for these required materials.
- Request and evaluate quotations.
- Determine according to price and quality which is the best and the lowest supplier.
- Determine the date for supply to arrange for testing and receiving materials (Ahuja, 1980).

ii) Material usage.

The materials received from the supplier are then checked against the original requisition by the on-site materials clerk. It is the cost engineer's responsibility to see that all material costs are properly allocated.

Based on the quantities used so far, the quantity to be used up to completion is forecasted for each material and is compared with the corresponding quantity in the bill of materials. The variance, whether surplus or shortage, is worked out and investigated. The price of the material received is also noted (Ahuja, 1980).

iii) Wastage control and shortage prevention.

There are several areas where materials control is required. If possible, material delivery should be staggered to correspond with job progress. Off-site warehouse storage incurs extra transportation costs, but on-site storage may result in theft or lose due to lack of security. The amount and value of materials determine how they should be stored. Pilferage can be reduced by providing adequate security arrangement. Applying a material control system will probably reduce the supply costs and significantly improve overall project efficiency (Ahuja, 1980).

2.15.1.2 Standard costs and variances

It is not possible to provide meaningful analysis of cost data that have been collected in the field unless there is available a standard to which they can be compared. Standards in construction are usually set by estimating the possible outcome from historic performance and experience. Initial budgets for work are established from estimated costs and the variances between actual and estimated is calculated. If the actual cost is greater than the standard, then the variance is negative or *unfavorable.* In the reverse situation the variance is *favorable.*

Variances occur for one or both of two reasons:

- The price actually paid for the materials is greater or less than that estimated in the standards.
- The quantity of materials actually used is either greater or less than that estimated in the standards.

In using variance analysis, inefficiencies are highlighted in terms of cost and attention can be concentrated on limited areas where these inefficiencies exist. It also draws a distinction between those variances that occur because of price differences and those due to quantity differences. The following generalizations are true:

- Actual Cost (AC) = actual quantity (AQ) * actual price (AP)
- Standard Cost (SC) = standard quantity (SQ) * standard price (SP)
- Total Cost variance = standard cost (SC) – actual cost (AC)
  = (SQ * SP) – (AQ * AP)

Variance analysis will first of all be applied to the purchase and use of materials. The outcome of material costs will be due to variances either in price or in quantity from those estimated. There will be either a material price variance or a material usage variance. The first will amount to the difference between the standard and actual prices for the quantity of materials used; the second will be the difference between the standard and actual quantities of materials used.

Material Price Variance = AQ (SP – AP)

Material Usage Variance = SP (SQ – AQ)

Material Cost Variance = SC – AC = (SQ * SP) – (AQ * AP)

The consumption of materials can then be compared with the theoretical consumption for the quantities of work executed, taking into consideration the proportion in which each of the materials is used. Any appreciable variation should be carefully investigated to ensure that there has neither been any pilferage nor has the work been of substandard quality because of less use of materials (Oxley and Poskitt, 1992).

2.15.1.3 Material cost analysis

If the quantity and cost of materials for a particular work item do not match its estimate, the cost engineer must determine the reasons for the discrepancy and report to the project manager.

Ahuja et. al.(1994) list the major factors causing excessive material costs which are:

- Material waste and pilferage.
- Inaccurate measurement of quantities delivered.
- Escalation of material costs.
- Excessive handling of materials.
- Excessive transportation and storage costs.

- Improper selection of materials.
- Late payments of materials (not taking the advantage of discounts).

Harris and McCaffer (1989) add the following factors which are affecting the control of material costs. These are:

i. Price variances.

1. Inflation.
2. Changes in the buying situation since the estimate was prepared.

ii. Quantity variances.

1. Remedial work.
2. Delays at the recording system.
3. Inaccurate site measurement of work done.

2.15.2 Control of labor

Labor cost forms a major portion of the cost of many projects and is found to be one of the most sensitive costs to manage. For successful cost control, it is necessary to insure that labor costs are within the estimate. It is also necessary to take immediate corrective action in the case of deviations from the estimate. The most effective method of control is a day–to–day reporting system that provides a measure of performance to compare with the estimate (Ahuja 1980).

It should be noted that in construction work, there is little doubt that the most difficult of these divisions to control is that of labor. The difficulty starts at the estimating stage because the productivity of labor is so variable and therefore average productivity figures based on historic information must be used (Pilcher, 1973).

The labor cost of an activity can be calculated by multiplying the hourly direct cost of a man by the hours that he spends on a particular operation by the number of men which is allocated to that activity. Obtaining these costs will enable the unit labor cost to be calculated which is the unit direct cost of carrying out one unit of the work being undertaken. These unit costs can be then compared with the estimated rates for doing the work and comparisons can be made between performances and costs over different periods of time. The establishment of labor costs begins with the collection of the hours spent by each man in the field. These are recorded on a form with a brief description of the activity on which the men have been engaged (Pilcher, 1973).

2.15.2.1 Labor cost control factors

There are two major factors that influence the labor costs in construction. The first factor is the worker daily rate and the second factor is the productivity which is the amount of work that a worker or crew can accomplish in a defined period of time. While the daily rate may stay essentially constant over the duration of an activity, productivity can fluctuate wildly.

Variances in labor costs can stem from three possible sources:

- An original hourly takeoff error.
- A variation in the assumed labor rates.
- A variation from standard in actual labor productivity.

It should be noted that labor productivity is hard to be estimated, so it is expected to find more deviations in labor productivity (Ritz, 1994).

The factors that influence labor productivity on construction projects are:

- Regional Variations.
- Environmental Effects.
- Learning Curves. (Skill and productivity in performing tasks improve with experience and practice).
- Work Schedule. (Variations in productivity occur when comparing working overtime, or multi-shift work with 8 hrs standard work) (Barrie and Paulson, 1992).

There are many factors that might be contributing significantly to poor labor productivity and consequently to cost overrun. Woodward (1999) summarizes these factors as follows:

- Improper supervision.
- Unavailability of needed materials for work.
- Incomplete design drawings or design changes.
- Bad weather, strikes, and remote site access.
- Unexpected obstructions.

Besides the above factors, Ahuja et.al. (1994) add other factors which lead to poor labor productivity. These are:

- Lack of a steady flow of work.
- Time intervals between similar tasks (productivity rate).
- Engineering changes and rework.

2.15.2.2 Labor variances

The two important variances for labor costs are the *labor rate* and the *labor efficiency* variances. They are defined as follows:

- The labor rate variance arises from the difference between the standard wage rate and the actual wage rate paid; that is,

  Labor rate variance = actual time worked (standard rate – actual rate)

  = AH (SR – AR)

- The labor efficiency variance arises from the difference between the actual time and the standard time to do a job, measured at the standard rate.

  Efficiency variance = standard rate (standard time – actual time)

  = SR (SH – AH)

  Labor cost variance = Labor rate variance + Labor efficiency variance

  = AH (SR – AR) + SR (SH – AH)

  = (SR * SH) – (AH * AR)

  As a result,

Labor cost variance = Standard cost – Actual cost

= (standard hours * standard rate) – (actual hours * actual rate).

2.15.2.3 The field labor report

The primary use of the field labor report is to generate unit cost information to be used in the company's database; these unit costs will provides a means of comparison of actual costs with the unit costs estimated. The field labor report allows the project manager to monitor costs as they occur rather than wait until an operation has been completed to determine whether it has met the profit goals (Levy, 2002).

In the labor cost report, labor costs are monitored on a weekly basis. Project labor hours and quantities of work produced are recorded on a line-by-line basis. Each week, the project management team receives a report detailing the labor cost and quantity of work produced that week, actual unit price, cost to date, and both actual and projected cost shortfalls and overruns for each labor line item.

In estimating the cost of labor for the remaining work, an important factor will be labor productivity. The estimate was based on productivity factors developed during the pre-estimating survey which may be rough estimates based on large assumptions.

During construction, you begin to find the actual job productivity which is found by monitoring of hours worked and the quantity of work completed. The actual productivity must be reflected in the revised cost to complete (Patrascu, 1978).

It should be noted that the productivity starts low because of job start-up problems and the learning curve for new people on the job. Then the productivity peak occurs during the peak loading period on the labor curve and then tapers off as the work winds down at the end of the project (Ritz, 1994).

2.15.3 Control of equipment

Equipment used on a project will generally fall into one of two categories: equipment owned by the company versus equipment leased or rented by the company (Hinze, 1998). In this research, we will concentrate on the control of rented equipment costs.

2.15.3.1 Equipment costs

Equipment costs also charge to work items just like man-hours and material costs. To do this, a record of number of hours per work item and the hourly rate for each equipment is required. These are accumulated and are compared with estimate unit costs. There are many reports for recording equipment costs. These are:

a. Daily Equipment Time Report: This report indicates the equipment type and number, a description of the job(s) on which the equipment was used, the number of hours it worked, repair time, as well as the idle time.
b. Equipment Summary Sheet: This sheet provides a daily history of equipment on the job. For each equipment, the number of hours used for work, idling, and repair are tabulated and multiplied by the standard hourly rate to give the total cost for operating the equipment.
c. Equipment Unit Cost Report: This report takes each item and compares the equipment cost to the units of work performed, arriving at a cost of equipment per unit of work. It gives the "estimated", "this period" and "to-date" quantity, cost, and unit cost. As well, it shows the percentage difference in the "to-date" unit cost and the 'estimated" unit cost. Should an overrun become apparent in the Project Cost Report, reference is made among others to the Equipment Unit Cost Report to determine the source of excessive cost (Ahuja, 1980).

2.15.3.2 Equipment cost analysis

The following are some factors affecting equipment costs:

- Poor equipment management.
- Too much equipment on the job.
- Lack of operator skill.
- Uneconomical mode of acquiring equipment.
- Higher operating and maintenance costs.
- Low productivity of equipment.
- Lack of preventive maintenance program (Ahuja, et. Al. 1994).

An alternative to buying equipment, is the renting of equipment. Renting of equipment may be costly, but can be advantageous in some cases. The contractor can get the most modern equipment on the market, with no capital investment.

2.15.4 Control of subcontract costs

Subcontractors are widely used throughout the construction industry. It is considered that their use is beneficial for many reasons including:

- They enable their employer (the main contractor) to carry out specialized tasks without maintaining a skill base.
- It consequently removes the requirement to operate a large human resources office with sizable overheads.
- They reduce the fluctuations in direct labor level of their employer.
- They provide a degree of certainty with respect to cost and time.

However, employing subcontractors to carry out work has many drawbacks including:

- They are less controllable than a company's own labor.
- They can be more expensive.
- Subcontractors may have little or no commitment to the main contractor.
- The line of control between operatives and management may be longer than using own labor and could consequently be less efficient (Mawdesley, 1997).

Cost control of fixed price subcontracts is managed by a system that reports the percent complete of each line item as compared to current contract amount, the amount billed to date, paid to date, and amount to complete. All subcontractor

billings are reviewed by the project team for accuracy concerning the reported percent complete. Before payment approval, any deviations between subcontractor billings and the project team's approximations of subcontractor's work in place must be validated and verified to assure all work is in compliance with contract documents (Hamilton, 2001).

Controlling of subcontract cost may be an easy task since contracts between the main contractor and the subcontractor determines the unit cost for each job. Therefore, it is expected that this unit cost is usually fixed except in rare occasions.

2.15.5 Control of indirect costs

Indirect costs include field costs, office overhead, interest, contingency, and escalation. All of which must be added to the contractor's direct cost of labor, materials, and equipment to arrive at his project cost. Generally, controlling indirect and overhead costs is critical for all construction mangers. Increased competition and slim profit have forced contractors to take a hard look at overhead cost management.

Field costs: field costs include supervisory and field engineering salaries, tests, surveys, inspection, water, power, telephone, insurance, bond, small tools, sign board, temporary structure (warehouse and offices), temporary roads, photographs, first aid and medical facilities, and transportation, etc.

These costs are measured as a lump sum and compared with the estimated money. Indirect expense distribution may sometimes be difficult, so it is proposed to classify these expenses into items so as to be monitored and controlled (Ahuja, 1980).

Office Overhead: overhead costs include costs of headquarter, engineering and administrative staff, travel expenses, depreciation, safety, telephone, accounts, and stationary. Overhead cost accumulates in headquarters and must be distributed over the projects.

Control of overhead cost consists of monthly statement comparing actual expenditures incurred on overhead work items with their budget provisions (Ahuja. et al. 1994).

Interest: provision for interest costs in an estimate becomes necessary when project funding is required by a contractor to meet the difference between progress payments

received and the amount actually expended by him. When this difference is large and the project has a long duration, these interest costs can be significant.

Interest can be controlled by making a company monthly cash flow to comply with financial requirements. In this case a program of borrowing during the year is made with a view of keeping interest costs at a minimum (Ahuja, 1980).

Contingencies: another important item in an estimate covers an allowance for possible unforeseen occurrences. It could be estimated as a percentage of the subtotal of all direct costs in the estimate and requires a high level of cost engineering judgement (Ahuja, 1980). As more expertise is gained in uncertain areas, the contingency allowance should be reduced to prevent its abuse.

Escalation: the contractor's quantity takeoff is priced using the current prices to give the project cost. If all the work on the project can be performed instantaneously, the estimate will hold well. However, in many projects construction works may take several years. An allowance must therefore be made for the rise during this period in material costs, equipment costs, and labor costs. To control escalation, a separate prediction is made for each period of the project duration based on cost indices published in many cost data handbooks (Ahuja, 1980).

Finally, it should be noted that because the nature of overhead costs is such that immediately effective action is rarely possible, the response time between action and its results is somewhat longer than with hourly paid labor (Pilcher, 1973).

2.16 Project Cost Coding System

It should be kept in mind that one tool used to assist in the monitoring of project expenditures is a project code of accounts to readily identify work by areas, disciplines, multiple work forces, and other variables for the project (Martin, 1992). The success of a cost coding system will depend to a large extent on an ability to develop a sound system of identification coding for the basic cost data. An adequate coding system will simplify the data-handling facility, simplify the task of referring to the items to be coded, and provide economy of storage of these data (Pilcher, 1973). A project cost code is a systematic classification and categorization of all items of work or cost pertaining to a particular project. There is normally a different cost code for each project, but each should be derived from the standard cost code.

Barrie and Paulson (1992) introduce a method to construct a project cost code system which is based on **CSI** Masterformat. Figures 2.5 and 2.6 illustrate the project coding system.

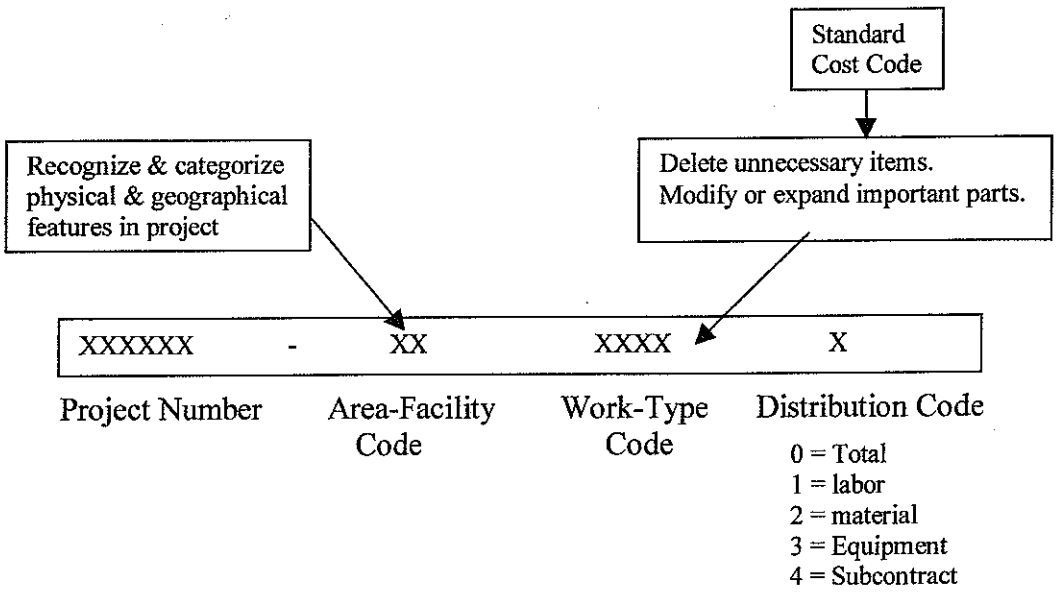

Fig 2.5 Developing project code from standard code

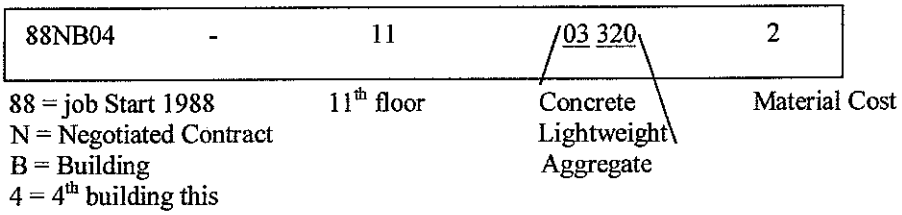

Figure 2.6 Example project code

Shawa (1992) proposed a simpler system for a project cost coding. The proposed system is shown in Annex 11.

The cost coding system should be simple enough for ready understanding by those who will be allocating the hours of labor, equipment, and quantities of materials against the individual codes. Also, there is a wide school of thought that supports the opinion that a cost control coding system should be uniform throughout a company. Undoubtedly, there are advantages of such a system, especially for the staff who permanently employed and will be moving from one contract to another (Pilcher, 1992).

It must be born in mind that a system that is too detailed will lead to difficulties in the allocation of expenses, particularly in the field. If insufficient detail is provided then the costing system as a control system will be ineffective, since it will not be possible to locate the most inefficient of the operations that have been included under a single all-embracing code.

Finally, the design and development of a cost coding system have a significant impact on the cost management of a company or a project. Management is free to establish its own cost code that helps it in reaching financial and cost control objectives (Halpin and Woodhead, 1998).

2.17 Properties of Cost Control System

An important property of any cost control system is to make the data available to management in a timely manner (Barrie and Paulson, 1992). Besides this, other properties should be in the control system. These are:

1. The system must give early warning of problems so that the contractor can take remedial action quickly.
2. You need to check that costs are correct and ensure that values are not optimistic.
3. The simpler the system, the more effective it is likely to be in use.
4. The system should report the exact position of the project and shows how to forecast the result at completion based on the results to date. Reporting requires a good record keeping and careful analysis; forecasting the future is an art which the cost engineer most often learns with experience (Horlroyd, 1999)

On the other hand, a major property of any cost control system is the effectiveness of it. Pilcher (1992) states that the effectiveness of the cost control system is measured by the profitability of the work. This means that the value of the work that will be returned must be compared with the cost of the work, which has been carried out, to the contractor. Also, the effectiveness of a control system can be measured by its average response time, i.e. the average time between the occurrence of a deviation outside the limits and its detection. Traceability is another measure of effectiveness – this is the ability of the system to identify the source of the problem causing the deviations (Hamilton, 2001).

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter discusses the methodology adopted in this research. This methodology includes reviewing literature related to cost control topics, questionnaire for collecting and gathering data, data analysis, developing and evaluating of a computerized cost control system.

This chapter provides information about the research strategy and design, research population and sample, questionnaire design, process of data collection, and statistical data analysis. The literature was discussed in chapter 2, and the computerized cost control system is discussed in chapter 5.

3.2 Research Strategy

Research strategy can be defined as the way in which research objectives can be questioned. There are two types of research strategies, namely "quantitative research" and "qualitative research" (Naoum, 1998). Quantitative research is "objective" in nature. It is defined as an inquiry into a social or human problem, based on testing a hypothesis or a theory composed of variables, measured with numbers, and analyzed with statistical procedures (Naoum, 1998). Also, quantitative research seeks to gather factual data and to study relationships between facts and how such facts and relationships accord with theories and the findings of any research executed previously. Qualitative approach seeks to gain insights and to understand people's perceptions (Fellows and Liu, 1997). Both qualitative and quantitative techniques are utilized in this research. Also, this research has practical implementation through designing a computerized cost control system which satisfies local construction contractors.

3.3 Research Design

Research design is an action plan for getting from "here" to "there", where "here" may be defined as the initial set of questions to be answered, and "there" is some set of conclusions (answers) about the questions (Naoum, 1998).

In this research, a structured questionnaire with personal interview is used for data gathering. Naoum (1998) states that the structured questionnaire is probably the most widely used data collection technique for conducting surveys. Questionnaires have been widely used for descriptive and analytical surveys in order to find facts, opinions and views.

The main advantages of the structure questionnaire with personal interview are:

1. The answers can be more accurate.
2. The response rate is relatively high, especially if interviewees are contacted directly.
3. The answers can be explored with finding out "Why" the particular answers are given.

Figure 3.1 summarizes the methodology in a flow chart.

3.4 The Questionnaire Design

In this research, the questionnaire is used as a technique to collect information in order to investigate the current local practice of construction contractors in implementing the cost control tools and techniques. The questions included in the questionnaire are "closed - ended" questions. In most questions, the respondent has to choose the appropriate selection through multiple-choice selections in a grading sequence.

The questionnaire consists of 17 questions; the first eight questions cover general information about the company (Company Profile). The following three questions inquire about the basic requirements of cost control such as cost estimate, cost baseline, and timing of using cost control.

Question 12 investigates about the necessity degree, the usage range, and the usage method of the different cost control methods and techniques. In question 13, the main obstacles which may hinder using cost control in controlling project costs are listed, and the contractors have to choose the effect of these obstacles.

Questions 14 and 15 investigate the tools, techniques, and procedures that are used by local contractors which are mainly required in any control system. These questions are designed to measure the necessity degree of the tools, techniques and

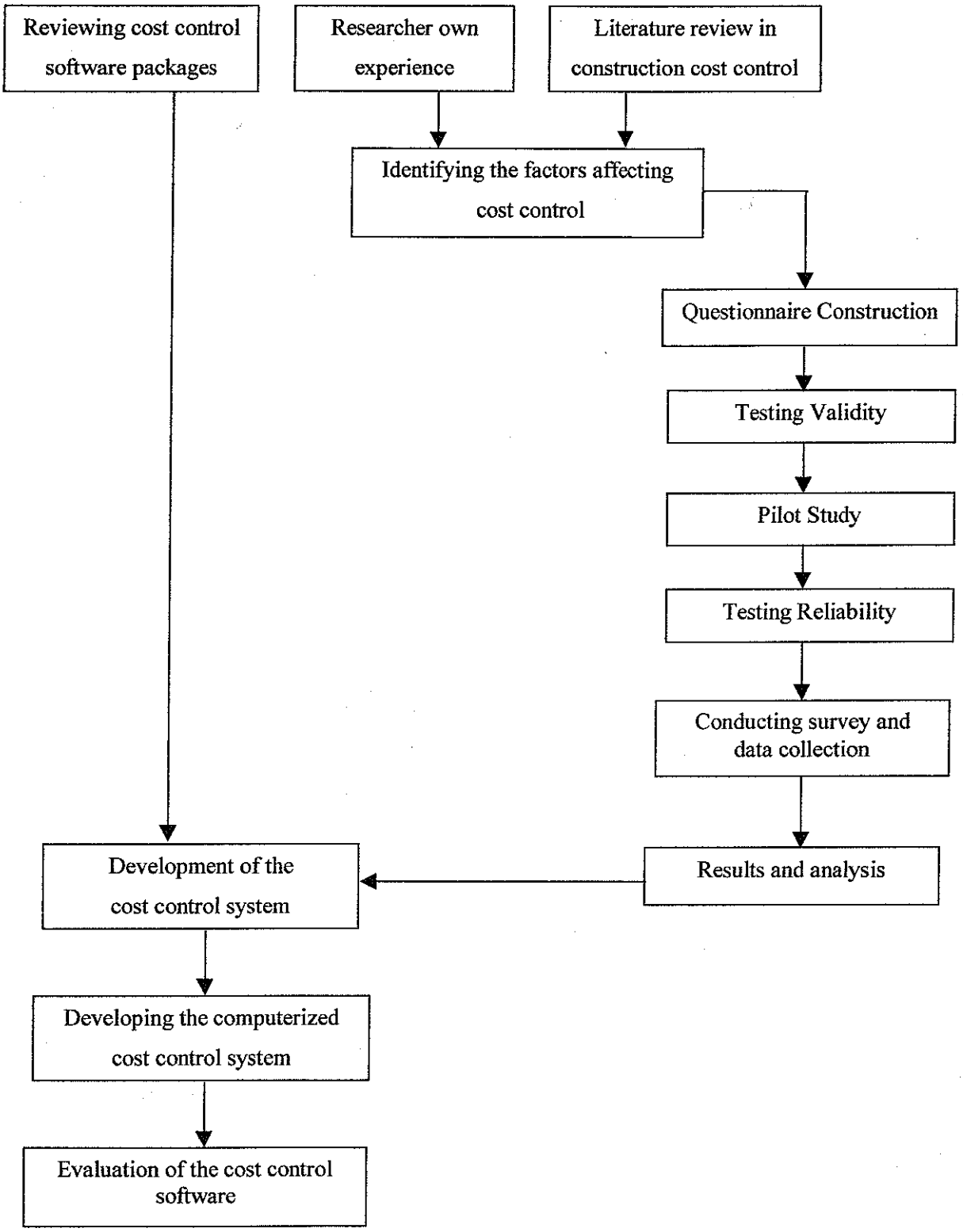

Figure 3.1 Methodology flow chart

procedures in implementing the cost control system. Also, it is used to measure the actual implementation in local practice. In cases of actual implementing these tools and techniques, the contractors are asked to choose the method they use. The usage methods are classified into four degrees: without recording (mentally), recording without using forms, recording using forms, and recording using computerized forms. Question 16 is designed to evaluate the benefits that are expected from implementing a cost control system. In the last question, the respondents are asked to determine the factors that help in implementing a cost control system.

The questionnaire was discussed with the supervisor and amended according to his advice. In addition, it was discussed with experts, university professors and a group of master degree students. They gave important advice which was taken into consideration in the final revision of the questionnaire.

The original questionnaire was developed in Arabic and distributed to samples of contractors. The questionnaire is shown in Annex 2, and the English version of it in is included Annex 3.

3.5 Research Population

The research population includes all contracting companies of first class (A & B) and second class for building, road, and sewerage & water works that have valid registrations in January 2003 with Palestinian Contractors Union (**PCU**) in Gaza Strip. Also, the sample is chosen to be currently involved in construction business.

The number of Gaza Strip contracting companies registered by **PCU** is shown in Figure 3.2 for the years between 1995 and 2002. Also, in this figure the number of companies which withdrew from the list of the previous year is shown.

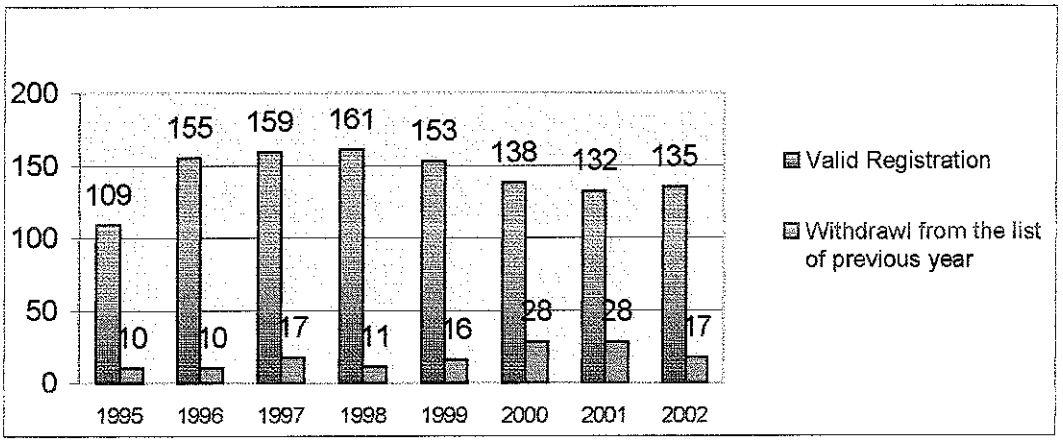

Figure 3.2 Distribution of Contracting Companies in the 1995 - 2002

3.6 Sample Size

A good sample is one that is logically appropriate to the population under study and that in practice is a reliable basis for decision-making. The term 'Sample' means a specimen or part of the whole (Population) which is drawn to show what the rest is like (Naoum, 1998).

To choose the sample size from the population (contracting companies), a statistical calculation for the sample size was conducted. The total number of contractors is 62 enterprises distributed between first category (class A and class B) and second category.

To choose the sample size from the population which equals 62 companies, the formula shown below was used for unlimited population (Creative Research System, 2001).

$$SS = \frac{Z^2 * P * (1-P)}{C^2}$$

Where SS = Sample size.

Z = Value (e.g. 1.96 for 95% confidence level).

P = Degree of variance between the elements of population (0.5).

C = Confidence interval (0.06).

$$SS = \frac{1.96^2 * 0.5 * (1-0.5)}{0.06^2} = 266.77 = 267$$

Correction for finite population, use the formula below:

$$\text{New SS} = \frac{SS}{1 + \frac{SS-1}{POP}}$$

$$\text{New SS} = \frac{267}{1 + \frac{267 - 1}{62}} = 50$$

The contracting companies that are classified as third, fourth, and fifth categories by the contractors union are excluded from target population. This exclusion is justified as these companies are small and the work volume is also small. Another reason is that any cost control system needs a trained staff which is probably not available in these categories.

3.7 Method of Collecting Data

Fifty contracting companies were selected randomly from each level of the mentioned categories. The contractor's union list is ordered chronologically according to their date of registration. The person in charge was interviewed and asked to fill the questionnaire. It was a face-to-face interview in which the interviewer asked the respondents questions and made a brief clarification for the ideas included in the questionnaire. The respondents who returned the questionnaire were 44 companies which constitute 88.0 % of the sample size.

3.8 Questionnaire Validity

The validity of an instrument is a determination of the extent to which the instrument actually reflects the abstract construct being examined (Grove and Burns, 1993). Validity refers to the degree to which an instrument measures what it is supposed to be measuring. The validity of a question is determined by whether the question actually measures the concept of interest. To improve validity, questions should be worded to increase the likelihood that they will mean the same thing to each respondent (Nolinske, 1995).

The validity content of the questionnaire is tested by four professional experts. They were given one week to comment on its content. These comments are valuable and were taken into account in the final questionnaire.

3.9 Pilot Study

Whenever you conduct a questionnaire, it is advisable to complete a pilot study before you collect the final data from the whole sample. A pilot study provides a trial run for the questionnaire, which involves testing the words of the questions, identifying ambiguous questions, testing the technique that you use to collect the data and measuring the effectiveness of your standard invitation to respondents (Naoum, 1998). All questionnaires should initially be piloted; completed by small sample of respondents (Fellows and Liu, 1997).

A pilot study for the questionnaire was conducted before starting data collection. Six questionnaires were distributed among first and second class contractors. They were invited to participate in the piloting process and they were provided with an

explanation about the study and asked to complete the questionnaires. They inquired about some terms and requested to modify some wording of the questionnaire. At the end of this process, some minor changes and modifications were introduced to the questions and the questionnaire was finalized.

3.10 Questionnaire Reliability

To establish the quality of any research, the researcher must deal with the reliability problem. The reliability of a measuring instrument is a major criterion for assessing its quality and adequacy. An instrument can be said to be reliable if its measures accurately reflect the "true" measures of the attribute under investigation (Polit and Hungler, 1999).

Reliability is a measure of consistency. It is the degree to which the same (or similar) measures obtained in the same way from the same population will produce the same results at different times (Backstorm and Cesar, 1981). Assessment of stability of a measuring tool is derived through procedures refereed to as test – retest. The value of the reliability coefficient theoretically can range between -1.00 to +1.00. For most purposes, reliability coefficients above 0.70 are considered satisfactory (Polit and Hungler, 1999).

Six questionnaires are re-distributed among six contracting companies of various categories to re-test their answers. The reliability coefficient is calculated and found to be (0.85) which indicates a high level of reliability and the correlation is significant at 0.01 level.

3.11 Measurement Scales

In order to be able to select the appropriate method of analysis, you need to understand the level of measurement. For each type of measurement, there is/are an appropriate method/s that can be applied and not others (Naoum, 1998). Often, types of data are identified in terms of the nature of the scales of measurement used (Fellows and Liu, 1997). Naoum (1998) divides the level of measurement into four types of scales: nominal, ordinal, interval and ratio.

The most popular scales are nominal and ordinal scales. Nominal numbering implies belonging to a classification or having a particular property and a label. It does not

imply any idea of rank or priority. Nominal numbering is conventional, positive, and whole integers. Ordinal scale is a ranking or a rating data that normally uses integers in ascending or descending order. The numbers assigned to the agreement scale (5, 4, 3, 2, and 1) do not indicate that the interval between the scales are equal, nor do they indicate absolute quantities. They are merely numerical labels (Naoum, 1998). Both scales are used to present the results.

3.12 Computer Assisted Data Analysis

The data is collected from interviewed contractors. Statistical Package for Social Sciences (SPSS) software is chosen to analyze the data. SPSS is chosen because it is popular in researches and easy to use. The questionnaires are numerically coded to enable efficient data entry. After entering the data, it is double-checked to minimize the probability of error.

After entering the data, the following statistical tools have been utilized.

1. Category frequencies and percentages.
2. Computing the variable weights.
3. Ranking the different factors in an ascending or a descending order.
4. Conducting statistical tests which are divided into:
   - 4.1 Parametric t-tests are conducted to interpret the differences when the distribution is interval or ratio (two samples – one variable).
   - 4.2 Analysis of variance (ANOVA) tests are conducted where there are more than two samples.
   - 4.3 Spearman correlation (rho) test is used for measuring the correlation in ranking between contractors of different classes.

As it is discussed in chapter 4, descriptive statistics such as frequency and percentage are computed for each item in the questionnaire. For analyzing data using an ordinal scale, an importance index (I) is used.

The importance index is computed using the following equations.

$$I_1 = \sum_{i=1}^{i=n} (a_i x_i / n\text{-}1) * 100, \qquad I_2 = \sum_{i=1}^{i=n} (a_i x_i / n) * 100$$

Where: I_1 = importance index if the level of ranking rate is not used or not necessary.

I_2 = importance index if all the ranks have positive rating factor.

a_i = constant expressing the weight of the i^{th} response,

a_i = 0, 1, 2 for importance index I_1, and a_i = 1, 2, 3, 4 for I_2.

x_i = frequency of the i^{th} response given as a percentage of the total responses for each case.

i = response category index where i = 1, 2, 3, 4,.....

The importance index for all cases is calculated and ranked for all contractors. In some questions where the respondents are asked to select the method of using; the importance index has no meaning. In this case, the results are presented in numbers and percentages only.

3.13 Developing the Cost Control Software

After reviewing the cost control related literature and some of the cost control software packages, a cost control model was first structured. The initial model was reviewed with the supervisor. Valuable comments were taken into account when the final draft cost control model was approved initially. After the analysis of the questionnaire results, some modifications on the initial model were made to satisfy the local contractors' needs.

After the modified cost control model was approved by the supervisor, it was transferred to a computerized system. The computerized cost control system was programmed using Visual Basic language. The cost control software was tested by the researcher for six weeks. The sample project used in the test was a project with six items.

After finishing this step, the software was evaluated by three contracting companies and two professional experts. The three companies were chosen from first class (A), first class (B), and second class contractors. The evaluation process began by installing the software; a brief illustration was given to the contractor followed by demonstration for the software using a sample project. The contractors used this software for one week; then, they were requested to fill a questionnaire to evaluate the software. The evaluation results were used to make slight modifications on the cost control software. The modified program has been reported and illustrated in this thesis.

CHAPTER 4

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

Analysis of the surveyed data is done through two statistical analysis methods. The first method, which is called "The Descriptive Statistic Method", provides a general overview of the results. It gives an idea about what is happening. The other method is "The Inferential Statistics Method". It provides different statistical tests to be applied for different parts of the sample to make comparison of results (Naoum, 1998).

4.2 The Descriptive Statistic Method

The descriptive statistic method is applied on the survey data collected. It will either analyze the responses in percentages or will contain actual numbers.

4.2.1 Company profile

The followings are the attributes of the surveyed companies which are related to company profile.

4.2.1.1 Year of establishment

As depicted in Table 4.1, it is clear that most surveyed companies (56.8 %) are established in the years between 1994 and 1996 after the establishment of the Palestinian National Authority.

Table 4.1 Summary of companies' year of establishment

	Year	No	%
Year of establishment	Before 1994	11	25.0
	1994 – 1996	25	56.8
	After 1996	8	18.2

4.2.1.2 Company main field of work

From Table 4.2, it is found that nearly all surveyed contracting companies (95.5 %) consider building works as a main branch of business. On the other hand, half of the contracting companies (50 %) consider road works as a main branch of business and almost the same number (52.3 %) consider water and sewage works as a main branch of business. One may conclude that most contracting companies are involved mainly into at least two types of works.

Table 4.2 Distribution of companies' according to main field of work

Company scope of work	Type of work		No	%
	Building	Main field	42	95.5
		Secondary	2	4.5
		None	0	0.0
	Road	Main field	22	50.0
		Secondary	22	50.0
		None	0	0.0
	Sewage and water	Main field	23	52.3
		Secondary	21	47.7
		None	0	0.0

4.2.1.3 Classification of the contracting companies

Three classes of contracting companies were surveyed as shown in Table 4.3. It is noted that 52.3 % of the investigated contracting companies are classified under the first class (A) and (B) in building works.

Table 4.3 Classification of contractors according to PCU

Category		First class (A)	First class (B)	Second class	Third class	Unclassified
Building	No.	14	9	20	1	0
	%	31.8	20.5	45.6	2.3	0.0
Roads	No.	5	2	13	10	14
	%	11.4	4.5	29.6	22.7	31.8
Sewerage and water	No.	12		12	8	12
	%	27.3		27.3	18.2	27.3

4.2.1.4 Company staff

As shown in Table 4.4, it is noted that about two thirds (65.9 %) of the contracting companies have a technical staff of five to ten persons. Also, it is noted that only 20.5 % of the contractors have more than 20 employees. This reflects how small the company size is in Gaza Strip.

Table 4.4 Company staff distribution

Company Staff	No. of persons	No.	Percentage
Technical Staff	Less than 5	7	15.9
	(5 – 10)	29	65.9
	More than 10	8	18.2
Employees	Less than 10	17	38.6
	(10 – 20)	18	40.9
	More than 20	9	20.5

4.2.1.5 Number of projects executed during the last five years

As shown in Figure 4.1, it is found that about half the surveyed contracting companies (45 %) have a volume of work between (11-20) projects in the last five years. This indicates an average of executing three projects per year.

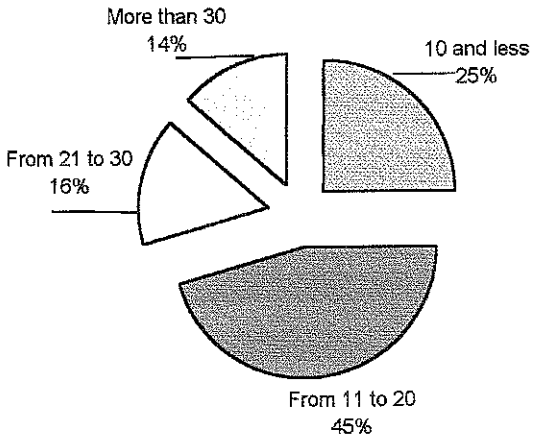

Figure 4.1 Distribution of the number of the projects

4.2.1.6 Value of projects executed during the last five years

From Figure 4.2, it is noted that 40.9 % of the companies have a volume of work with a value from 3.1 to 6.0 million dollars, which means that the local construction projects are mainly small projects. From this, it is concluded that the surveyed companies have an average volume of work of about one million dollar per year.

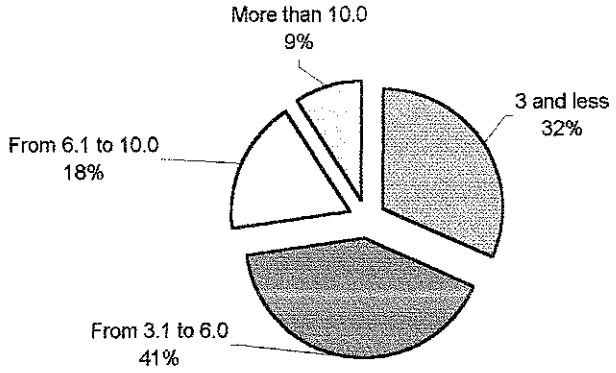

Figure 4.2 Distribution of the value of the projects in million dollars

4.2.1.7 Position of the respondent

As shown in Figure 4.3, most of the respondents (59.1 %) have the title of firm director, and 34.1 % of them are projects manager. This indicates the high cooperation of top management in this study.

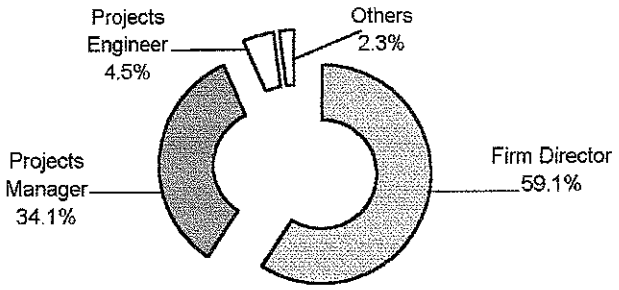

Figure 4.3 Distribution of respondent's occupation

4.2.2 Cost Control Basic Requirements

The following three questions in the questionnaire ask about the basic requirements of any cost control system. These are method of cost estimating, project cost baseline, and timing of cost control.

4.2.2.1 Method of cost estimating

In this question, the contractors are asked to choose one of the established methods of cost estimating. As shown in Table 4.5, it is found that the majority of contractors (81.2 %) mostly estimate their costs in precise detailed estimate to all contributing elements such as materials, labor, equipment, subcontract and overhead. On the other hand, 11.4 % of the firms mostly estimate their costs in detail for only most significant items.

In addition, the survey shows that only one company of the 44 surveyed companies uses the price of previous executed projects as a major method in cost estimating. Also, one company uses previous experience as a tool in cost estimating without going in details in estimating the items. As a conclusion, most of contractors have the prerequisite for the cost control system which is a detailed cost estimate for all components of BOQ items.

Table 4.5 Frequency of using cost estimating tools

Method of cost estimating		Frequency of using				
		M	O	R	Index	Rank
Precise detailed estimate for most BOQ items.	No.	**36**	**8**	**0**	94.09	1
	%	81.2	18.2	0.0		
Precise detailed estimate for most significant items.	No.	**5**	**16**	**23**	53.01	2
	%	11.4	36.4	52.3		
Similar items in previous projects.	No.	**1**	**14**	**29**	45.31	3
	%	2.3	31.8	65.9		
Previous experience and current market situation without detailed estimate.	No.	**1**	**12**	**31**	44.01	4
	%	2.3	27.3	70.5		

(M = mostly used, O = occasionally used, R = rarely used)

4.2.2.2 Project cost baseline

As shown in Table 4.6, it is found that the majority of contractors (61.4 %) mostly use the cost estimate prepared during tendering as a cost baseline to compare actual costs with estimated costs. Also, it is found that one fourth (25.0 %) of the contractors are making new cost estimate for all BOQ items and nearly one fourth (22.7 %) of the contractors make new cost estimate for significant items.

Table 4.6 Frequency of using cost baseline

Project Cost Baseline		Frequency of using				
		M	O	R	Index	Rank
Cost estimate prepared during tendering is used as a baseline.	No.	**27**	**15**	**2**	84.57	1
	%	61.4	34.1	4.5		
A new cost estimate analysis is made for most BOQ items to be used as a baseline.	No.	**11**	**16**	**17**	62.60	2
	%	25.0	36.4	38.6		
A new cost estimate is made only for most significant items.	No.	**10**	**16**	**18**	60.97	3
	%	22.7	36.4	40.9		
No cost control is made in spite of the availability of cost breakdown.	No.	**6**	**4**	**34**	46.33	5
	%	13.6	9.1	77.3		
No cost control is made because there is no cost breakdown.	No.	**6**	**5**	**33**	47.17	4
	%	13.6	11.4	75.0		

(M = mostly used, O = occasionally used, R = rarely used)

4.2.2.3 Timing of cost control

From Table 4.7, it is observed that nearly three fourths (72.7 %) of the contractors control their costs mostly at the end of executing the project. Also, it is found that nearly one fourth (22.7 %) of the contractors mostly control project costs at monthly payment. On the other hand, it is observed that about one contractor of five (20.5 %)

control the project costs at the end of the financial year for all projects, and it is nearly the same (18.2 %) for the contractors who control the project costs at the end of the financial year for every project.

Table 4.7 Timing of projects' cost control

Timing of cost control		Frequency of using				
		M	O	R	Index	Rank
At the end of the project.	No.	**32**	**9**	**3**	88.67	1
	%	72.7	20.5	6.8		
At the end of financial year for all projects under construction in this period.	No.	**9**	**14**	**21**	57.67	3
	%	20.5	31.8	47.7		
At the end of the financial year for every project.	No.	**8**	**11**	**25**	54.00	5
	%	18.2	25.0	56.8		
At receiving the interim payment certificate.	No.	**10**	**15**	**19**	60.00	2
	%	22.7	34.1	43.2		
At the end of each month.	No.	**9**	**14**	**21**	57.67	3
	%	20.5	31.8	47.7		
Biweekly.	No.	**9**	**9**	**26**	53.67	6
	%	20.5	20.5	59.1		

(M = mostly used, O = occasionally used, R = rarely used)

4.2.3 Types of cost control systems

The following are the results of the necessity degree, actual using, and the method of using the different types of cost control systems.

4.2.3.1 Necessity degree and frequency of using

From Tables 4.8 and 4.9, it is observed that there is a clear consistency between the necessity degree and the actual using of the cost control method which controls the project cost at the end of the project. In this case, 34 companies of the 44 surveyed companies show that this method is necessary while 31 companies actually apply this method. In addition, eight companies say that it is somewhat necessary, and nine companies occasionally use it.

When the respondents are asked about controlling project costs according to monthly payment, 56.8 % show that this method is necessary, whilst 31.8 % of them apply this method mostly. Finally, while the majority of contractors (75 %) show that controlling costs based on unit cost is necessary, only 38.6 % mostly apply this method in controlling the project costs.

Table 4.8 Distribution of necessity degree of using cost control system types

Cost control system types		Necessity degree				
		N	NSW	NN	Index	Rank
Cost control is done at the end of the project by comparing payments with expenditures.	No.	**34**	**8**	**2**	88.37	1
	%	77.3	18.2	4.5		
Cost control is done by comparing monthly payments with expenditures for same period.	No.	**25**	**14**	**5**	74.42	3
	%	56.8	31.8	11.4		
Cost control is done by comparing the item's expenses with earned value of these items.	No.	**18**	**19**	**7**	63.95	4
	%	40.9	43.2	15.9		
Cost control is done in unit price basis for both estimated and actual costs.	No.	**33**	**7**	**4**	84.88	2
	%	75.0	15.9	9.1		

(N = necessary, NSW = somewhat necessary, NN = not necessary)

Table 4.9 Distribution of usage range of cost control system types

Cost control system types		Usage Range				
		M	O	R	Index	Rank
Cost control is made at the end of the project by comparing payments with expenditures.	No.	**31**	**9**	**4**	87.12	1
	%	70.5	20.5	9.1		
Cost control is done by comparing monthly payments with expenditures for same period.	No.	**14**	**20**	**10**	62.12	4
	%	31.8	45.5	22.7		
Cost control is done by comparing the item's expenses with earned value of these items.	No.	**13**	**19**	**12**	67.42	3
	%	29.5	43.2	27.3		
Cost control is made in unit price basis for both estimated and actual costs.	No.	**17**	**16**	**11**	71.21	2
	%	38.6	36.4	25.0		

(M = mostly used, O = occasionally used, R = rarely used)

4.2.3.2 Method of using

From Table 4.10, it is found that in average (40 %) of the contractors are not using special forms when applying one of the above methods of cost control. This means that they control project costs without the basic requirements of documentation and recording.

When contractors are asked about using cost control based on unit price, only 22.7 % of the contractors are using forms (either computerized or non-computerized forms) to control their project costs. In average, few contractors (about 15 %) use computers in controlling projects costs.

Table 4.10 Distribution of method of using of cost control system types

Cost control system types		Method of Using					
		NU	WR	RWUF	RUF	RUCF	Total
Cost control is made at the end of the project by comparing payments with expenditures.	No.	**4**	**2**	**18**	**12**	**8**	**44**
	%	9.1	4.5	40.9	27.3	18.2	
Cost control is done by comparing monthly payments with expenditures for same period.	No.	**10**	**4**	**16**	**8**	**6**	**44**
	%	22.7	9.1	36.4	18.2	13.6	
Cost control is done by comparing the item's expenses with earned value of these items.	No.	**12**	**5**	**19**	**3**	**5**	**44**
	%	27.3	11.4	43.2	6.8	11.4	
Cost control is made in unit price basis for both estimated and actual costs.	No.	**11**	**4**	**19**	**4**	**6**	**44**
	%	25.0	9.1	43.2	9.1	13.6	

NU = Not Used, WR = Without Recording, RWUF = Recording Without Using Forms
RUF = Recording Using Forms, RUCF = Recording Using Computerized Forms.

4.2.4 Obstacles in implementing cost control systems

In question 13 of the questionnaire, the contractors are asked to evaluate the effect of the obstacles which restrict contracting companies from implementing cost control in managing their projects. From Table 4.11, it is found that the main obstacle which restrict construction companies in implementing cost control systems is "the non-existence of local software specialized in cost control". Thirty-three contracting companies state that this obstacle has a high and very high effect on not using cost control systems.

The next two factors which have approximately the same index are "the non availability of technical staff for cost monitoring and control" and "the pre-determined belief that the increase in project cost is due to the current situations". Other factors such as "implementing a cost control system costs more than what it may save", "the technical staff resistance of implementing cost control system", and "previous projects have no increase in cost" have moderate effects on hindering the implementation of the systems.

Finally, it is found that most contractors are generally familiar with the concept of cost control as they show their positive responses regarding their desire, conviction, and realization effects in implementing cost control systems.

Table 4.11 Distribution of obstacles causes deterrence of implementation cost control

No	Implementation Obstacles		Effect					Index	Rank
			VH	H	M	L	VL		
1	Non realization the importance of cost control system.	No.	**0**	**1**	**4**	**18**	**21**	33.2	9
		%	0.0	2.3	9.1	40.9	47.7		
2	No conviction in implementing cost control system.	No.	**0**	**2**	**3**	**21**	**18**	35.0	7
		%	0.0	4.5	6.8	47.7	40.9		
3	Non-desire in implementing cost control system.	No.	**0**	**1**	**5**	**21**	**17**	35.4	8
		%	0.0	2.3	11.4	47.7	38.6		
4	Implementing cost control system costs more than what it may save.	No.	**4**	**6**	**18**	**8**	**8**	55.4	4
		%	9.1	13.6	40.9	18.2	18.2		
5	Preexisting belief that the increase in cost is due to surrounding situation.	No.	**8**	**11**	**13**	**9**	**3**	65.4	3
		%	18.2	25.0	29.5	20.5	6.8		
6	Non availability of technical staff for cost monitoring and control.	No.	**9**	**15**	**6**	**8**	**6**	66.0	2
		%	20.5	34.1	13.6	18.2	13.6		
7	Previous projects have no increase in cost, thus no need to control cost.	No.	**1**	**2**	**14**	**17**	**10**	45.0	6
		%	2.3	4.5	31.8	38.6	22.7		
8	The technical staff resistance of implementing cost control system.	No.	**4**	**6**	**13**	**16**	**5**	54.6	5
		%	9.1	13.6	29.5	36.4	11.4		
9	Non existence of local software specialized in cost control.	No.	**19**	**14**	**4**	**5**	**2**	79.6	1
		%	43.2	31.8	9.1	11.4	4.5		

(VH = very high, H = high, M = moderate, L = low, VL = very low)

4.2.5 Cost control tools, techniques, and procedures

The following results discuss the necessity degree and the actual using of different tools and techniques required to any cost control system. These tools are classified according to general, material related, labor related, equipment related, and subcontract related cost control tools.

4.2.5.1 General tools

Table 4.12 summarizes the frequency of the necessity degree and the actual usage of the contractors to the general tools, techniques, and procedures in any cost control system. The eight tools and techniques in question 14 in the questionnaire are grouped with the six procedures in question 15. The fourteen tools, techniques, and procedures are listed in Table 4.12 with the results of the surveyed contractors

It is found that the most necessary tool is "investigate about the causes of cost overrun". This tool becomes in the fourth place when the contractors are asked about

Table 4.12 Distribution of necessity degree and frequency of using cost control tools and techniques (General Tools)

No.	General Items		Necessity Degree					Usage Frequency				
			NN	NSW	N	Index	Rank	R	O	M	Index	Rank
1	Daily record of actual executed quantities.	No.	7	19	18	63.95	13	11	26	7	63.67	13
		%	15.9	43.2	40.9			25.0	59.1	15.9		
2	Weekly record of actual executed quantities.	No.	4	14	26	76.74	8	7	23	14	72.00	11
		%	9.1	31.8	59.1			15.9	52.3	31.8		
3	Monthly record of actual executed quantities.	No.	1	6	37	93.02	3	2	9	33	90.00	1
		%	2.3	13.6	84.1			4.5	20.9	75.0		
4	Cost variance is expressed in absolute values.	No.	2	25	17	68.60	11	3	28	13	74.33	9
		%	4.5	56.8	38.6			6.8	63.6	29.5		
5	Cost variance is expressed as a percentage value.	No.	4	14	26	76.74	8	9	11	24	78.00	6
		%	9.1	31.8	59.1			20.5	25.0	54.4		
6	The project manager follows up the corrective action steps.	No.	0	15	29	84.88	6	1	26	17	78.67	5
		%	0.0	34.1	65.9			2.3	59.1	38.6		
7	Keeping cost information of previous executed projects as feedback for future cost estimating.	No.	1	8	35	90.70	4	1	17	26	85.67	2
		%	2.3	18.2	79.5			2.3	38.6	59.1		
8	Measuring of remaining quantities to estimate cost at completion.	No.	5	13	26	75.58	10	6	21	17	75.00	8
		%	11.4	29.5	59.1			13.6	47.7	38.6		
9	Announcement top management in cases of apparent increase in the actual cost of some items.	No.	0	12	32	88.37	5	7	16	21	77.33	7
		%	0.0	27.3	72.7			15.9	36.4	47.7		
10	Investigate about the causes of cost overrun.	No.	0	6	38	95.35	1	3	20	21	80.33	4
		%	0.0	13.6	86.4			6.8	45.5	47.7		
11	Taking immediate corrective action to adjust the significant increase in the cost of items.	No.	0	7	37	94.19	2	3	19	22	81.00	3
		%	0.0	15.9	84.1			6.8	43.2	50.0		
12	Cost control is concentrated on significant items.	No.	5	21	18	66.30	12	10	16	18	72.67	10
		%	11.4	47.7	40.9			22.7	36.4	40.9		
13	Trying to reduce project duration to minimize project overhead.	No.	3	11	30	82.56	7	9	19	16	72.00	11
		%	6.8	25.0	68.2			20.5	43.2	36.4		
14	Controlling costs using cash flow S – curve.	No.	6	27	11	56.98	14	24	16	4	51.67	14
		%	13.6	61.4	25.0			54.5	36.4	9.1		

(N = necessary, NSW = somewhat necessary, NN = not necessary) (M = mostly used, O = occasionally used, R = rarely used)

the actual using of it. The second most necessary tool is "taking immediate corrective action to adjust the project cost". This tool becomes in the third place regarding the actual implementation. It is also observed that "the monthly record of the executed quantities" is the most used tool in controlling project costs. The second used tool is "keeping cost information as a feedback for future cost estimating". Also, these tools still have high priorities regarding the necessity degree of using cost control systems.

The aforementioned two tools; in addition of being main tools in any cost control system are used by local contractors for other purposes. "The monthly record of the executed quantities" is used for preparing monthly payments and "keeping cost information as a feedback for future cost estimating" is used to estimate future projects. Also, it is found that when contractors are asked about expressing cost variances, they slightly prefer to express them in percentage rather than in absolute values. Finally, controlling costs using cash flow S – Curve has the lowest rank for both the necessity and the actual using.

4.2.5.2 Material related tools

The four tools and techniques related to material items in question 14 are also grouped with the four procedures in question 15. Table 4.13 lists the eight tools and techniques that are related to material items. It is found that the surveyed contractors rank the necessity degree and the usage range approximately in the same order.
From these results it is obvious the inclination of most contractors towards considering the material related tools necessary in controlling projects costs. It is observed that more than 70 % of the contractors consider six of the above eight factors are necessary in any cost control system and the rest considers them somewhat necessary.

When considering the actual applying of the material related tools, it is found that the most used tool is "compare delivered quantities to site with material invoice". In this case, it is found that the majority of contractors (84.1 %) mostly compare materials delivered to site with material invoice. Also, it is found that about two thirds (65.9 %) of the contractors mostly compare the quantity of delivered materials to site with quantities in monthly payments.

Table 4.13 Distribution of necessity degree and frequency of using cost control tools and techniques (Material Tools)

No	Material related tools		Necessity Degree					Usage Range				
			NN	NSW	N	Index	Rank	R	O	M	Index	Rank
1	Comparing delivered quantities to site with material invoice.	No.	**0**	**1**	**43**	98.86	**1**	**2**	**5**	**37**	93.33	1
		%	0.0	2.3	97.7			4.5	11.4	84.1		
2	Inspection of the quality of delivered materials.	No.	**0**	**6**	**38**	95.35	2	**1**	**21**	**22**	82.67	3
		%	0.0	13.6	86.4			2.3	47.7	50.0		
3	Comparing the quantity of delivered materials to site with certified quantities in monthly payments.	No.	**0**	**6**	**38**	95.35	2	**3**	**12**	**29**	86.33	2
		%	0.0	13.6	86.4			6.8	27.3	65.9		
4	Comparing actual used quantity with estimated quantities in the cost estimate.	No.	**0**	**8**	**36**	93.02	4	**6**	**19**	**19**	76.67	5
		%	0.0	18.2	81.2			13.6	43.2	43.2		
5	Existence of stock management system to the different projects.	No.	**2**	**19**	**23**	75.58	8	**18**	**16**	**10**	60.67	8
		%	4.5	43.2	52.3			40.9	36.4	22.7		
6	Investigate about the cause of the increase in material cost.	No.	**0**	**13**	**31**	87.21	6	**5**	**22**	**17**	75.67	6
		%	0.0	29.5	70.5			11.4	50.0	38.6		
7	Taking action to adjust the increase in material cost.	No.	**0**	**10**	**34**	90.70	5	**3**	**19**	**22**	81.00	4
		%	0.0	22.7	77.3			6.8	43.2	50.0		
8	Change the supplier in the cases of the increase in material price.	No.	**1**	**18**	**25**	79.07	7	**7**	**18**	**19**	75.67	6
		%	2.3	40.9	56.8			15.9	40.9	43.2		

(N = necessary, NSW = somewhat necessary, NN = not necessary) (M = mostly used, O = occasionally used, R = rarely used)

In addition, only half of the surveyed contractors mostly make quality inspection for materials delivered to project site. Finally, it is observed that only 22.7 % of the contractors mostly use stock management system for controlling material supply.
From the above, it is concluded that most of the surveyed contractors give materials cost control great attention when managing construction projects. This is referred to the fact that material cost has the lion's share in the project cost.

4.2.5.3 Labor related tools

Table 4.14 groups the tools and techniques in question 14 with the procedures in question 15. It is observed that while about two thirds of the surveyed contractors show that the first four tools related to labor items are necessary to be used in the cost control system, only about half of these contractors mostly use them in managing their projects.
For example, while 70.5 % of the contractors say that comparing actual labor costs with estimated costs in the cost estimate is necessary in any cost control system, only 36.4 % of the contractors mostly apply it in their projects. On the contrary, there is a less difference between the necessity degree and the usage range when the contractors are asked about making agreements with labor to work a specified quantity of work with a predetermined period of time.

4.2.5.4 Equipment related tools

Table 4.15 establishes the tools and techniques related to equipment. It seems that there is a considerable difference between the necessity degree and the usage range of the surveyed contractors. While 75 % of the contractors say that comparing the actual costs of equipment with the estimated costs in the cost estimate is necessary, only 22.7 % of them mostly apply it in their projects. The same thing can be said about comparing the total costs of owned equipment with the renting cost of similar equipment but to a lesser extent. The difference seems to diminish when they try to group the items that need the same equipment.

Table 4.14 Distribution of necessity degree and frequency of using labor cost control tools, techniques and procedures (Labor tools)

No.	Labor related tools		Necessity degree					Usage Range				
			NN	NSW	N	Index	Rank	R	O	M	Index	Rank
1	Comparing actual costs for labor with estimated costs in the cost estimate.	No.	**1**	**12**	**31**	86.05	1	**5**	**23**	**16**	75.00	1
		%	2.3	27.3	70.5			11.4	52.3	36.4		
2	Comparing the productivity rate for labor with estimated rates in the cost estimate.	No.	**3**	**13**	**28**	80.23	3	**9**	**24**	**11**	68.33	4
		%	6.8	29.5	63.6			20.5	54.5	25.0		
3	Comparing the actual daily wage of labor with estimated wages in the cost estimate.	No.	**3**	**11**	**30**	82.56	2	**9**	**22**	**13**	69.67	3
		%	6.8	25.0	68.2			20.5	50.0	29.5		
4	Taking action to adjust the increase in labor cost in cases that permit.	No.	**2**	**15**	**27**	80.23	3	**7**	**21**	**16**	73.67	2
		%	4.5	34.1	61.4			15.9	47.7	36.4		
5	Make agreement with labor to do a specified jobs in a predetermined time and cost.	No.	**4**	**23**	**17**	66.28	5	**11**	**21**	**12**	67.33	5
		%	9.1	52.3	38.6			25.0	47.7	27.3		

(N = necessary, NSW = somewhat necessary, NN = not necessary) (M = mostly used, O = occasionally used, R = rarely used)

Table 4.15 Distribution of necessity degree and frequency of using equipment cost control tools, techniques and procedures (Equipment tools)

No.	Equipment related tools		Necessity degree					Usage Range				
			NN	NSW	N	Index	Rank	R	O	M	Index	Rank
1	Compare total (operating + owned) costs of owned equipment with the renting cost of similar ones.	No.	**4**	**13**	**27**	77.91	3	**10**	**24**	**10**	66.67	3
		%	9.1	29.5	61.4			22.7	54.5	22.7		
2	Comparing the actual costs of equipment with the estimated costs in the cost estimate.	No.	**0**	**11**	**33**	89.53	1	**5**	**29**	**10**	70.45	2
		%	0.0	25.0	75.0			11.4	65.9	22.7		
3	Trying to group the items that need the same equipment at the same time to reduce cost.	No.	**1**	**10**	**33**	88.37	2	**2**	**18**	**24**	83.33	1
		%	2.3	22.7	75.0			4.5	40.9	54.4		

(N = necessary, NSW = somewhat necessary, NN = not necessary) (M = mostly used, O = occasionally used, R = rarely used)

4.2.5.5 Subcontract related tools

From Table 4.16 and Table 4.17, it seems that there is a clear relationship between the necessity degree and the usage range for the subcontract related tools. This is obvious from comparing the adjacent index factors for the two items established below.

Table 4.16 Distribution of necessity degree of using subcontract cost control tools & techniques

No	Subcontract related tools		Necessity degree			
			NN	NSW	N	Index
1	Subcontract parts of a project to control the costs of these parts.	No.	3	15	26	77.91
		%	6.8	34.1	59.1	
2	Subcontract parts of a project to concentrate on cost control other parts of the project.	No.	6	24	14	60.47
		%	13.6	54.5	31.8	

(N = necessary, NSW = somewhat necessary, NN = not necessary)

Table 4.17 Distribution of frequency of using subcontract cost control tools & techniques

No	Subcontract related tools		Usage Range			
			R	O	M	Index
1	Subcontract parts of a project to control the costs of these parts.	No.	4	20	20	78.79
		%	9.1	45.5	45.5	
2	Subcontract parts of a project to concentrate cost control other parts of the project.	No.	15	21	8	61.36
		%	34.1	47.7	18.2	

(M = mostly used, O = occasionally used, R = rarely used)

4.2.6 Summary of necessity and usage results

This section summarizes the results of the necessity degree and the usage range of all the tools, techniques, and procedures. It presents the most ten widely used and the most ten necessary tools and techniques according to the surveyed contractors.

4.2.6.1 Necessity degree

Table 4.18 summarizes the first ten necessary tools and techniques which are selected by the surveyed contractors. They are ranked according to their index values. These tools contain five tools which are related to materials, four of them are related to general techniques, and one of them is related to equipment tools.

Table 4.18 The most ten necessary tools and techniques

No.	Tools and Techniques	Related to	Index
1	Compare delivered quantities to site with material invoice.	Material	98.86
2	Comparing the quantity of delivered materials to site with certified quantities in monthly payments.	Material	95.35
3	Investigate about the causes of cost overrun.	General	95.35
4	Inspection of the quality of delivered materials.	Material	95.35
5	Taking immediate corrective action.	General	94.19
6	Monthly record of actual executed quantities.	General	93.02
7	Compare actual used quantity with estimated quantities.	Material	93.02
8	Keep cost information of previous projects as feedback for future cost estimate.	General	90.70
9	Taking action to adjust the increase in material cost.	Material	90.70
10	Comparing the actual costs of equipment with the estimated costs in the cost estimate.	Equipment	89.53

4.2.6.2 Usage range

Table 4.19 summarizes the most ten widely used tools and techniques ranked in a descending order. These tools and techniques are selected by the surveyed contractors from 32 tools and techniques.

From the table below, it is found that the most widely used tool is "comparing delivered material quantity with material invoice". It is followed by "the monthly record of executed quantities". It is also observed that four of these tools and techniques are related to general tools, and also four are related to materials tools. Finally, one tool is related to equipment, and the last is related to subcontract cost control.

Table 4.19 The most ten widely used tools and techniques

No.	Tools and Techniques	Related to	Index
1	Compare delivered quantities to site with material invoice	Material	93.33
2	Monthly record of actual executed quantities.	General	90.00
3	Comparing the quantity of delivered materials to site with certified quantities in monthly payments.	Material	86.33
4	Keep cost information of previous projects as feedback for future cost estimate.	General	85.67
5	Try to group the items that need the same equipment.	Equipment	83.33
6	Inspection the quality of delivered materials.	Material	82.67
7	Taking action to adjust the increase in material cost.	Material	81.00
8	Taking immediate corrective action.	General	81.00
9	Investigate about the causes of cost overrun.	General	80.33
10	Subcontract parts of a project to control the costs of these parts.	Subcontract	78.79

From Tables 4.18 and 4.19, it is found that "compare delivered quantities to site with material invoice" tool is ranked in the first place in both the necessity degree and the usage range. Also, "comparing the quantity of delivered materials to site with certified quantities in monthly payments" is ranked second in the necessity degree and the contractors rank it in the third class regarding the usage range. On the contrary, while most of the contractors consider "investigate about the causes of cost overrun" is necessary by ranking it in the third place, the surveyed contractors do not use it widely.

4.2.7 Method of using tools and techniques

In question 14 of the questionnaire, there is a part in the question asking about the method of using different tools and techniques related to cost control. The respondent has to choose one method of the four listed methods which his company uses in managing the project costs. These methods are: Without Recording, Recording without Using Forms, Recording Using Forms, and Recording Using Computerized Forms. In case the respondent answers that the usage range of any tool is rarely used, a fifth column is created in the table to reflect this answer. This column is created for analysis purposes and it is titled NU (Not Used).

4.2.7.1 General tools

Table 4.20 shows that computerized forms are generally rarely used for the general cost control tools. However, using computerized forms are considerably obvious in two of the eight general tools. These tools are "monthly record of executed quantities" and "keep cost information for future cost estimate". In addition, these tools in spite of being of major importance of the cost control system, the contracting companies use them for other purposes such as preparing monthly payments or making cost estimates for future projects. Also, when the contractors are asked about the method of using "follow up of implementing corrective action" tool, it is found that one fourth of the surveyed contractors are using this tool without recording and more than half of them are using it without using forms.

Excluding the previously discussed two tools, it is found that less than 50 % of the contracting companies use forms either computerized or non-computerized in recording.

Table 4.20 Distribution of method of using cost control general tools & techniques

No.	General tools		Method of Using				
			NU	WR	RWUF	RUF	RUCF
1	Daily record of actual executed quantities.	No.	**11**	**4**	**15**	**12**	**2**
		%	25.0	9.1	34.1	27.3	4.5
2	Weekly record of actual executed quantities.	No.	**7**	**3**	**14**	**18**	**2**
		%	15.9	6.8	31.8	40.9	4.5
3	Monthly record of actual executed quantities.	No.	**2**	**1**	**6**	**23**	**12**
		%	4.5	2.3	13.6	52.3	27.3
4	Cost variance is expressed in absolute values.	No.	**3**	**11**	**23**	**4**	**3**
		%	6.8	25.0	52.3	9.1	6.8
5	Cost variance is expressed as a percentage value.	No.	**9**	**6**	**19**	**7**	**3**
		%	20.5	13.6	43.2	15.9	6.8
6	Follow up of implementing corrective actions.	No.	**1**	**11**	**23**	**6**	**3**
		%	2.3	25.0	52.3	13.6	6.8
7	Keep cost information of previous projects as feedback for future cost estimating.	No.	**1**	**0**	**15**	**19**	**9**
		%	2.3	0.0	34.1	43.2	20.5
8	Measuring of remaining quantities to estimate cost at completion.	No.	**6**	**4**	**21**	**10**	**3**
		%	13.6	9.1	47.7	22.7	6.8

4.2.7.2 Material related tools

When considering the tools and techniques used in material cost control, it is shown in Table 4.21 that recording using forms, either computerized or non-computerized, has a special consideration. For example, about two thirds (63.7 %) of the contractors

Table 4.21 Distribution of method of using cost control material related tools & techniques

No.	Material related tools		Method of Using				
			NU	WR	RWUF	RUF	RUCF
1	Compare delivered quantities to site with material invoice.	No.	**2**	**1**	**14**	**23**	**4**
		%	4.5	2.3	31.8	52.3	9.1
2	Inspection of the quality of delivered materials.	No.	**1**	**6**	**22**	**14**	**1**
		%	2.3	13.6	50.0	31.8	2.3
3	Compare the quantity of delivered materials to site with quantities in monthly payments.	No.	**3**	**1**	**12**	**23**	**5**
		%	6.8	2.3	27.3	52.3	11.4
4	Comparing actual quantity used with quantities estimated in the cost estimate.	No.	**6**	**5**	**20**	**11**	**2**
		%	13.6	11.4	45.5	25.0	4.5

NU = Not Used, WR = Without Recording, RWUF = Recording Without Using Forms
RUF = Recording Using Forms, RUCF = Recording Using Computerized Forms.

compare the quantity of delivered materials to site with quantities in monthly payments using forms. In addition, it is found that comparing actual used quantity with the estimated quantities in the cost estimate, which is a major tool in any cost control system, is the least used tool in recording using forms.

4.2.7.3 Labor related tools

From Table 4.22, it is observed that only one company of the 44 surveyed companies uses all of the tools related to labor cost using a computerized form. In general, less than one fourth of the surveyed contractors use computerized or non-computerized forms related to labor cost control.

Table 4.22 Distribution of method of using cost labor related control tools & techniques

No.	Labor related tools		Method of Using				
			NU	WR	RWUF	RUF	RUCF
1	Comparing actual costs for labor with estimated costs in the cost estimate.	No.	**5**	**9**	**20**	**9**	**1**
		%	11.4	20.5	45.5	20.5	2.3
2	Comparing the productivity rate for labor with estimates rates in the cost estimate	No.	**9**	**13**	**15**	**6**	**1**
		%	20.5	29.5	34.1	13.6	2.3
3	Comparing the daily wage of labors with the estimated wages in the cost estimate	No.	**9**	**9**	**18**	**7**	**1**
		%	20.5	20.5	40.9	15.9	2.3

NU = Not Used, WR = Without Recording, RWUF = Recording Without Using Forms
RUF = Recording Using Forms, RUCF = Recording Using Computerized Forms.

4.2.7.4 Equipment related tools

From Table 4.23, it is seen that none of the 44 surveyed companies use computerized forms in equipment cost control. Only 13.6 % of the surveyed companies use non-computerized forms when they compare the actual costs of equipment with the estimated costs in the cost estimate. This percentage decreases to 11.4 % for comparing operating costs of owned equipment with renting cost of similar equipment.

Table 4.23 Distribution of method of using cost control equipment related tools & techniques

No.	Equipment related tools		Method of Using				
			NU	WR	RWUF	RUF	RUCF
1	Compare operating costs of owned equipment with renting cost of similar equipment.	No.	**10**	**12**	**17**	**5**	**0**
		%	22.7	27.3	38.6	11.4	0.0
2	Comparing the actual costs of equipment with the estimated costs in the cost estimate.	No.	**5**	**14**	**19**	**6**	**0**
		%	11.4	31.8	43.2	13.6	0.0

NU = Not Used, WR = Without Recording, RWUF = Recording Without Using Forms
RUF = Recording Using Forms, RUCF = Recording Using Computerized Forms.

It is concluded from the results the low tendency among the surveyed contractors towards using forms for the tools related to labor cost. The explanation is that as most local contractors usually subcontract their works and little of them are done by labor force, they show little attention towards labor related tools. In this case, labor cost control becomes the duties of the subcontractors. Another cause for the above, is that in local construction projects the materials cost is approximately three to four times more than the labor costs.

Also, the low percentage of the surveyed companies towards using forms in controlling equipment costs can be explained as most of the contractors are mainly involved in building construction projects which do not need much equipment.

4.2.8 Implementation Success Factors and Benefits

This section discusses the factors which help in the success of implementing cost control systems by local contractors. Also, it refers to the expected benefits when applying cost control systems by the surveyed contractors.

4.2.8.1 Success factors

Table 4.24 shows that all the surveyed contractors believe that the logical and balanced cost estimate is the most necessary factor in implementing any cost control system as all of them consider the effect of this factor either very high or high. The same thing, but to a lesser degree, can be concluded about the factor related to the "availability of qualified technical staff for cost monitoring and cost analysis".

Table 4.24 Distribution of the success factors of implementing cost control system

No.	Implementing success factors		Effect				
			VH	H	M	L	VL
1	The logical and balanced cost estimate.	No.	**30**	**14**	**0**	**0**	**0**
		%	68.2	31.8	0.0	0.0	0.0
2	The availability of qualified technical staff for cost monitoring.	No.	**24**	**18**	**2**	**0**	**0**
		%	54.5	40.9	4.5	0.0	0.0
3	The early taking decisions to correct the project cost.	No.	**15**	**22**	**7**	**0**	**0**
		%	15.9	50.0	34.1	0.0	0.0
4	The early implementation of corrective action to control costs.	No.	**17**	**17**	**10**	**0**	**0**
		%	38.6	38.6	22.7	0.0	0.0
5	Precise follow up for implementation of corrective action to control costs.	No.	**15**	**16**	**12**	**1**	**0**
		%	34.1	36.4	27.3	2.3	0.0
6	Top management commitment in cost control.	No.	**11**	**16**	**12**	**4**	**1**
		%	25.0	36.4	27.3	9.1	2.3
7	Incentives for employees when executing the project within budget.	No.	**11**	**12**	**14**	**6**	**1**
		%	25.0	27.3	31.8	13.6	2.3

(VH = very high, H = high, M = moderate, L = low, VL = very low)

When these factors are ranked in a descending order as in Table 4.25, it is found that "the early taking decisions to corrective action", "the early implementation of corrective action", and "follow up of the corrective implementation" also have high scores in the success factors to implement any cost control system.

Table 4.25 Ranking of the factors that succeed the implementation of cost control system

Implementing success factors	Index	Rank
The logical and balanced cost estimate.	93.60	1
The availability of technical staff for cost monitoring.	90.00	2
The early taking decisions to correct project cost.	83.60	3
The early implementation of corrective action.	83.20	4
Follow up of corrective action implementation.	80.40	5
Top management commitment in cost control.	74.60	6
Incentives for employees when executing within budget.	71.80	7

4.2.8.2 Expected benefits

When considering the expected benefits from applying cost control in managing project costs, it is found as shown in Table 4.26 that nearly all contractors see that "accurate determining the items which the actual costs exceed its estimated costs" and "accurate determining the causes which led the increase in items costs" are the

major benefits that are expected to gain when implementing the cost control system. A subsequent benefit is "provide accurate information as feedback for future estimates"

Table 4.26 Distribution of the expected benefits of implementing cost control system

No.	Expected benefits		Effect				
			VH	H	M	L	VL
1	Accurate determining the items which actual costs exceed its estimated costs.	No.	**21**	**22**	**1**	**0**	**0**
		%	47.7	50.0	2.3	0.0	0.0
2	Accurate determining the causes which led the increase in items costs.	No.	**21**	**21**	**2**	**0**	**0**
		%	47.7	47.7	4.5	0.0	0.0
3	Determining the responsibilities of company's employees.	No.	**13**	**15**	**14**	**2**	**0**
		%	29.5	34.1	31.8	4.5	0.0
4	Increasing employees' competence.	No.	**11**	**19**	**14**	**0**	**0**
		%	25.0	43.2	31.8	0.0	0.0
5	Increasing competitive capability of the firm.	No.	**10**	**18**	**12**	**4**	**0**
		%	22.7	40.9	27.3	9.1	0.0
6	Helping in estimating variation orders.	No.	**12**	**21**	**10**	**1**	**0**
		%	27.3	47.7	22.7	2.3	0.0
7	Helping in logical estimate of claims.	No.	**13**	**21**	**8**	**2**	**0**
		%	29.5	47.7	18.2	4.5	0.0
8	Provide accurate information as feedback for future estimates.	No.	**23**	**14**	**4**	**3**	**0**
		%	52.3	31.8	9.1	6.8	0.0

(VH = very high, H = high, M = moderate, L = low, VL = very low)

An Illustration of the expected benefits from implementing cost control in managing projects is shown in Table 4.27. These benefits are ranked in a descending order according to their index values.

Table 4.27 Ranking of the expected benefits of implementation of cost control system

Expected benefits	Index	Rank
Accurate determining the items which actual costs exceed its estimated costs.	91.20	1
Accurate determining the causes which lead the increase in items costs.	88.60	2
Provide accurate information as feedback for future estimates.	86.00	3
Helping in logical estimate of claims.	80.40	4
Helping in estimating variation orders.	80.00	5
Increasing employees' competence.	78.60	6
Determining the responsibilities of company's employees.	78.20	7
Increasing competitive capability of the firm.	75.40	8

4.3 Inferential Statistics

Inferential statistical tests are used to verify some basic elements in the structure of questionnaire. These tests are shown below.

4.3.1 t- test

The t-test is conducted to find if there is a significant difference between the responses of first class and second class contractors regarding the ranking of the most ten necessary tools and techniques in any cost control system.

- *The research question:*

Do First Class contractors and Second Class contractors are looking at the most ten necessary cost control tools and techniques differently?

- *The research hypothesis:*

There is a significant difference in ranking the most ten necessary cost control tools and techniques between First Class contractors and Second Class contractors.

- *The null hypothesis:*

There is no significant difference in ranking the most ten necessary cost control tools and techniques between the two classes.

Table 4.28 t – test results comparing first class and second class companies

Factor	First Class N = 23		Second Class N=20		t - value
	Mean	Std. Dev.	Mean	Std. Dev.	
Compare delivered quantity to site with Q in monthly payments	1.9565	0.2085	1.700	0.4702	1.4212
Taking immediate corrective action for item cost overrun.	1.9565	0.2085	1.650	0.4894	1.6737
Compare delivered quantity to site with material invoice.	1.9130	0.2881	1.950	0.2236	0.2403
Investigate about the causes of cost overrun.	1.9130	0.2881	1.800	0.4104	0.6216
Monthly record of actual executed quantities.	1.8696	0.4577	1.800	0.4104	0.3462
Keep cost information as feedback for cost estimating.	1.8696	0.4577	1.700	0.5712	0.8129
Compare actual used quantity with estimated quantities.	1.8261	0.3876	1.800	0.4104	0.1350
Inspection the quality of delivered materials.	1.7826	0.4217	1.550	0.5104	1.1107
Taking action to adjust material cost increase.	1.7826	0.4217	1.750	0.4443	0.1619
Compare the actual costs of equipment with estimated costs	1.7391	0.3876	1.550	0.4894	0.4728

The t value obtained from the last column of Table 4.28 is compared with the critical value of t at a selected level of significance. The critical values are illustrated in the table shown in Annex 8.

For the t-test, the degree of freedom df = (23-1) + (20-1) = 41

For this value of df, and at 95 % significant the critical value of t = 2.021.

It is shown that the calculated t in Table 4.28 is smaller than the critical value of t.

From the above findings, it is concluded that the null hypothesis has to be accepted, i.e. there is no significant difference in ranking the most ten necessary cost control tools and techniques between the two classes.

4.3.2 One - Way ANOVA Test

One - Way ANOVA test is done to find if there is a significant difference due to asking different categories in building. One-Way ANOVA test is used when there is more than two groups belonging to one variable. In this case, First Class (A), First Class (B), and Second Class are related to one variable which is classification of contractors in buildings. The most ten widely used tools and techniques among all contractors as in Table 4.19 are used in this test.

- *The research question:*

Do the different classes of contractors in building affect the actual use of the most widely tools and techniques in cost control?

- *The research hypothesis:*

There is a significant difference in implementing the most ten widely used cost control tools and techniques among different classes of contractors in building.

- *The null hypothesis:*

There is no significant difference in implementing the most ten widely used cost control tools and techniques between the different classes.

- *Hypothesis testing:*

From the results shown in Table 4.29, it is found that the P value is greater than 0.05 in seven of the most ten widely used tools and techniques as presented below. This means that there is no significant difference between implementing seven of the most

widely used tools and techniques. It seems that due to the necessity of above tools and techniques, there is no significant difference among the contractors to use them to control the cost of their projects.

On the other hand, the difference seems to appear in three tools which are "compare delivered material to site with materials invoice", "taking action to adjust material cost increase", and " try to group the items that need the same equipment".

Table 4.29 One Way ANOVA Results

Factor	Description	Sum of Squares	df	Mean Squares	F	Sig.
Compare delivered quantity with materials invoice.	Between Groups Within Groups Total	0.043 41.116 41.159	1 42 43	0.043 0.979	0.044	0.835
Monthly Record of actual executed quantities.	Between Groups Within Groups Total	7.569 33.590 41.159	2 41 43	3.785 0.819	4.619	0.016
Compare delivered quantity with quantity in monthly payment.	Between Groups Within Groups Total	2.747 38.412 41.159	1 42 43	2.747 0.915	3.003	0.090
Keep cost information as feedback for future cost estimate.	Between Groups Within Groups Total	3.773 37.386 41.159	2 41 43	1.887 0.912	2.069	0.139
Try to group the items that need the same equipment.	Between Groups Within Groups Total	0.000 41.159 41.159	1 42 43	0.000 0.980	0.000	0.978
Inspection the quality of delivered materials.	Between Groups Within Groups Total	0.291 40.868 41.159	1 42 43	0.291 0.973	0.299	0.588
Taking action to adjust material cost increase.	Between Groups Within Groups Total	0.027 41.132 41.159	2 41 43	0.014 1.003	0.014	0.986
Taking immediate corrective action for item cost overrun.	Between Groups Within Groups Total	5.267 35.892 41.159	1 42 43	5.267 0.855	6.164	0.017
Investigate about the causes of item cost overrun.	Between Groups Within Groups Total	0.606 40.553 41.159	1 42 43	0.606 0.966	0.628	0.433
Subcontract parts of a project to control the costs of these parts.	Between Groups Within Groups Total	0.062 41.097 41.159	1 42 43	0.062 0.979	0.063	0.803

4.3.3 The Spearman (rho) Correlation Coefficient Test

The Spearman correlation coefficient test is used to find if there is a significant difference between the response of the first and the second classes contractors towards the obstacles which hinder implementing cost control in their projects.

The Spearman test is made on the average weighted factors resulted from ranking the obstacles which prevent implementing cost control system.

- *The research question*

Do First Class contractors and Second Class contractors differ in ranking the obstacles in implementing cost control system?

- *The research hypothesis:*

There is a significant difference between the first class contractors and second class contractors in ranking the obstacles in implementing cost control systems.

- *The null hypothesis:*

There is no significant difference between the first class contractors and second class contractors in ranking the obstacles in implementing cost control systems.

Table 4.30 shows the data of ranking the factors that hinder implementing cost control.

Table 4.30: Spearman test results

No	Implementation Obstacles	Rank for First Class	Rank for second Class	Difference in ranks $Di = A - B$	Difference in ranks square $D_i^2 = (A - B)^2$
1	Non realization cost control importance.	1	1	0	0
2	No conviction in implementing cost control.	2	3	1	1
3	No desire in implementing cost control.	3	2	1	1
4	Implementing cost control adds extra overhead.	5	6	1	1
5	The belief that the increase in cost is due to surrounding situation	6	8	2	4
6	Non existence of staff for cost monitoring	8	7	1	1
7	Previous projects have no increase in cost, thus no need to cost control system.	4	4	0	0
8	The resistance of implementation	7	5	2	4
9	Non-existence of local software specialized in cost control.	9	9	0	0
Total $D_i^2 = 12$					

To calculate the Spearman rank correlation coefficient (rho), the following formula is used (Naoum, 1998):

$$\text{Rho} = 1 - \frac{6\sum Di^2}{N(N^2-1)}$$

Where, D_i = the difference in ranking between each pair of factors.

N = number of factors

$$\text{Rho} = 1 - \frac{6*12}{9(81-1)}$$

$$= 0.900$$

For any number of factors N, if the value of the calculated (rho) is equal to or larger than the critical values of (rho) shown in table 4.31 at the same number of factors N and at a certain level of significance, then there is a significant correlation between ranking the factors (Naoum, 1998).

According to Table 4.31, the critical value of (rho) is 0.60 at the significant level of P = 0.05 , and at the number of factors N equals 9. It is clear that the calculated value (rho = 0.90) is more than the critical value (rho = 0.60). Therefore it is concluded that there is a correlation between the ranking of both groups and the null hypothesis should be accepted.

Table 4.31 Critical values of rho at various levels of probability (Naoum, 1998)

N (number of factors)	Level of Significance (P)			
	0.05	0.025	0.01	0.005
5	0.900	1.000	1.000	---
6	0.829	0.886	0.943	1.000
7	0.714	0.786	0.893	0.929
8	0.643	0.738	0.833	0.881
9	0.600	0.683	0.783	0.833
10	0.564	0.648	0.746	0.794
12	0.506	0.591	0.712	0.777
14	0.456	0.544	0.645	0.715
16	0.425	0.506	0.601	0.665
18	0.399	0.475	0.564	0.625
20	0.377	0.450	0.534	0.591
22	0.359	0.428	0.508	0.562
24	0.343	0.409	0.485	0.537

CHAPTER 5

COST CONTROL SOFTWARE (CCS)

5.1 Introduction

This chapter discusses the computerized cost control system (software) which the researcher developed to improve the cost control practices of Gaza Strip contractors. This software is named Cost Control Software (**CCS**). The chapter describes the software components and the method of use. Also, the evaluation and the limitations of the software are discussed.

5.2 Concepts

The researcher reviewed the local cost control practice of Gaza Strip contractors in managing their construction projects. This is done by interviewing 44 local contracting companies. The researcher found out that the local cost control practice is not implemented efficiently. Most contractors wait until the end of the project to find out if the project is profitable or not. The main obstacle for this as found out by the survey results is the lack of cost control systems that suit the local conditions. The researcher develops a cost control software to fill this gap and to improve the current practice.

Also, the researcher in developing **CCS** had reviewed many software packages related to construction cost control. As these software packages are developed to serve non-local companies, it is expected that they are not suitable for local use. The researcher benefited from the advantages of some of these packages when developing **CCS**. A list of these software packages are shown in Annex 4.

The developed software is designed to be simple, and easy to install and operate. It is expected that the simpler the software, the more chance it has to be used by a large group of companies. Also, the software is designed to use the commonly available project data not the complicated ones. The reports produced from this software are designed to be easily understood by the project team.

The developed software is designed to be suitable for wide range of construction projects including buildings, roads, and infrastructure projects. Also, **CCS** has the capacity to control many projects at the same period. It should be noted that this software is designed to handle unit price contracts, as they are the most commonly used contracts.

The software is designed to be compatible with other programs and systems used by the company. In this case, the software is built within Visual Basic Environment. Visual Basic is an Integrated Development Environment (IDE) that allows the researcher to custom, design, interface forms using standard window controls and to code routines using the Visual Basic programming language.

There are several pragmatic reasons for using Visual Basic language. First, it is easily accessible in many popular software packages and can be used in combination with other MS office tools like spreadsheets (Excel), database management (Access), and word processing (Word). Second, Visual Basic is well supported through reference books and extensive online help. Third, Visual Basic is a relatively simple programming environment. Visual Basic is an object-oriented, and powerful development platform, ideally suited for producing impressive Windows applications.

5.3 Cost Control Software Overview

The Cost Control Software (**CCS**) is a software that is specifically designed for the local construction contractors to support cost control practices. Survey results show that most contractors are interested to have a tool to help them to track project costs on more frequent basis.

CCS is a software application that has been developed to provide instant access to information about the project's cost status. It effectively defines, manages, and controls costs from project inception to completion of construction activities. A major prerequisite to implement **CCS** is a detailed cost estimate for all bill of quantity items. If the cost estimate is not previously made, or some items are not previously estimated in detail, the contractor can make this later on. Also, if the company has a cost estimate software, the user can import cost estimates from it for developing the project cost baseline.

The second requirement for **CCS** is the weekly input quantity and cost data for project items. This data represents the actual executed quantities and costs spent on different project items for all cost components such as materiel, labor, equipment, and subcontract.

The cost control software flowchart is illustrated in Figure 5.1. This flowchart is designed to clarify the process of using this software. The flowchart consists of four groups. Group **A** represents the company, project and item identification. Group **B** represents the data which is prepared during the estimating process for direct and indirect costs. This data is entered in the beginning of the project and is considered the cost base line. Group **C** represents the actual weekly input data for direct costs and monthly input data for indirect costs. This data represents the actual executed quantities and the actual costs of all cost components. The final group shows the reports which are weekly and monthly produced.

5.4 Software Installation

At the first time the user installs **CCS**, he is requested to fill some basic information about the company. This information is the company name, address, phone, fax, and the company logo. It should be noted that some of this basic information appears on the printed cost reports. A sample of this screen is shown in Figure 5.2 below.

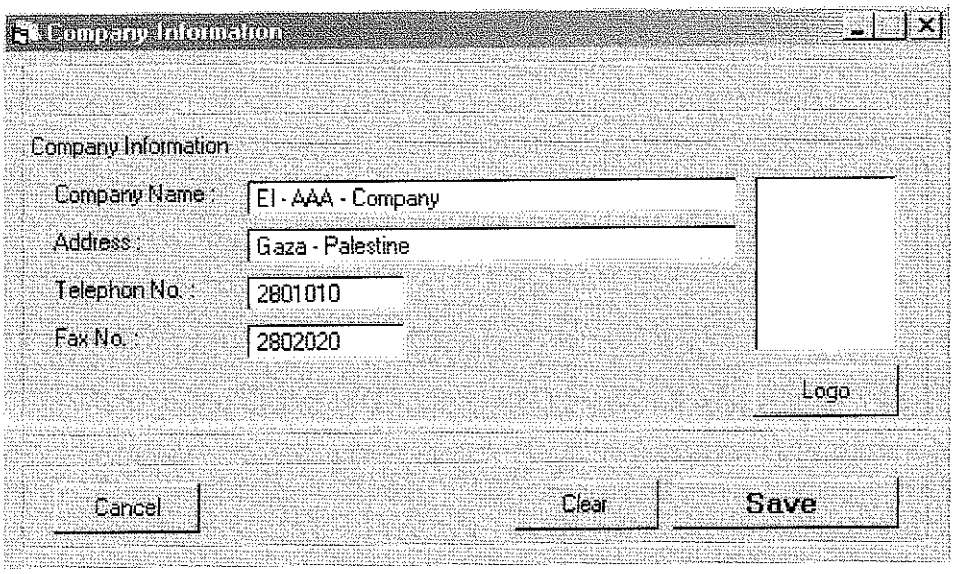

Figure 5.2 Company Information Screen

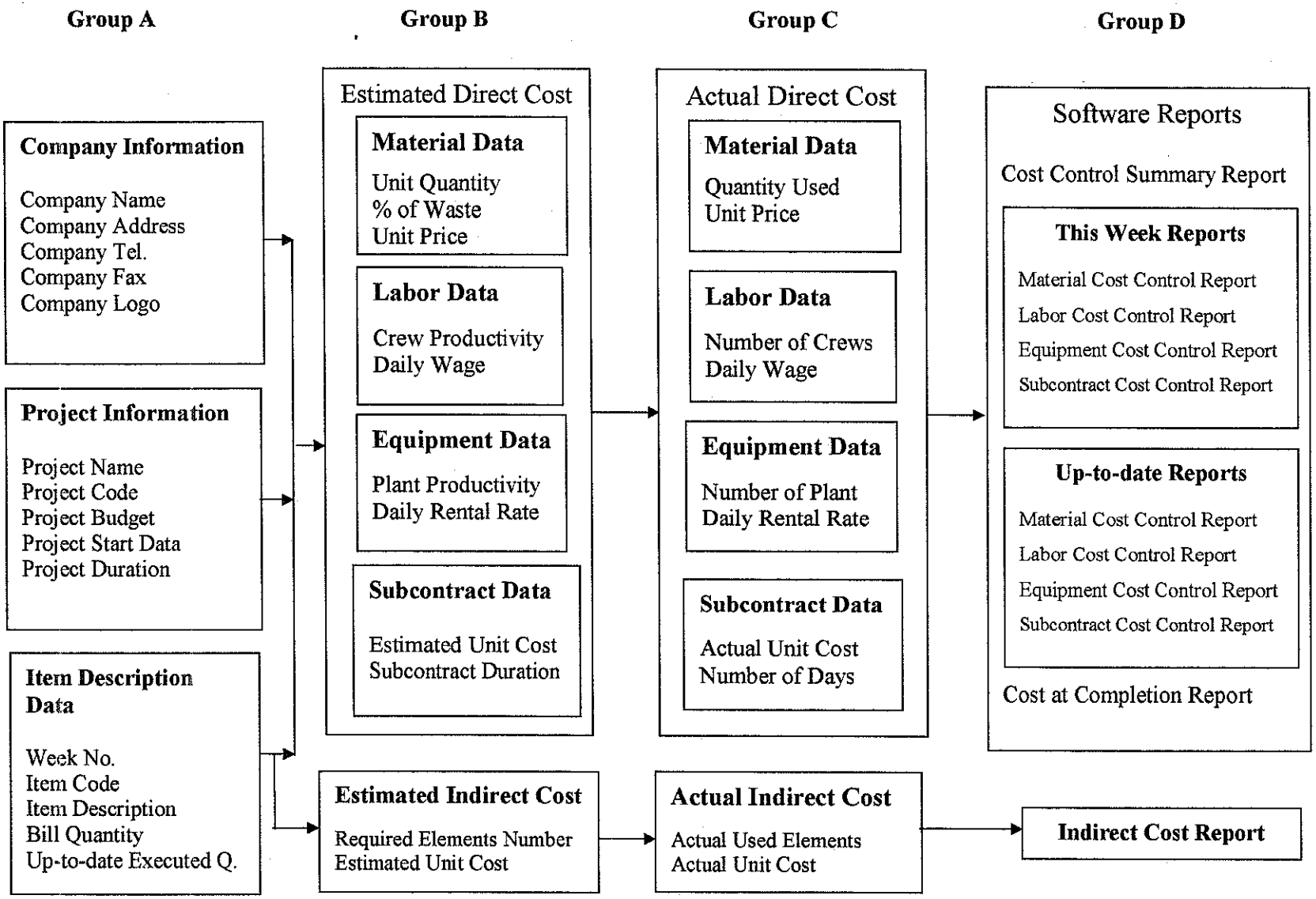

Figure 5.1 Cost Control Software Flowchart

5.5 Entering Project Information

After entering the basic information about the company in the first screen, the user needs to enter information about the new project. A new project can be added from ***File*** menu. **CCS** uses Microsoft Access database to store its information. Projects created using **CCS** will be saved as Microsoft Access database files with (mdb) extension. When the user adds a new project, a second screen appears inquiring about the basic information for the project under control. This screen as shown in Figure 5.3 includes data about the project like the project name, project code number, project budget, project start date, project duration, and any other notes needed such as client or supervisor. This data can automatically appear on the top of sheets and reports for distinction.

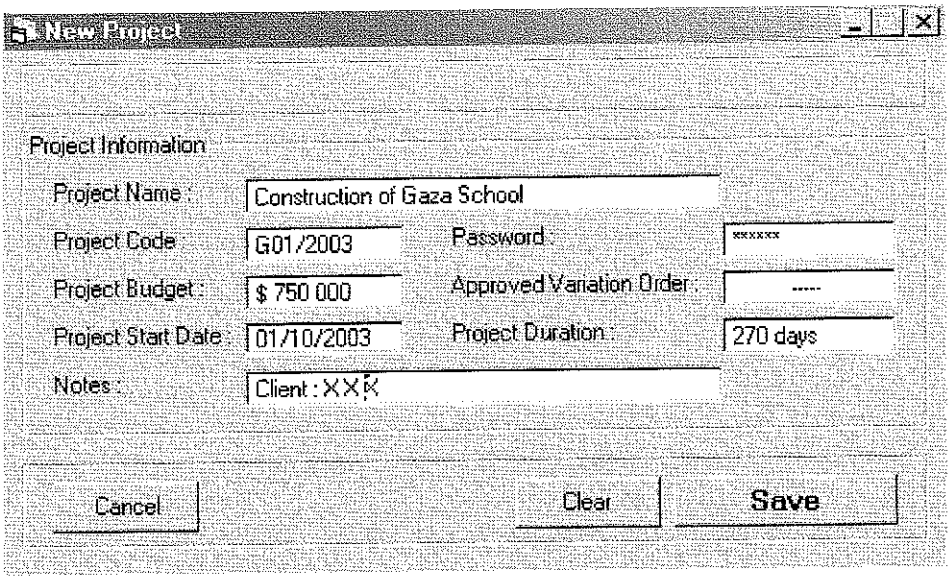

Figure 5.3 Project Information Screen

Also, the user can set a password for every project to prevent unauthorized modification of the project data and configuration by any person. After the user enters the project information, he has to save it. After he clicks on "***Save***" button, this information is saved and the screen disappears.

When the user needs to go to any project executed by his company, he should click on *show all projects* under the ***File*** menu. This will open the screen as shown in Figure 5.4. Once he clicks on a specific project in the shown list, the project name appears on the bottom of the screen and then the Project Screen opens as shown in Figure 5.5. In this screen, the project name is shown and the week number of the designated project is presented also. The week number is counted referred to the project start. Now, the user can enter the project-input data after clicking on "***Next***" button.

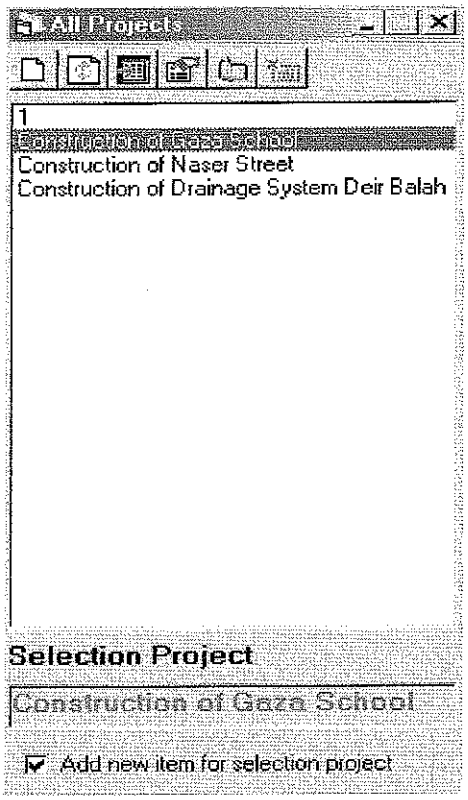

Figure 5.4 All Projects Screen

5.6 Entering Project Items

The first step of entering project items requires the construction of a suitable coding system to enable the ready transfer of information and data from one area of the system to another. Item codes should represent accurately the items in the bill of quantities. It should be noted that each company could choose its own coding system to facilitate the transfer of information and data between the company's staff. In this software, any consistent coding system consists of a number with three to six digits is accepted.

Figure 5.4 Project Screen

After clicking on the "Next" button in the previous screen, a new screen opens. This screen is called "Item Description Screen". The screen which is shown in Figure 5.5 contains some basic information about each item. The first time the user enters this screen, he needs to fill week number, item code, item description (preferred to be brief), bill quantity, and its unit. When the user needs to restore this information, he needs only to fill item code, and then all of the above information is viewed on the screen. The only cell which is needed to be filled weekly is the up-to-data executed quantity.

The up-to-data executed quantity is calculated on site by the site engineer or any authorized person on site. The previous executed quantity is previously known and it is the up-to-data executed quantity in the previous week. The actual quantity executed

this week is automatically calculated and appears in the last cell. The final thing the user should choose in this screen is that if the item is finished in this week or still on going.

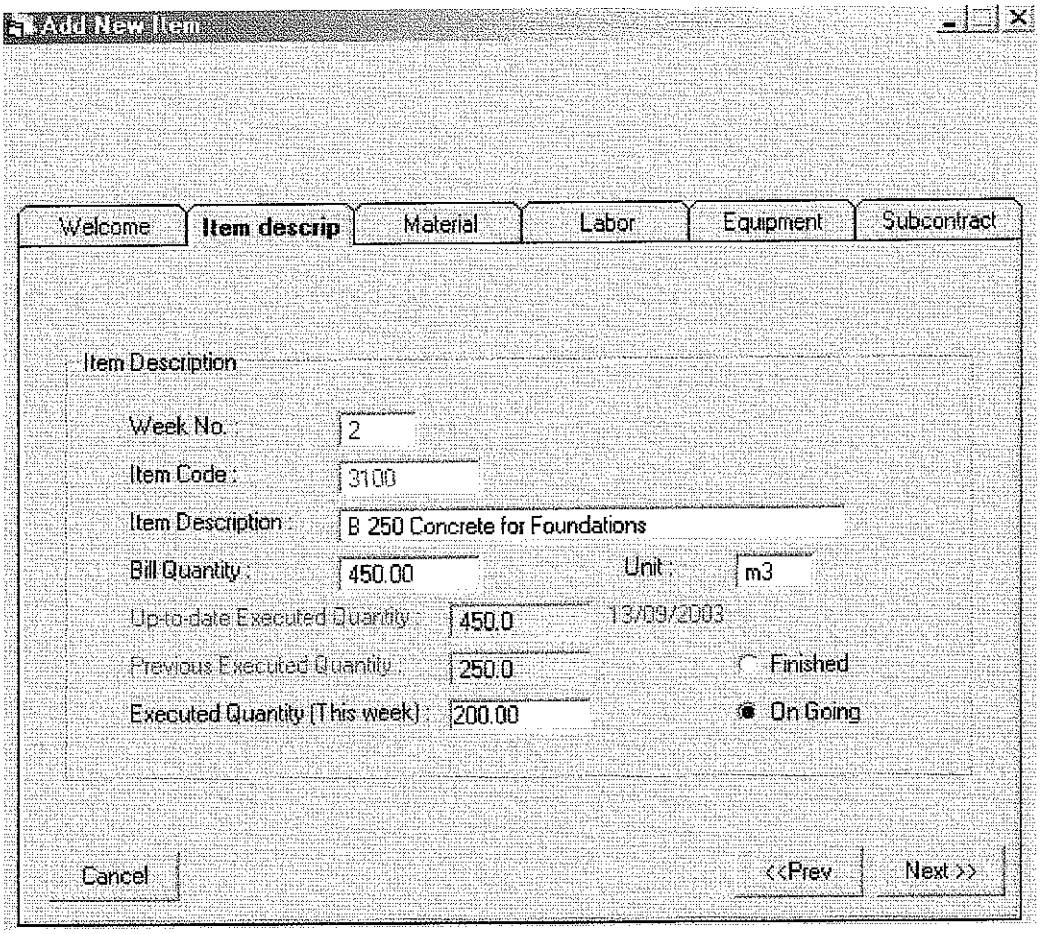

Figure 5.6 Item Description Screen

5.7 Entering Material Data

After entering item description date, the user should click on the "Next" button to open material screen. The first time the user enters this screen, he is prompted by a question asking him if there are material costs to be controlled. In some cases, some items are subcontracted for both materials and labor, so the subcontractor duties are to control both material and labor costs. In these case, the user should choose "No" option. In other cases, the items are either executed by subcontractors' labor or by company's labor. In these cases, the contractor's duties are to control material costs and the user should choose "Yes" option in this screen, i.e. (there are material costs). Next, a sub screen is opened in the bottom of the main material screen.

At the top of this screen, some basic information about each item is shown. This includes week number, item code, item description, unit, bill quantity, and the executed quantity in this week. A sample of this screen is shown in Figure 5.7.

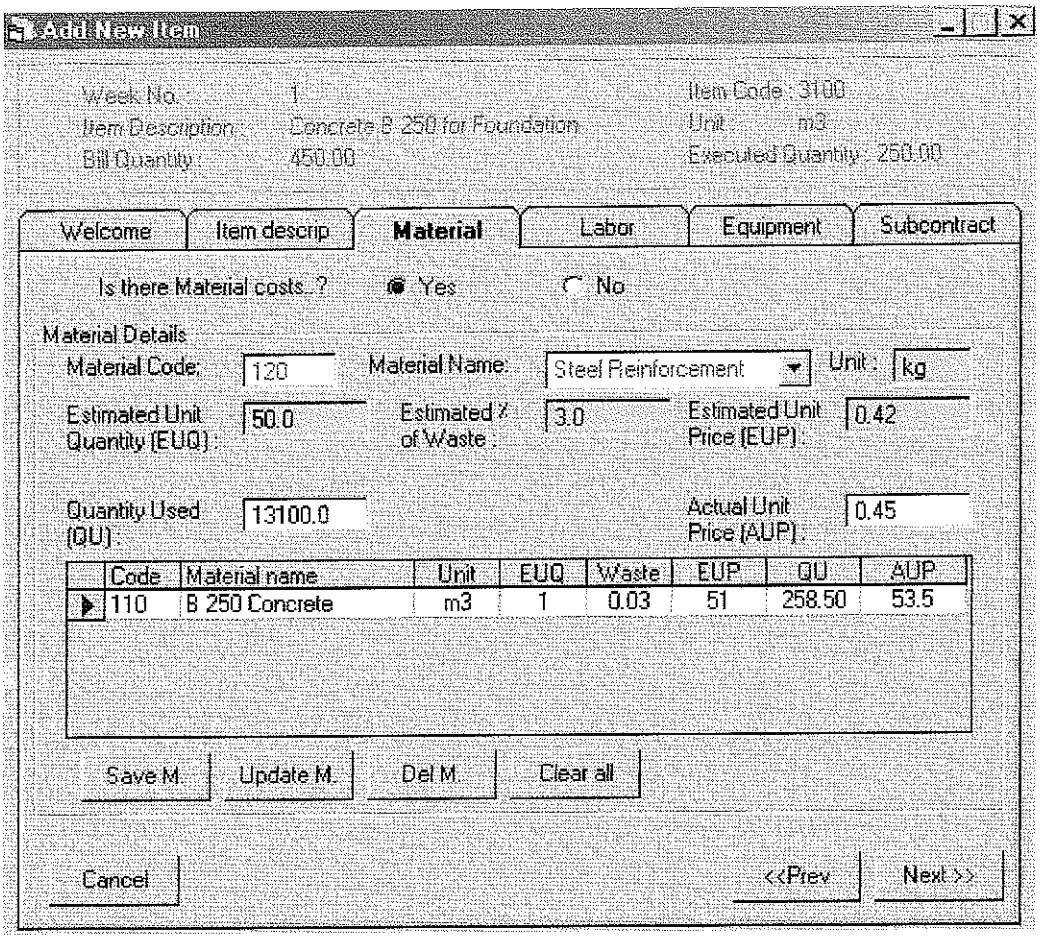

Figure 5.7 Material Screen

In the material screen, the user is requested to enter two types of data about materials. The two types are: estimated material data and actual material data. They are detailed as follows:

5.7.1 Estimated material data

The first type of data entry in the material screen is the estimated data which is entered only once at the first week of executing an item. This estimated data can be entered by the user or can be transferred electronically from any cost estimating software or spreadsheet. The estimated data includes:

- Material Code: for each material, there is a unique code which distinguishes it.
- Material Name.
- Material Unit.
- Estimated Unit Quantity (EUQ): It is the estimated unit quantity of this material per unit of item in BOQ.
- Estimated Percentage of Waste: It is expressed as a percentage of unit quantity.
- Estimated Unit Price: It is the price which is taken from quotations of many suppliers or of previous updated company's materials list price.

The following is an example illustrating the above parameters. If we have an item which is "Supply and cast B 300 reinforced concrete for foundation" expressed in m^3, then this item is composed of three materials which are B300 concrete, steel reinforcement, and fixing wire. The estimated unit quantity per m^3 is estimated to be 1.0 m^3/ m^3, 50 kg/ m^3, and 4.0 kg/m^3 respectively. This data is estimated from bill of quantities, project drawings, or previous experience.

Another data entry is the percentage of waste that represents the expected percentage of waste for executing this item. The third and final data entry in this screen is the estimated unit-purchasing price for each item. It is extracted from the company's updated database for material prices, if any. Otherwise, it can be taken from materials suppliers. It is preferred to take more than one quotation about the price of each material. In this data entry, it must be taken into consideration the various units of purchasing materials for different item descriptions.

5.7.2 Actual material data

When the execution of any item begins, the user needs to enter actual prices and quantities used in this item. The data needed to be fed in the software is the actual quantities of materials used in this week and their purchasing price. The actual unit-purchasing price is taken from the materials invoice.

This input data is the actual quantity used and the actual unit price for each material in this week. For the previous example, the quantity used for executing 250 m^3 for the previous item "Supply and cast B 300 reinforced concrete for foundation" is 258.5 m^3 of concrete with actual unit price of $ 53.5 / m^3, the amount of steel is 13100 kg with actual unit price of $ 0.45 / kg, and the amount of fixing wire is 600 kg with actual unit price of $ 0.6 / kg.

It should be noted that after entering each material the user needs to click on "***Save M***" button to save this material and to begin entering the second material for the same item.

5.8 Labor Data Entry

After entering all of the materials data, the user should click on the "***Next***" button to begin entering labor cost data. The first time the user enters labor screen, there is a question asking him if there is labor cost. If there is no labor cost in this item, i.e. it is subcontracted, then labor cost will be zero. If the user chooses yes, then a sub screen opens. A sample of this screen is shown in Figure 5.8.

If it is the first time the user enters labor costs, then he needs to enter the estimated productivity rate for each crew (unit/day), and the estimated daily wage per each crew ($/day).

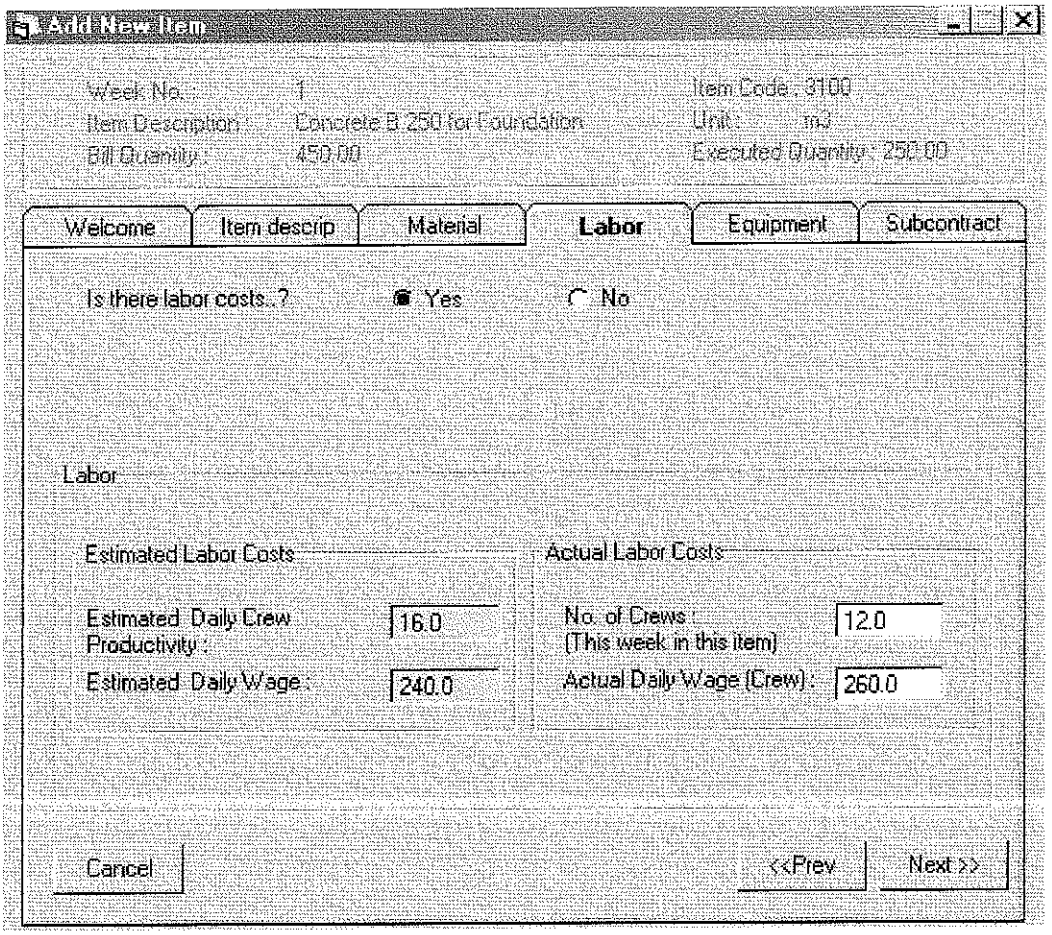

Figure 5.8 Labor Screen

For example, the estimated crew productivity for "Supply and build 20 cm block" is 40 m^2 / day / crew with an estimated daily wage of $ 60 / day / crew. Other data which need to be entered each week is the actual number of crews needed to finish the executed quantity this week and the actual daily wage. For example, in the previous item, it needs 8 crews to execute 300 m^2 of block this week with actual daily wage of $ 65 / day / crew.

It should be noted that the number of crews is determined from the weekly report and it represents the number of crews needed to execute this week quantity. The site engineer records daily the actual hours spent by site labor on each item. At the end of each week, these hours are summarized showing man-hours spread over various items. These hours are expressed as number of days or number of crews and broken down by a cost code number that identifies work item on which the man-hours are used.

5.9 Equipment Data Entry

In equipment costs, it is necessary to distinguish between equipment owned by the company and those rented to do a specific job. For equipment owned by the company, it is necessary to differentiate between operating costs and owning costs. Costs accumulated as a result of use of the equipment such as the operator's salary, fuel bill, and service costs are considered operating costs. Owing costs includes depreciation, taxes, insurance, license, and other costs.

For practical considerations, most contracting companies consider owned equipment as if it is rented from the company itself. To comply with this inclination, **CCS** is designed to control equipment costs based on rented equipment. Whether equipment is from a rental company or from the company's equipment department, a record is kept for its use and costs in an equipment rental record. This record indicates the equipment number, rental period, rental rate, the executed quantity, and the items that use this equipment.

After entering labor cost for a specific item, the user should enter equipment costs if equipment are used to achieve this item. If the user chooses that there is equipment costs, then a sub screen opens. A sample screen is shown in Figure 5.9. At this screen, the user needs to enter equipment code, equipment name, estimated equipment productivity / day when executing this item, and the estimated daily rental rate.

The actual number of equipment used and the actual number of working days are the input data for each week. Also, the user should enter the actual rental rate. After entering these data, the user needs to save the data of this equipment, then to enter the data for the second equipment until finishing the equipment needed to execute this item.

From this data, the estimated equipment unit cost is calculated. For example, suppose that to execute a certain item such as "Supply and compact 25 cm thick base course", three equipment are needed which are Bulldozer, Grader, and Compactor. The daily productivity for each equipment to execute this item is estimated to be 200 m^2/day, 400 m^2/day and 300 m^2/day, respectively. The estimated renting rate is $ 150 / day, $ 200 / day, and $ 150 / day, respectively. In this case, the equipment unit cost is estimated to be (150/200) + (200/400) + (150/300) = $ 1.75 / m^2.

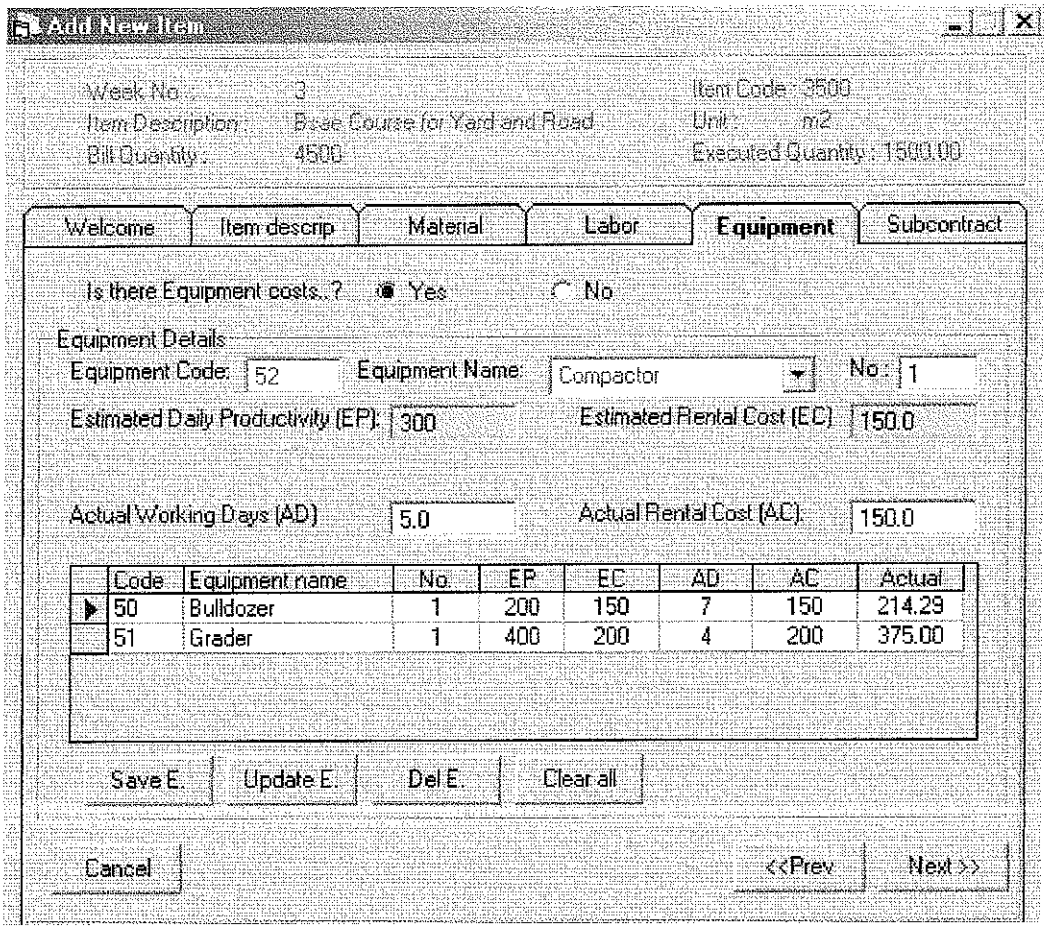

Figure 5.9 Equipment Screen

5.10 Subcontract Data Entry

The final data entry for the item direct cost is the subcontract cost. For controlling subcontract costs, we need to be sure that the unit cost of performing a specific type of work does not exceed the estimated unit cost. Also in this software, we need to ascertain that the period of executing this subcontract will not exceed the predetermined contract period. Otherwise, cost overrun may occur due to the increase of indirect costs and overhead. In the subcontract screen as shown in Figure 5.10, two estimated values need to be entered. One is the estimated unit cost for performing this subcontract, and the other is the period to complete this subcontract. The weekly entered data for subcontract costs are the actual unit cost for this subcontracted item, and the actual number of working days in this item.

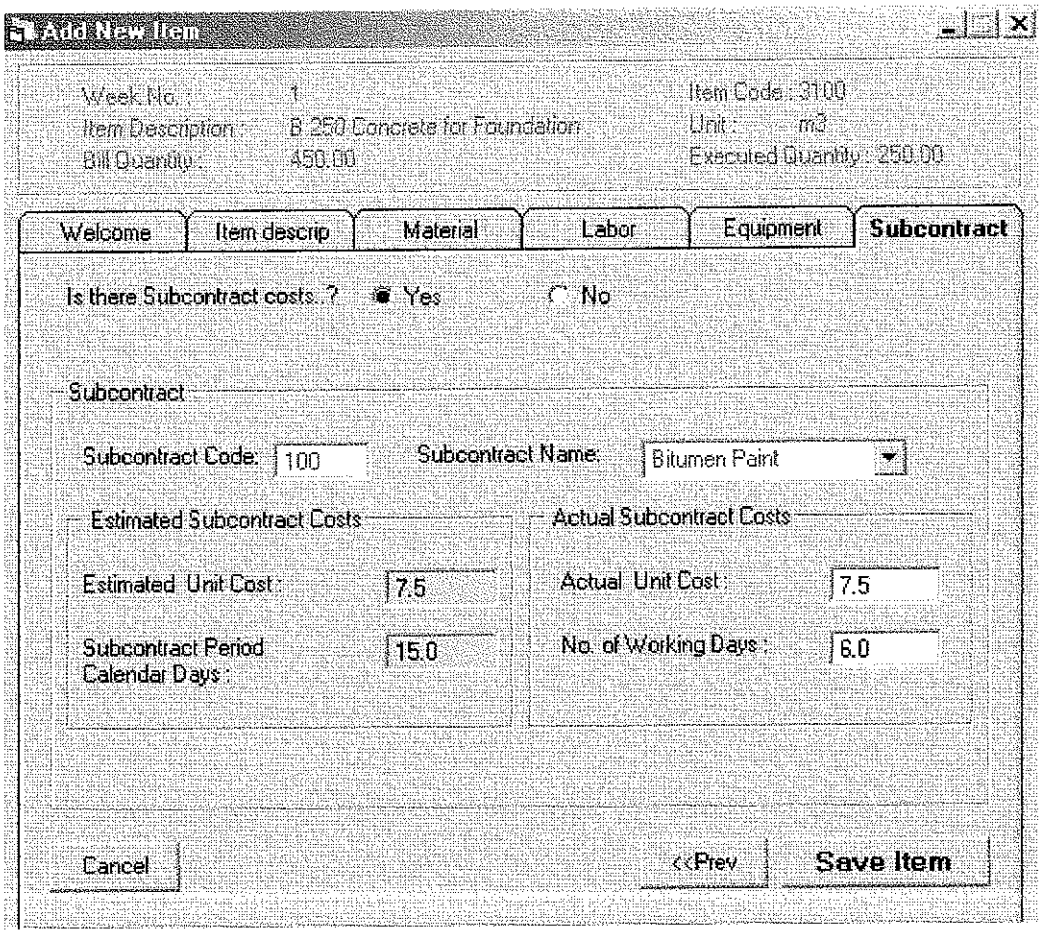

Figure 5.10 Subcontract Screen

After entering the cost data related to all of materials, labor, equipment, and subcontract for an item, the user needs to save this data entry on project database file. This can be done by clicking on "***Save Item***" button. After saving this item, you can add another item and follow the same procedures.

5.11 Cost Reports

There are many reports produced from **CCS**. These reports are listed under "***Reports***" in the "***File***" *menu*. When you click on "***Reports***" command, a screen slides showing all the reports generated by **CCS**. These reports are:

- Cost Control Summary Report.
- Component Cost Control Reports (This week).
  - Material cost control report (This Week).
  - Labor cost control report (This Week).
  - Equipment cost control report (This Week).
  - Subcontract cost control report (This Week).
- Component Cost Control Reports (Up-to-date).
  - Material cost control report (Up-to-date).
  - Labor cost control report (Up-to-date).
  - Equipment cost control report (Up-to-date).
  - Subcontract cost control report (Up-to-date).
- Cost at Completion Report.
- Indirect Costs Report.

5.11.1 Cost control summary report

This report is a comprehensive report to show where there are deficiencies in cost components for each item. These cost components are material cost, labor cost, equipment cost, and subcontract cost.

The first three columns of the report represent item code, item description, and item unit. The next eight columns represent the four cost components which are materials, labor, equipment, and subcontract. For each cost component, there is a pair of columns. One of these columns represents this week unit cost, and the second column represents up-to-date unit cost. The subsequent three columns represent the estimated

total unit cost, the actual total unit cost for this week, and the up-to-date actual total unit cost. The following two columns represent the percentage of cost variance for this week and up-to-date. The variance here is referred to the estimated cost. The final two columns represent the value of cost variance for each item in this week and up-to-date.

The variance has a positive sign for unfavorable performance and a negative sign for good performance. Any significant variance whether it is favorable or unfavorable should be analyzed to know the reasons behind it, so that suitable corrective action for unfavorable performance can be taken. A sample representative report is shown in Table 5.1.

5.11.2 Component cost control reports (This week)

When the user receives the cost control summary report and if he needs more details about cost components, he can click on any button in *"Reports"* sliding screen to illustrate the cost component reports which needs more investigation. The component cost control reports for this week are related to material, labor, equipment, and subcontract. These reports are described in more details below.

5.11.2.1 Material cost control report (This week)

The material cost control report for each week is shown in Table 5.2. The first three columns give information about each item which are: item code, item description, and the unit of this item. The next four columns show the estimated values which are previously entered in the input screen. These estimated values are the estimated unit quantity including the percentage of waste, the estimated quantity, the unit purchasing price for each material, and the estimated unit cost for each material. The estimated unit cost for each material is calculated by multiplying the estimated unit quantity including the percentage of waste times the estimated unit purchasing price.

The next five columns show the actual executed quantity in this week, the actual unit quantity, the quantities of materials used, the actual unit purchasing price for each material used, and the actual unit cost for each material comprising this item. The following two columns show the variances in material quantities. One of these two columns represents the variance between the estimated quantity and the actual quantity used as an absolute value and the other column shows it in a percentage value.

Table 5.1 Cost Control Summary Report

Cost Control Summary Report																		
Item Code	Item Description	Unit	Material Unit Cost		Labor Unit Cost		Equipment Unit Cost		Subcontract Unit Cost		Total Unit Cost			% of Variance		Value of Variance	
			This week	To-date	This week	To-date	This week	To-date	This Week	To-date	Estimate	This Week	To-date	This Week	To-date	This Week	To-date
	Week No. 3 (13/09 – 20/09)																
3200	B 300 RC for Columns	m^3	108.40	110.30	38.40	35.20	0.00	0.00	0.00	0.00	126.51	146.80	145.50	16.04	15.01	1014.5	2088.4
3400	Blocks 20 cm for Walls	m^3	7.35	7.35	1.59	1.59	0.00	0.00	0.00	0.00	7.98	8.94	8.94	12.10	12.10	772.0	772.0
3500	20 cm Base course for Yard	m^3	6.76	6.76	1.33	1.33	2.13	2.13	0.00	0.00	9.24	10.22	10.22	10.64	10.64	1473.7	1473.7

Table 5.2 Material Cost Control Report

Material Cost Control Report																	
Item Code	Item Description	Unit	Estimated (Quantity + Purchasing Price)				Actual (Quantity + Purchasing Price)					Quantity Variance		Purchasing Price Variance		Cost Variance	
			Unit Q	Quantity estimate	Unit Purchase	Unit Cost	Executed Q	Unit Q	Quantity Used	Unit Purchase	Unit Cost	Absolute	%	Absolute	%	%	Value
	Week No. 1 (29/08 – 06/09)																
3100	B 250 Con. (foundation)	m^3				**76.24**	**250.0**				**80.58**					**5.69**	**1084.75**
110	B 250 Concrete	m^3	1.03	257.5	51.00	52.53		1.03	258.5	53.50	55.32	1.00	0.39	2.50	4.90	4.90	697.25
210	Steel Reinforcement	kg	51.50	12875	0.42	21.63		52.40	13100.0	0.45	23.58	225.00	1.75	0.03	7.14	7.14	487.50
910	Fixing Wire	kg	4.16	1040.0	0.50	2.08		2.80	700.0	0.60	1.68	- 340.00	- 32.69	0.10	20.00	- 20.00	- 100.00

The next are the price variance columns expressed as an absolute value and as a percentage value. The final two columns in this report are the materials cost variance expressed as a percentage and as an absolute value. It should be noted that there are five figures presented in this report in the main row related to each item. These figures are:

- The estimated unit cost, which is the summation of all estimated unit costs for all used materials.
- The executed quantity in this week.
- The actual unit cost, which is the summation of all actual unit costs for all used materials.
- The percentage of cost variance for material component.
- The value of cost variance, which is the summation of cost variances for all materials comprising this item.

5.11.2.2 Labor cost control report (This week)

The primary use of the labor cost control report is to generate labor cost information to be compared with the estimated labor cost developed during the estimating process. Table 5.3 shows a sample of a labor cost control report. The first four columns represent information about the item such as item code, item description, unit, and bill quantity. The next three columns illustrate estimated values for daily productivity rate per crew, estimated daily wage, and estimated labor unit cost. The estimated productivity rate and the estimated daily wage are input data as previously explained. The third column in this group represents the estimated labor unit cost which is the product of dividing productivity rate by daily wage. The next five columns represent actual labor data for this week. These columns show the executed quantity in this week, the number of crews needed to finish this quantity, the actual productivity for executing this quantity (which is produced by dividing the executed quantity by the number of crews), the actual daily wage per crew, and the actual labor unit cost. The next two columns represent the percentage of variance in crew productivity and in daily wage. The final two columns represent the labor cost variance expressed as a percentage and as an absolute value. An important note in this report is that the negative sign for the productivity variance indicates unfavorable performance contrary to other figures in the different reports.

Table 5.3 Labor Cost Control Report

Labor Cost Control Report															
Item Code	Item Description	Unit	Bill Q	Estimated			This Period (Actual)					% of Variance		Cost Variance	
				Productivity unit/day	Wage $/day	Unit Cost $/unit	Executed Q	No. of crews day	Productivity unit/day	Wage $/day	Unit Cost $/unit	Product.	Wage	%	Value
	Week No. 3 (13/09 – 20/09)														
3200	B 300 RC for Columns	m^3	160.0	6.0	150.0	25.00	110.0	24.0	4.58	160.0	34.90	- 23.61	6.67	**40.80**	**1090.0**
3400	Blocks 20 cm for Walls	m^2	2000.0	60.0	90.0	1.50	800.0	15.0	53.33	85.0	1.50	- 11.11	- 5.56	**6.25**	**75.0**

Table 5.4 Equipment Cost Control Report

Equipment Cost Control Report															
Item Code	Item Description	Unit	Bill Q	Estimated			This Period (Actual)					% of Variance		Cost Variance	
				Productivity unit/day	Rent Rate $ / day	Unit Cost $/unit	Executed Q	No. of Equip.	Productivity unit/day	Rent Rate $ / day	Unit Cost $/unit	Product.	Rate	%	Value
	Week No. 3 (13/09 – 20/09)														
3500	**20 cm Base course**	m^2	**4500.0**			**1.75**	**1500.0**				**1.89**			**7.81**	**205**
50	Bulldozer	No.		200.0	150.0	0.75		8	187.5	160.0	0.85	- 6.25	6.67		
51	Grader	No.		400.0	200.0	0.50		4	375.0	200.0	0.53	- 6.25	0.00		
52	Compactor	No.		300.0	150.0	0.50		5	300.0	150.0	0.50	0.00	0.00		

Table 5.5 Subcontract Cost Control Report

Subcontract Cost Control Report											
Item Code	Item Description	Unit	Bill Quantity	Executed Quantity	Estimated		This Period (Actual)		% of Variance		Value of Variance
					Unit Cost	Productivity	Unit Cost	Productivity	Unit Cost	Productivity	
	Week No. 2 (06/09 – 13/09)										
3100	B 250 Con for Foundation	m^3	450.0	200.0	5.0	30.0	5.0	28.57	0.00	- 4.76	**0.00**

5.11.2.3 Equipment cost control report (This week)

Like the two previous reports, the equipment cost control report shows the basic information for the item under study in the first four columns. These are item code, item description, unit, and bill quantity. The next three columns show the estimated values for the productivity rate for each equipment in this item, daily renting rate, and the estimated unit cost for all equipment used. The next five columns show actual values for the executed quantity in this week, the number of equipment used in this week, the actual productivity rate (which is produced by dividing the executed quantity by the number of equipment used), the actual renting rate, and the actual equipment unit cost. The subsequent two columns show the variance in the productivity rate, and the daily renting rate for each equipment expressed as a percentage value. The final two columns in this report show the value of variance in equipment cost for this item expressed as a percentage value and in absolute value. Table 5.4 shows a sample of equipment cost control report.

5.11.2.4 Subcontract cost control report (This week)

The final report related to direct cost components is the subcontract cost control report. Table 5.5 shows a sample of the subcontract cost control report. Like the other previous reports, the first four columns in the subcontract report show item code, item description, unit, and bill quantity. The next column shows the executed quantity in this week. The subsequent two columns show the estimated unit cost and the estimated productivity predicted to execute this type of work. The next two columns show the actual unit cost and the actual productivity in executing this week quantity. The subsequent two columns show the percentage in variance in unit cost and in productivity rate. The final column represents the value of variance in executing this subcontracted item. It should be noted that the value of variance stems only from the variance from unit cost. On the other hand, the productivity variance does not affect the value of variance. It is only an indication to pinpoint that there is a delay in this subcontract which should be taken into account. This delay may lead to cost overrun to the main contractor due to increasing of indirect costs.

5.11.3 Component cost control reports (Up-to-date)

Other reports produced from this software are the up-to-date cost component reports which are produced for materials, labor, equipment, and subcontract. Samples of the up-to-date reports are shown in Annex 7. These reports are:

5.11.3.1 Material cost control report (Up-to-date)

This report is like this-week material cost control report, except that the values in the report are for up-to-date quantities and prices. These values show the up-to-date used quantities, the up-to-date unit quantity, and the up-to-date unit-purchasing price for each material. The up-to-date quantity is the total of the quantities of used materials. The up-to-date unit-purchasing price is the average value of the prices of the used materials. For example, if the contractor supplies 100 m^3 of concrete with $ 50 in week 1, and 60 m^3 of the same type with $ 55 in week 2, then the up-to-date unit purchasing price is (100*50+60*55)/(100+60) = $ 51.875.

The rest of this report presents the quantity variances and price variances in both absolute and percentage values. The final two columns show the up-to-date cost variance for each item expressed as a percentage and as an absolute value.

5.11.3.2 Labor cost control report (Up-to-date)

Besides the basic information for each item and the estimated value for labor cost, the up-to-date labor cost control report shows the up-to-date executed quantities, the total number of crews needed to execute these quantities, the corresponding crew productivity, the average of the daily wage, and the associated unit cost for the up-to-date period. The next three columns show the percentage of variance in productivity, wage, and unit cost. The last column shows the up-to-date value of variance.

5.11.3.3 Equipment cost control report (Up-to-date)

In this report, the total number of different equipment needed to execute the up-to-date quantity is shown. Also, the average of the productivity rate and the average rental rate of each equipment is established. From these data, the equipment unit cost for each item is calculated. Also, this report shows the percentage of variance for the up-to-date productivity, renting rate, and unit cost. The final column of this report shows the value of variance of the equipment component to this item.

5.11.3.4 Subcontract cost control report (Up-to-date)

This report is similar to this week subcontract cost control report except that the data for the unit cost and the productivity rate are the average of the previous weeks taking into account the weighted average of the executed quantities each week.

In this software, all the reports can be printed by pressing on the print command in the standard toolbar or from "***File***" menu.

5.12 Selective Reports and Corrective Action

After all the reports are presented, the items which have a significant cost overrun are highlighted. These items have the property of being isolated in a selective report which shows only the items having a significant cost overrun or underrun. The user needs to choose the absolute value and percentage limit which he finds that below or above these limits, those items need more investigations.

For example, if the user needs to show only the items which have 3 % overrun/underrun or it leads to absolute value of 200 $, these values should be filled in the control limits screen shown in Figure 5.11. In this case, only the items which its variance are equal or above of these limits will be shown in the report.

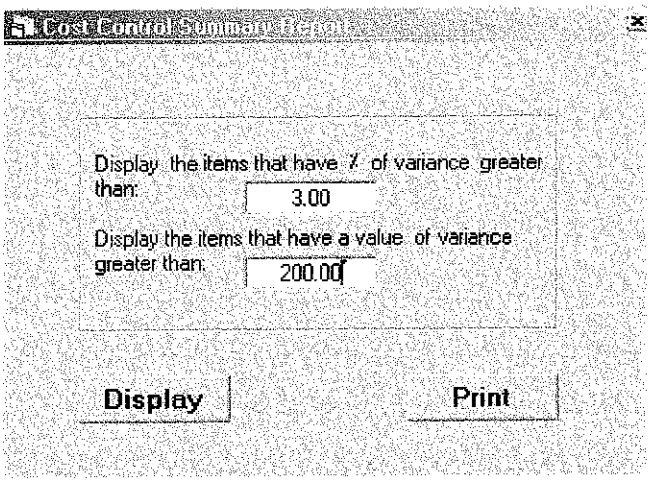

Figure 5.11 Control Limit screen

The causes of cost overruns are investigated with the project team. The reasons for cost overruns may be due to one or more of cost components that comprise this item. In this step, we have detected the areas of cost overrun but it is insufficient to find the main cause. In each one of the previous reports, there may be more than one cause for cost overrun. In material cost report, cost overrun may be due to consuming more material than estimated materials or due to the increase in unit purchasing price. In labor cost report, cost overrun may be due to low productivity, or due to higher wages. The same thing can be said about equipment and subcontract.

Once, the symptoms which lead to cost overrun are detected, the project manager in coordination with other staff involved in the project are going to begin a corrective action plan. This can be done by narrative reports explaining the causes of cost overrun for some significant items. The narrative report is a report that includes the comments on the main produced reports from the software output. It includes information that the project manger believes should be brought to the attention of senior management.

5.13 Cost Forecast

At the same time of investigating the reasons which lead to cost overrun, the cost control cycle is continued. In this step, the project manager needs to forecast the unit cost (cost to complete) for each item to the remaining quantities. For each cost component of material, labor, equipment, and subcontract, the user should predict the forecasted cost for the remaining quantities. This can be done by choosing the cost component in the sliding screen under the "***Forecast***" command in "***File***" menu.
In **CCS**, there are provisions for four methods to calculate the forecasted cost, and the project manager can choose which method he finds appropriate for estimating the remaining costs.

These methods are summarized as follows:

- The first method assumes that the remaining quantities will be executed according to the estimated costs with no extra cost overrun or underrun in the cost of the remaining quantities.

- The second forecasting method assumes that the past performance of the project will continue at the same rate of efficiency or inefficiency for the balance of the project.
- The third forecasting method assumes that the forecasted unit cost will be the average of the estimated unit cost and the actual unit cost assuming that the project staff will do their best to go back to the estimated costs.
- The final method is left to the project manager judgment and he has to choose the value he finds it appropriate to complete the project.

A sample of this forecasted cost screen is shown in Figure 5.12 below.

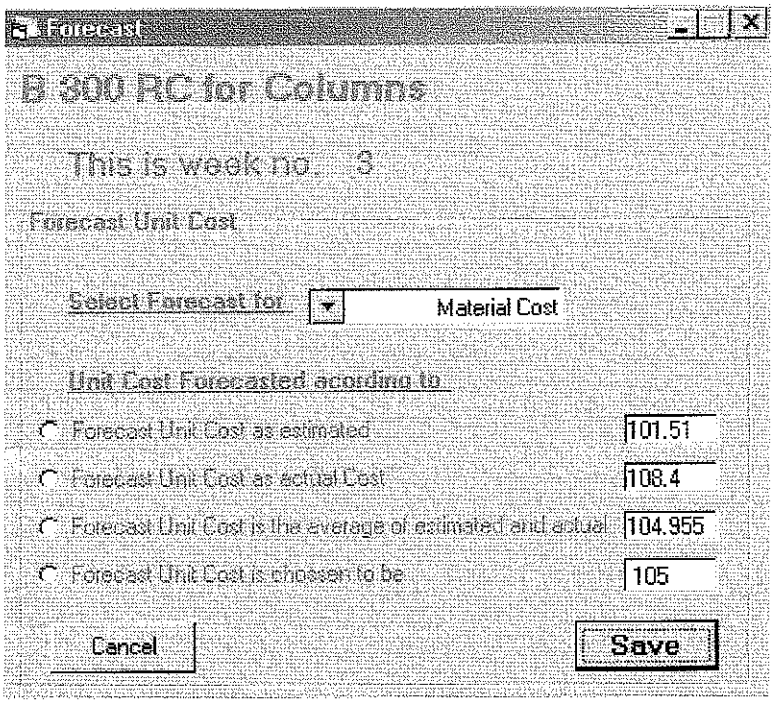

Figure 5.12 Forecast Unit Cost Screen

The user should select the appropriate method for calculating the forecasted unit cost for the remaining quantities for every cost component. In the forecast screen, the forecasted unit cost is automatically calculated and shown in the cell adjacent to its method for the first three methods. For the fourth method, the user should fill the figure he finds appropriate for the remaining quantities.

5.14 Cost at Completion Report

The purpose of the cost at completion report is to illustrate the forecasted trend of the project cost. In this report, the first four columns show basic information about an item such as: item code, item description, unit, and bill quantity. The following two columns show the estimated unit cost and the estimated cost for bill quantity. The subsequent two columns show the up-to-date executed quantity and the remaining quantity up-to-date. The following two columns show the up-to-date actual unit cost, and the forecasted unit cost for the remaining quantity. The subsequent three columns show the actual cost, the forecasted cost (cost to complete), and the cost at completion for each item when it is completed according to the new situation. The final two columns show the variance between the estimated cost and the cost at completion expressed as an absolute value and as percentage.

It should be noted that the bill quantity in this report is the quantity in the bill if the item is still on going. When this item is finished, the bill quantity will be the final executed quantity and all calculations are done according to this quantity. A sample report for cost at completion report is shown in Annex 7.

5.15 Indirect Costs

Controlling indirect costs is critical for all contracting companies. Increased competition and slim profit margins have forced contractors to look seriously at overhead cost management. In some projects, indirect costs constitute a considerable percentage of the project cost. Because the indirect costs vary according to project requirements, a special form is created to control indirect costs.

In this software, the user should click on the "***Add indirect cost***" command under "***File***" menu, then the screen related to indirect costs opens. In this screen, the user should fill each of the indirect cost requirements in addition to its unit of measurement. In the same screen, the user should fill the estimated number of the indirect cost elements and its estimated unit cost. For practical considerations, controlling indirect costs is done at the end of each month. In the indirect cost screen, the user should fill the actual number of indirect cost elements actually used and its actual unit cost at the end of each month. A sample for indirect cost input data screen is shown in Figure 5.13.

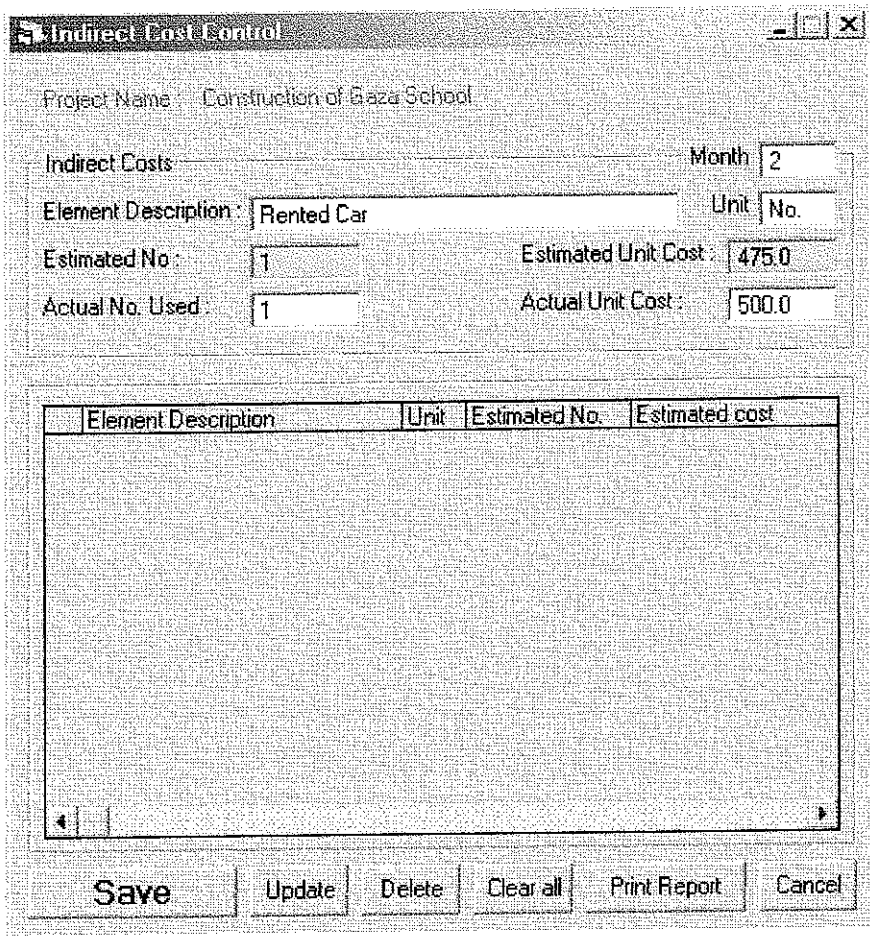

Figure 5.13 Indirect Cost Screen

It should be noted that the common practice of local contractors is to estimate overhead cost as a percentage of the project cost. This estimate is done according to previous project records taking into account the value of each project. In this case, the monitoring and control of the overhead cost will be done once at the end of the project.

5.16 Indirect Costs Report

In this report, the first three columns show the serial number, the list of indirect cost elements and the unit of measurement for each element. The following two columns show the estimated required numbers and the estimated unit cost for each unit of the indirect cost elements. The subsequent two columns show the actual used number and its actual unit cost. The final two columns represent the cost variance in the indirect cost elements as a percentage in one column, and as an absolute value in the second one. At the end of each month, the total value of indirect cost variances is shown. A sample of the indirect cost report is shown in Annex 7.

Once **CCS** has produced all these cost reports, they become wealth information for the estimator to estimate the costs for future projects with similar items. These data are the final data if the project is finished, or it is the up-to-date unit cost if the project is not completed.

5.17 Software Evaluation

In order to test the applicability of the Cost Control Software (**CCS**) to local contracting practice, it is tested by the researcher using a sample project. The sample project is described in Annex 7 showing all input data and output produced reports. Also, the software should be applied to real projects and evaluated by practicing contractors. The objectives of the evaluation process are:

- To determine how far the software satisfies the contractors requirements.
- To identify the applicability of the tools and techniques offered by the software.
- To clarify the advantages of the software.
- To identify the difficulties that face the contractors when they use **CCS**.
- To recognize the contractors' criticism and comments on the software.

The evaluation process involves the development of a questionnaire to evaluate **CCS**. The evaluation process is conducted after software development and the results are analyzed to determine the acceptability of the software. The questionnaire is filled by three contracting companies and two professional experts. They are requested to fill the questionnaire after explaining the software method of use and feeding some data of a sample project. They are given one week for program training to get familiar with.

The questionnaire consists of five questions. The first question asks about the software suitability in terms of data entry, the tools and techniques, and the produced reports. In this question, the respondents have to give their opinion about these indicators. The second question asks about the main advantages which the software offers. In the third question, the respondents have to state the difficulties which face them when they use the software. The fourth question asks the respondents to provide suggestions to make the software more beneficial. The final question is left for the respondents to add any comments on the software. The Arabic and English versions of the questionnaire are shown in Annex 5 and Annex 6 respectively.

5.18 Evaluation Questionnaire Results

The results of the first question is shown in Table 5.6. From these results, it is found that there is general satisfaction (Agreement Index = 78.1 %) of the surveyed sample when they are asked about the applicability of the cost control software tools, techniques and indicators. The results of the first question are clustered in groups. The following is an illustration for these groups:

Data entry: From the survey results, it is found that there is a relatively strong agreement among the surveyed sample about the suitability of the method of entering project data (90 %) and entering project items data (80 %). When they are asked about entering the indirect cost data, the satisfaction has reduced to 65 %.

Input Data Collection: The survey results reveal that most of the surveyed sample strongly agrees that the input data related to material costs are easily collected (85 %). However, the satisfaction is reduced when they are asked about the easiness of collecting the input data related to labor costs (65 %) and equipment costs (70 %).

Reports: Survey results show that most of the surveyed sample agree or strongly agree (80 % – 90 %) that all the direct cost reports illustrate the cost information in a good format. These reports are related to material, labor, equipment, and subcontract reports. On the other hand, the satisfaction is reduced to 70 % and 75 % for the reports related to indirect costs and cost at completion reports respectively. Also, it is found that all of the surveyed sample either strongly agree or agree that the classification and sorting of cost reports are appropriate.

Software: Most of the surveyed sample (75 %) agree that the software is appropriate for relatively large projects and it is relatively easy and does not need a long time to be familiar with.

Finally, Most of the surveyed sample (75 %) agree that the methods for predicting remaining quantities to calculate the forecasted costs to complete are appropriate and could be applied.

Table 5.6 The results of the evaluation questionnaire

No.	Techniques and Data Entry		Strongly Agree	Agree	Moderate Agree	Slightly Agree	Disagree	% of Average *
1	The method of entering project data is appropriate.	No.	**3**	**2**	**0**	**0**	**0**	**90**
		%	60.0	40.0	0.0	0.0	0.0	
2	The method of entering project items data is appropriate.	No.	**2**	**2**	**1**	**0**	**0**	**80**
		%	40.0	40.0	20.0	0.0	0.0	
3	The method of entering indirect cost data is appropriate.	No.	**0**	**3**	**2**	**0**	**0**	**65**
		%	0.0	60.0	40.0	0.0	0.0	
4	The actual material input data (Quantity + Price) is easily obtained.	No.	**2**	**3**	**0**	**0**	**0**	**85**
		%	40.0	60.0	0.0	0.0	0.0	
5	The actual labor input data (Productivity + Wage) is easily obtained.	No.	**0**	**3**	**2**	**0**	**0**	**65**
		%	0.0	60.0	40.0	0.0	0.0	
6	Actual equipment input data (Productivity + Rental rate) is easily obtained.	No.	**0**	**4**	**1**	**0**	**0**	**70**
		%	0.0	80.0	20.0	0.0	0.0	
7	Material cost control report illustrates the cost information in a good style.	No.	**2**	**3**	**0**	**0**	**0**	**85**
		%	40.0	60.0	0.0	0.0	0.0	
8	The labor cost control report illustrates the cost information in a good style.	No.	**3**	**2**	**0**	**0**	**0**	**90**
		%	60.0	40.0	0.0	0.0	0.0	
9	Equipment cost control report illustrates the cost information in a good style.	No.	**2**	**2**	**1**	**0**	**0**	**80**
		%	40.0	40.0	20.0	0.0	0.0	
10	Subcontract cost control report illustrates the cost information in a good style.	No.	**2**	**3**	**0**	**0**	**0**	**85**
		%	40.0	60.0	0.0	0.0	0.0	
11	The indirect cost control report illustrates the cost information in a good style.	No.	**1**	**2**	**2**	**0**	**0**	**70**
		%	20.0	40.0	40.0	0.0	0.0	
12	The cost-to-complete report illustrates the cost information in a good style.	No.	**1**	**3**	**1**	**0**	**0**	**75**
		%	20.0	60.0	20.0	0.0	0.0	
13	The classification and sorting of the weekly cost reports are appropriate.	No.	**2**	**3**	**0**	**0**	**0**	**85**
		%	40.0	60.0	00.0	0.0	0.0	
14	The software is easy and does not need a large time to be familiar with it.	No.	**1**	**3**	**1**	**0**	**0**	**75**
		%	20.	60.0	20.0	0.0	0.0	
15	The software is applicable in the relatively large project in Gaza Strip.	No.	**1**	**3**	**1**	**0**	**0**	**75**
		%	20.0	60.0	20.0	0.0	0.0	
16	Methods of predicting cost to complete for remaining quantities are appropriate.	No.	**1**	**3**	**1**	**0**	**0**	**75**
		%	20.0	60.0	20.0	0.0	0.0	
	General Agreement Index							**78.1**

* Average percentage is computed according to these weight factors

Strongly Agree = 4, Agree = 3, Moderate Agree = 2, Slightly Agree = 1, Disagree = 0

5.19 Software Advantages

In the second question, the surveyed sample is asked to state the main advantages of the software. From the results of this questionnaire, the main mentioned advantages are:

- **CCS** pinpoints to the items which lead to project cost overrun.
- **CCS** helps in measuring the quantities needed to be supplied to site. Also, it helps in determining the loss or damage in materials.
- **CCS** helps in controlling the productivity of labor and equipment. This will encourage local companies to use the productivity rates as a control tool for project costs.
- In general, **CCS** is easy to use and capable of updating information.
- **CCS** encourages contracting companies to go in more details in estimating BOQ items.
- **CCS** gives detailed reports for each of the cost components (material, labor, equipment, and subcontract).

5.20 Software shortcomings

In the third question, the surveyed sample is asked to state the main difficulties they face when they use the software. The main shortcomings are:

- **CCS** is demanding. It needs a coding system, detailed cost estimate and a staff for monitoring materials, labor, and equipment.
- Local contractors have difficulties in the availability of productivity rates for labor crews and equipment.
- Indirect cost requirements should be listed in the screen to readily choose the needed requirement.

It seems that the main difficulties which face local contractors in using **CCS** is the unavailability of some basic requirements for any contracting company. The detailed cost estimate is the responsibility of each contracting company to prepare. Other requirements such as coding system and productivity rates are not widely used locally. Until preparing a national coding system and a local productivity rate manual, local contracting companies should do it to cope with international trend.

Of course, applying a cost control system will have its own cost burden on the project budget. The more sophisticated the system is, the more useful it will be in controlling the project cost but also the more expensive it will be. On the other hand, there is no doubt of the importance of introducing the cost control aspect to management of construction projects. So, the researcher advises the users to allocate the necessary resources in running the cost control system which will result in a saving to the total cost. For contracting companies with small turnover, they should begin slightly with using cost control in managing their projects.

It is expected that operating **CCS** will need at most one foremen to collect the required data to feed the software. For large projects, the cost of operating this software will be covered by the money saved when operating the cost control software. In small projects, **CCS** can be operated by the project general foremen who can do this job besides his other duties.

In general, a research may be required to compare the cost of operating **CCS** with the money that is expected to save in order to determine the effectiveness of **CCS.**

5.21 Respondents Suggestions

In the fourth question, the respondents are asked to give their suggestions to improve the software. Most of the respondents state that this software is a good start point for local contractors to begin controlling their project costs effectively. However, the following suggestions are expressed to improve **CCS**:

- To make a provision to consider estimating and control of indirect cost using a percentage of direct cost to have it compatible with the common practice.
- To provide the software with a pool of general items and item codes to be a basis for selecting project items.
- To add a help or method of use in the software.
- To make a provision to control equipment cost owned by the contractor.
- To include a facility to control some project items in a duration less than one week to accommodate the short duration of these items
- All output reports should be weekly separated (i.e. each week should be in a separate page).

The above suggestions have valuable ideas. Some of them are taken into account by the researcher in the modification process. Others are left for further researches.

Chapter 6

Conclusions and Recommendations

6.1 Introduction

The research aim is to explore the practice of local contractors in construction cost control and to develop a tool to enhance this practice. **CCS** is the fruit of this research. This chapter includes the conclusions of this research and practical recommendations addressed to different parties involved in the construction sector. Also, it introduces recommendations for proposed further studies.

6.2 Conclusions

- Most of the surveyed contractors are aware of the concept and the necessity of cost control in managing their projects. They realize its necessity and they have the desire to implement it. The main obstacle for not doing this is the non-existence of suitable cost control software that considers the local practice.

- Although local contracting companies do not use a comprehensive system for cost control, they use some of the fragmented cost control tools and techniques. The most notable of these tools and techniques are:

  - Comparing delivered material to site with material invoice.
  - Monthly recording of actual executed quantities.
  - Keeping cost information of previous projects as feedback for future estimate.
  - Taking immediate corrective action to adjust the increase in material cost.
  - Investigating the causes which lead to cost overrun.
  - Comparing delivered materials to site with quantities approved in monthly payments.

The above tools and techniques are usually implemented using manual forms. Computerized forms are seldom used.

- Survey results reveal that some important tools and techniques for cost control are rarely used by local contractors. These tools and techniques are:
  - Recording of actual daily and weekly executed quantities.
  - Predicting the cost at completion for different items.
  - Comparing the actual used quantities with the quantities in the cost estimate.
  - Comparing the actual labor productivity rates with the estimated rates.
  - Comparing the actual wages of labor with the wages in the cost estimate.

- The most two factors which the contractors consider important to the success of any cost control system are "having the logical and balanced cost estimate" and "the availability of qualified technical staff that could handle cost monitoring and control processes". Furthermore, The most important benefits gained by applying a cost control system are:
  - Pinpointing the items that have cost overrun.
  - Accurate determining the causes which lead to cost overrun.
  - Providing accurate information as feedback for future estimates.

- There is no significant difference in ranking the most ten necessary cost control tools and techniques between First Class contractors and Second Class contractors. Also, there is no significant difference among the different classes of contractors in implementing the most widely used cost control tools and techniques. In addition, it is concluded that there is no significant difference between the first class contractors and second class contractors in ranking the obstacles in implementing cost control systems.

- The evaluation process indicates that there is general satisfaction of the applicability of the cost control software regarding data entry, input data collection, output reports, easiness of use and its suitability to local use. Also, **CCS** encourages contracting companies to estimate BOQ items in details and it has the capabilities to pinpoints to the items which lead to cost overrun. However, applying **CCS** needs some requirements such as coding system, detailed cost estimate, estimated productivity rates for labor and equipment which may not be available to local contracting companies.

6.3 General Recommendations

To Local Contracting Companies

- The top management of contracting companies should show more commitments to apply cost control systems to manage their projects. They should allocate more resources for this process because this will benefit the company.

- Contracting companies of various classes should provide training programs about cost control for their technical staff to explain the concept of cost control and its benefits.

- All contracting companies should use information technology in managing their projects. They are encouraged to keep historical data of the finished projects, the up-dated price of the construction materials, quotations of subcontractors, renting rate of different equipment and any other requirements.

To Public Owners

- In order to raise the level of local contracting companies, public owners should request the cost control system to be one of contract requirements for projects pre-qualification.

- As the main prerequisite for any cost control system is the detailed estimate, public owners should request from contracting companies to submit a detailed cost estimate for all bill of quantities items with the tender documents.

- Public owners should hold training courses for their employees to explain the concept of cost control.

To Contractors Union, Universities, and Association of Engineers:

- Training courses and seminars should advise top management of contracting companies that applying cost control will lead to minimize cost and maximize profit, or at least cover the operation of this system.

- It is important to conduct seminars for contracting companies in Gaza Strip to explain the cost control process in detail and to explain the expected benefits. This can be followed by holding training sessions for the staff of the contracting companies.

6.4 Recommendations for further studies

- As the cost control system is mainly dependent on cost coding system and this cost coding system is not used locally, it is recommended to develop an integrated cost coding system for the most used items.

- The use of cost control system is dependent on some estimated values which local contracting companies do not have experience with. Some of these values are: the estimated daily productivity for equipment, the estimated daily crew productivity for different jobs and crew compositions. It is recommended to conduct researches to prepare manuals for these values on professional basis.

- It is recommended to conduct researches to find out the estimated percentage of waste for different materials.

- **CCS** deals with equipment assuming it is rented even when it is actually owned by the company. It is recommended to develop equipment cost control system that controls the owing and operating costs.

- It is recommended to conduct researches to integrate **CCS** with other estimating and scheduling software packages.

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List of Annexes

Annex 1

List of the Surveyed Contracting Companies

Serial No.	Company Name	Main Address	Company Classification by Field		
			Building	Roads	Sewage & Water
1	Mushtaha and Hasouna Contracting Co.	Gaza	First (A)	First (A)	First
2	Darwish Abu Moeleq Contracting Co.	Gaza	First (B)	Second	Second
3	Babel Contracting Co.	Gaza	First (B)	First (B)	First
4	Al – Manar Contracting Co.	Gaza	First (B)	Second	Second
5	Al – Zaition Contracting Co.	Gaza	Second	Second	Fourth
6	The Arab Contractors Co. - Gaza	Gaza	First (A)	First (A)	First
7	Usama Kuhail & brothers Contracting Co.	Gaza	First (A)	--	--
8	Salama Contracting Co.	Kh/Younis	First (A)	Third	Third
9	Al – Faraa brothers Contracting Co.	Kh/Younis	First (A)	Second	--
10	Rehan for Trade and Contracting Co.	Jabalia	First (B)	Second	Third
11	Shuhab for Trade and Contracting Co.	Gaza	First (B)	Third	Third
12	Imad Al Ashqar and Partners Contracting Co.	Gaza	First (A)	Third	Fourth
13	Abu Ziyada For Trade & Contracting Co.	Gaza	First (A)	Second	Second
14	Abu Shahlaa For Trade & Contracting Co.	Gaza	Second	--	--
15	Al Bunian International Group.	Gaza	First (A)	Third	Third
16	A/Hakim Isma'il Contracting Co.	Gaza	First (A)	Third	Second
17	Al – Montar Contracting Co.	Gaza	Second	First (B)	First
18	The Golden Company for Trade & Contracting	Gaza	Second	--	Second
19	Abu Shammala and Abu Dan Contracting Co.	Gaza	First (A)	Second	Second
20	Saqa and Khodari Contracting Co.	Gaza	First (A)	First (A)	First
21	Dawas Company for Trade and Contracting	D/Balah	Second	Second	First
22	Al – Shawa for Trade and Contracting	Gaza	First (B)	Third	First
23	First for Trade and Contracting.	Gaza	Second	Second	Second

Serial No.	Company Name	Main Address	Company Classification by Field		
			Building	Roads	Sewage & Water
24	Khatib and Anber Contracting Co.	Gaza	Second	Third	--
25	Al – Rabeta Contracting Co.	Kh/Younis	Second	Second	Third
26	Meda for Trade and Contracting Co.	Gaza	First (A)	Second	Fifth
27	Al – Mo'asera for Trade and Contracting Co.	Gaza	First (B)	Second	First
28	Al – Khisi Contracting Co.	Gaza	Second	--	First
29	A/Rahman Filfil Sons Contracting Co.	Jabalia	Second	Fifth	--
30	Al – Rafea' for Trade and Contracting Co.	Gaza	First (B)	--	--
31	Al – Yarmouk For Trade and Contracting Co.	Maghazi	Second	Fifth	--
32	The Golden Sands Contracting Co.	Gaza	First (A)	Third	Second
33	Ithamer Contracting Co.	Gaza	First (B)	Fifth	--
34	Al – Reda Contracting Co.	Gaza	Second	--	--
35	Avel for Trade and Contracting Co.	Gaza	Second	--	Fourth
36	Al – Fajr Al Jadid Contracting Co.	Gaza	Second	Third	--
37	Mea'mar Contracting Co.	Gaza	Second	Fourth	Fifth
38	Al – Hajar for Trade and Contracting Co.	Gaza	Second	Fifth	--
39	Abu Daia and Salman Contracting Co.	Jabalia	Third	Second	Second
40	Sera for Trade and Contracting Co.	Jabalia	First (B)	Third	Second
41	Sar for Trade and Contracting Co.	Gaza	First (A)	Second	First
42	Asas for Trade and Contracting Co.	Gaza	Second	Fifth	--
43	Atlas Contracting Co.	Gaza	Second	--	Fifth
44	Al – Mahed for Trade and Contracting Co.	Gaza	Second	--	--
45	Al – Esi for Trade and Contracting Co.	Gaza	No Response		
46	Hijazi Contracting Co.	Rafah	No Response		
47	Aiad for Trade and Contracting Co.	Gaza	No Response		
48	Al – Ghad El – Jaded Contracting Co.	Gaza	No Response		
49	Al – Absi for Contracting and General Trade Co.	Rafah	No Response		
50	Al – I'tidal for Trade and Contracting Co.	B/Hanoun	No Response		

Annex 2

الجامعة الإسلامية – غزة

قسم الهندسة المدنية

استبيان

لرصد واقع ضبط التكلفة (Cost Control) لمشاريع التشييد لدى مقاولي قطاع غزة

جزء من البحث التكميلي لنيل درجة الماجستير في إدارة المشاريع

الباحث / م. هاشم عرفه سكيك

المشرف / د. كمالين شعث

مارس 2003

استبيان

الأخ المشارك: _____

- نتقدم لكم بجزيل الشكر والعرفان لمساهمتكم بالوقت والمجهود في تعبئة هذا الاستبيان وتزويدنا بالمعلومات المطلوبة لمعرفة الواقع المحلي لشركات المقاولات في الأساليب التي تتبعها لضبط التكلفة للمشاريع (Project Cost Control)، ومعرفة احتياجات الشركات المحلية لعمل برنامج حاسوب يلائم صناعة التشييد المحلية في مجال ضبط التكلفة.

- هذا الاستبيان جزء من البحث لرسالة الماجستير في إدارة المشروعات الهندسية.

- جميع المعلومات في هذا الاستبيان سوف تستخدم فقط لأغراض البحث العلمي من أجل تطوير العمل في صناعة التشييد في قطاع غزة، مع الحفاظ على سرية المعلومات للشركة.

- بعد الانتهاء من الدراسة التحليلية سوف يتم اطلاع جميع المهتمين المشاركين في هذا الاستبيان على النتائج المستخلصة من هذا البحث ان شاء الله.

الباحث

م.هاشم سكيك

مارس ٢٠٠٣

استبيان

الجزء الأول: السيرة الذاتية للشركة

١. سنة التأسيس _____

٢. مجالات عمل الشركة :

أعمال مباني	☐	رئيسي	☐	فرعي	☐ لا يوجد
أعمال طرق	☐	رئيسي	☐	فرعي	☐ لا يوجد
أعمال مياه وصرف صحي	☐	رئيسي	☐	فرعي	☐ لا يوجد

٣. درجة التصنيف للشركة حسب تصنيف اتحاد المقاولين:

أعمال مباني	☐	درجة أولى أ	☐	درجة أولى ب	☐	درجة ثانية	☐ درجة ثالثة
أعمال طرق	☐	درجة أولى أ	☐	درجة أولى ب	☐	درجة ثانية	☐ درجة ثالثة
أعمال مياه وصرف صحي	☐	درجة أولى أ	☐	درجة أولى ب	☐	درجة ثانية	☐ درجة ثالثة

٤. متوسط عدد الموظفين في الشركة خلال الخمس سنوات الأخيرة _____

٥. متوسط عدد العمال والفنيين الدائمين في الشركة خلال الخمس سنوات الأخيرة _____

٦. إجمالي عدد المشاريع المنفذة خلال الخمس سنوات الأخيرة.

☐ ١ فأقل ☐ (١١-٢٠) ☐ (٢١-٣٠) ☐ أكثر من ٣٠

٧. إجمالي قيمة المشاريع المنفذة خلال الخمس سنوات الأخيرة (بالمليون دولار).

☐ ٣ فأقل ☐ (٣,١-٦) ☐ (٦,١-١٠) ☐ أكثر من ١٠

٨. الوظيفة الإدارية لمن يقوم بتعبئة الاستبيان

☐ مدير الشركة ☐ مدير المشاريع ☐ مدير المشروع ☐ أخرى. حدد _____

٩. أثناء دراسة شركتكم للعطاء بغرض تسعيره، فان تقدير التكلفة (Cost Estimate) يتم بناء على:

مسلسل	طريقة التسعير	غالبا	أحيانا	نادرا
أ	تسعير بشكل دقيق لمعظم بنود جدول الكميات (مواد، عماله، معدات، مقاول باطن، مصاريف إدارية).			
ب	تسعير بشكل دقيق فقط للبنود المهمة وذات القيم الكبيرة من بنود جدول الكميات (مواد، عماله، معدات، مقاول باطن، مصاريف إدارية).			
ج	أسعار البنود المشابهة في مشاريع سابقة.			
د	تسعير البنود بحسب الخبرة و الوضع الحالي للسوق بدون تحليل تفصيلي.			

١٠. عند رسو العطاء على شركتكم:

مسلسل	التكلفة القياسية (Cost Baseline)	غالبا	أحيانا	نادرا
أ	يتم استخدام تقدير التكلفة المعد أثناء التسعير كأساس للمقارنة بتكلفة البنود أثناء التنفيذ.			
ب	يتم عمل تحليل سعر جديد وذلك لمعظم بنود جدول الكميات لاستخدامه كأساس للمقارنة للتكلفة أثناء التنفيذ.			
ج	يتم إعادة تسعير البنود ذات القيم الكبيرة من أجل ضبط تكلفتها.			
د	لا يتم عمل ضبط التكلفة بالرغم من وجود تحليل سعر.			
هـ	لا يتم عمل ضبط التكلفة لعدم وجود تحليل سعر.			

١١. في المشاريع التي تقوم شركتكم بتنفيذها فإن ضبط التكلفة (احتساب فرق المبالغ المكتسبة عن المبالغ المصروفة) يتم في الفترات الزمنية التالية:

مسلسل	توقيت ضبط التكلفة	غالبا	أحيانا	نادرا
أ	نهاية تنفيذ المشروع			
ب	نهاية السنة المالية (الميزانية) وذلك لكل المشاريع تحت التنفيذ في تلك الفترة.			
ج	نهاية السنة المالية (الميزانية) وذلك لكل مشروع على حده.			
د	عند صرف الدفعات الشهرية لكل مشروع.			
هـ	نهاية كل شهر لكل مشروع.			
و	كل أسبوعين.			

١٢. فيما يلي بيان لبعض طرق ضبط التكلفة، يرجى إبداء الرأي في درجة ضرورة استخدام هذه الطـــرق، ومـــدى استخدامها فعلا من قبلكم، وكذلك طريقة الاستخدام:

(يرجى وضع علامة (X) مقابل الخيار المناسب لكل من درجة الضرورة ومدى الاستخدام وكذلك طريقة الاستخدام).

مسلسل	طرق ضبط تكلفة المشاريع	درجة الضرورة			مدى الاستخدام			طريقة الاستخدام			
		ضروري	ضروري نوعا ما	غير ضروري	غالبا	أحيانا	نادرا	بدون تسجيل(ذهنيا)	تسجيل بدون استخدام نموذج	تسجيل باستخدام نموذج	تسجيل باستخدام نموذج محوسب
أ	القيام بضبط التكلفة في نهاية المشـــروع وذلـك بمقارنـة المقبوضات بالمصروفات لكامل المشروع.										
ب	القيام بضبط التكلفة وذلك بمقارنة الدفعات الشهرية للمشروع بالمصروفات والالتزامات المالية لنفس الفترة.										
ج	القيام بضبط التكلفة وذلك بمقارنة المبلغ المصروف علـــى البند الواحد أو مجموعة من البنود بالمبلغ المكتسب من نفس البند أو نفس المجموعة من البنود.										
د	القيام بضبط التكلفة على أساس الوحدة للبند ومقارنة التكلفة الفعلية بالتكلفة المقدرة.										

١٣. يرجى إبداء الرأي في مدى تأثير المعوقات التالية في استخدام نظام ضبط التكلفة للمشاريع في شركتكم (يرجى وضع علامة (X) مقابل الخيار المناسب).

مسلسل	معوقات الاستخدام	كبير جدا	كبير	متوسط	ضعيف	ضعيف جدا
أ	عدم إدراك أهمية نظام ضبط التكلفة.					
ب	عدم وجود قناعة في تطبيق نظام ضبط التكلفة.					
ج	عدم وجود رغبة في تطبيق نظام ضبط التكلفة.					
د	الاعتقاد بأن تطبيق نظام ضبط التكلفة يحمل الشركة تكاليف إدارية تفوق ما يمكن توفيره.					
هـ	اعتقاد الشركة المسبق بأن زيادة التكلفة هي نتيجة الظروف المحيطة بنـــا وبالتالي ليس هناك جدوى من تطبيق نظام ضبط التكلفة.					
و	عدم وجود الطاقم الفني في الشركة الملائم لمراقبة التكاليف وتحليلها.					
ز	معظم المشاريع التي قمنا بتنفيذها لم يحدث بها زيادة في التكلفة وبالتـــالي ليس هناك حاجة لتطبيق نظام ضبط التكلفة.					
ح	مقاومة فكرة التطبيق من قبل مهندسي الموقع أو مدير المشروع					
ط	عدم توفر برامج محلية مختصة بضبط التكلفة.					

١٤. يرجى إبداء الرأي في درجة الضرورة ومدى الاستخدام الفعلي وطريقة الاستخدام لـــلأدوات والتقنيـــات الخـــاصة بنظام ضبط التكلفة لمشـــاريع البناء والتشييد من قبل الشركة وذلك بوضع علامة (X) مقـــابل الخيار المناسب لكل مجموعة.

التصنيف	مسلسل	الأدوات والتقنيات	درجة الضرورة			مدى الاستخدام			طريقة الاستخدام			
			ضروري	ضروري نوعا ما	غير ضروري	غالبا	أحيانا	نادرا	دون تسجيل (ذهنيا)	تسجيل بدون استخدام نموذج	تسجيل باستخدام نموذج	تسجيل باستخدام نموذج محوسب
أ (علم)	١	حصر الكميات الفعلية المنفذة نهاية كل يوم.										
	٢	حصر الكميات الفعلية المنفذة نهاية كل أسبوع.										
	٣	حصر الكميات الفعلية المنفذة نهاية كل شـــهر.										
	٤	يتم التعبير عن اختلاف التكلفة الفعلية للبنود عن تكلفتـــها المقـــدرة بصورة مطلقة (كمبلغ نقدي).										
	٥	يتم التعبير عن اختلاف التكلفة الفعلية للبنود عن تكلفتـــها المقـــدرة بنسبة مئوية منسوبة للتكلفة المقدرة.										
	٦	قيام مدير المشروع بمتابعة تطبيق خطوات الشركة التصحيحية.										
	٧	حفظ الشركة للمعلومات الخاصة بالتكلفة التفصيلية للمشاريع السابقة للاستفادة منها لتقدير التكلفة لمشاريع مستقبلية مشابهة.										
	٨	حصر الأعمال المتبقية من المشروع وتقدير تكلفة المشروع عنـــد الانتهاء بحسب المعلومات المستجدة أثناء التنفيذ.										
ب (المواد)	١	رصد كمية المواد الموردة للموقع ومقارنتها بإرسالية المواد.										
	٢	القيام بفحص نوعية المواد الموردة للموقع للتـــأكد مـــن مطابقتـــها للمواصفات الفنية.										
	٣	مقارنة كميات المواد الموردة للموقع بالكميات التي يتم حصرها فـــي المستخلصات الشهرية.										
	٤	مقارنة الكميات المستخدمة فعليا بالكميات المقـــدرة فـــي التســـعير (Cost Estimate).										
ج (العمالة)	١	مقارنة التكلفة الفعلية للعمالة بالتكلفة المقدرة لها في التسعير.										
	٢	مقارنة معدل إنتاج العمال في بعض البنود بالمشـــروع بمعـــدلات الإنتاج المقدرة في التسعير.										
	٣	مقارنة اختلاف أجور العمال الفعلية عن ما هو مقدر في التسعير.										
د (المعدات)	١	مقارنة تكلفة تشغيل المعدات المملوكة للشركة مع تكلفـــة اســـتئجار مثيلاتها.										
	٢	مقارنة تكلفة تشغيل المعدات الفعلية بالتكلفة المقدرة في التسعير.										

١٥. يرجى إبداء الرأي في درجة الضرورة ومدى الاستخدام الفعلي للإجراءات الخاصة بنظام ضبط التكلفة لمشاريع البناء والتشييد من قبل الشركة وذلك بوضع علامة (X) مقابل الخيار المناسب لكل مجموعة..

التصنيف	مسلسل	الإجراءات	درجة الضرورة			مدى الاستخدام		
			ضروري	ضروري نوعا ما	غير ضروري	غالبا	أحيانا	نادرا
أ (علم)	١	إشعار مدير المشروع للإدارة العليا للشركة عند وجود زيادة ملحوظة في تكلفة بعض البنود عن التكلفة المقدرة.						
	٢	قيام الشركة بالبحث والتحليل للوصول للأسباب التي أدت للزيادة الملحوظة في التكلفة الفعلية عن التكلفة المقدرة.						
	٣	اتخاذ الخطوات التصحيحية الفورية لمعالجة الزيادة الملحوظة للتكلفة الفعلية عن التكلفة المقدرة في البنود التي زادت تكلفتها.						
	٤	تركيز اهتمام الشركة بضبط التكلفة للبنود بحسب قيمتها المالية.						
	٥	محاولة تقليل مدة تنفيذ المشروع لتوفير المصاريف الإدارية (Site Overhead).						
	٦	القيام بضبط التكلفة باستخدام المنحنى S (S-Curve) للمقبوضات والمصروفات						
ب (المواد)	١	وجود نظام لإدارة المخازن في الشركة للمشاريع المختلفة.						
	٢	القيام بفحص السبب في زيادة تكلفة المواد لبعض البنود عن التكلفة المقدرة.						
	٣	القيام بخطوات لمعالجة زيادة التكلفة الفعلية للمواد في الحالات التي تسمح بذلك.						
	٤	تغيير المورد عند زيادة سعر المواد الموردة في الحالات التي تسمح						
ج (العمالة)	١	اتخاذ الخطوات لتعديل زيادة تكلفة بند العمال في الحالات التي تسمح بذلك.						
	٢	الاتفاق مع العمال بالعمل بنظام المقاولة (إنجاز كمية معينه خلال مدة محددة أو مقابل مبلغ مالي).						
د (المعدات)	١	محاولة تجميع البنود التي تحتاج لنفس المعدة من اجل تنفيذها في نفس الوقت من أجل تخفيض التكلفة.						
هـ (مقاولو الباطن)	١	إحالة أجزاء من المشروع على مقاولي باطن من أجل ضبط تكلفة تلك الأجزاء من المشروع.						
	٢	إحالة أجزاء من المشروع على مقاولي باطن من أجل التفرغ لضبط تكلفة باقي أجزاء المشروع.						

١٦ يرجى تحديد درجة أهمية العوامل التالية في نجاح وفعالية تطبيق نظام ضبط التكلفة وذلك بوضع علامة (X) مقابل الخيار المناسب.

مسلسل	عوامل نجاح تطبيق نظام ضبط التكلفة	كبير جدا	كبير	متوسط	قليل	قليل جدا
أ	التسعير الواقعي المتوازن للعطاءات.					
ب	وجود الطاقم الفني المؤهل لرصد التكاليف وتحديد توزيعها على البنود.					
ج	سرعة اتخاذ القرارات اللازمة لتصحيح مسار التكلفة في المشروع.					
د	سرعة تطبيق الخطوات التصحيحية لضبط التكلفة.					
هـ	المتابعة الدقيقة لتطبيق الخطوات التصحيحية لضبط التكلفة.					
و	التزام الإدارة العليا للشركة بموضوع ضبط التكلفة من خلال توفير الفرص للعاملين في الشركة لحضور دورات تدريبية تتعلق بضبط التكلفة.					
ز	تطبيق نظام الحوافز المادية والمعنوية للعاملين في الشركة في حالة تنفيذ المشروع في حدود التكلفة المقررة.					

١٧ قيم الفوائد المرجوة من تطبيق نظام ضبط التكلفة وذلك بوضع علامة (X) مقابل الخيار المناسب.

مسلسل	الفائدة المرجوة	كبير جدا	كبير	متوسط	قليل	قليل جدا
أ	دقة تحديد البنود التي تتجاوز تكلفتها الفعلية بشكل ملحوظ القيمة المقدرة في التسعير (Cost Estimate).					
ب	دقة تحديد الأسباب التي أدت لزيادة أسعار البنود لإتخاذ اجراءات تصحيحية لضبط تكلفة المشروع.					
ج	إعطاء تقدير موضوعي للتكلفة النهائية للمشروع منذ بداية المشروع حتى نهايته.					
د	تحديد المسئولية بين العاملين في الشركة.					
هـ	زيادة كفاءة العاملين بالشركة					
و	زيادة قدرة الشركة التنافسية.					
ز	المساعدة في عملية تسعير الأوامر التغييرية.					
ح	المساعدة في تسعير منطقي وواقعي للمطالبات (Claims).					
ي	توفير المعلومات الدقيقة لتقدير التكلفة للمشاريع المستقبلية (Feedback).					

Annex 3

THE ISLAMIC UNIVERSITY – GAZA

Faculty of Engineering – Civil Engineering Department

Questionnaire

for

Investigating the Local Practice of
Contracting Companies in Project Cost Control

A Partial Fulfillment of the Requirements for Degree of Master of Science in Construction Management

Researcher: Hashem Arafa Skaik

Supervised by: Dr. Kamalain Sha'at

March 2003

Questionnaire

Dear Contractor: _____

- First, I would like to present my appreciation and thanks for your participating with time and effort to fill this questionnaire. This questionnaire will supply the researcher with the required information to investigate the local practice of contracting companies in the methods used in controlling their project costs.
  Also, this questionnaire will help the researcher to know the local contractors needs in order to develop a software which suits the local construction industry in cost control field.

- This questionnaire is part of partial requirement for degree of Master of Science in construction management.

- All information in the questionnaire will be used for scientific research only in order to develop the local construction industry, with keeping secrecy for the company's information.

- When finishing this research, the involved and participant companies will have a copy of the survey results.

Researcher
Eng. Hashem Skaik
March 2003

Questionnaire

Company Profile

1. Year of establishment _____.

2. Company Scope of Work.

Building Works.	☐	Main Field	☐	Secondary Field	☐	None
Road Works.	☐	Main Field	☐	Secondary Field	☐	None
Sewage and Water Works	☐	Main Field	☐	Secondary Field	☐	None

3. Classification according to contractors' union classification.

Building Works.	☐	First Class (A)	☐	First Class (B)	☐	Second Class	☐	Third Class
Road Works.	☐	First Class (A)	☐	First Class (B)	☐	Second Class	☐	Third Class
Sewage & Water Works	☐	First Class (A)	☐	First Class (B)	☐	Second Class	☐	Third Class

4. Average number of employees during the last five years _____.

5. Average number of permanent technical staff during the last five years _____.

6. Total number of executed projects during the last five years.

☐ 10 and Less ☐ (11-20) ☐ (21-30) ☐ More than 30

7. Total value of executed projects during the last five years (in million dollars).

☐ 3.0 and Less ☐ (3.1-6.0) ☐ (6.1-10.0) ☐ More than 10.0

8. Position of respondent.

☐ Director of Company ☐ Projects Manager

☐ Project Manager ☐ Others. Specify_____

9. During tender stage, cost is estimated according to:

No.	**Method of cost estimating**	Mostly	Occasionally	Rarely
A	Precise detailed estimate for most bills of quantity items (materials, labor, equipment, subcontract, and overheads).			
B	Precise detailed estimate for most significant items (materials, labor, equipment, subcontract, and overhead).			
C	Similar items in previous projects.			
D	Previous experience and current market situation without doing a detailed estimate.			

10. After contract award.

No	**Cost Baseline**	Mostly	Occasionally	Rarely
A	Cost estimate prepared during tendering is used as a baseline to compare estimated costs with actual costs.			
B	A new cost analysis is made for most BOQ items to be used as a baseline to compare estimated costs with actual ones.			
C	A new cost estimate is made only for big value items.			
D	No cost control is made in spite of the availability cost breakdown.			
E	No cost control is made because there is no cost breakdown.			

11. In the projects executed by your company, cost is controlled:

No	**Timing of Cost Control**	Mostly	Occasionally	Rarely
A	At the end of the project.			
B	At the end of the financial year for all projects under construction in this period.			
C	At the end of the financial year for every project.			
D	At receiving the interim payment certificate.			
E	At the end of each month.			
F	Biweekly.			

12. The following are some methods for cost control, please give your opinion about the necessity of using these methods, actual usage, and the method of usage:

Please tick (X) opposite the appropriate selection for necessity degree, usage range, and method of usage.

No	Cost Control Methods	Necessity Degree			Usage Range			Usage Method			
		N	NSW	NN	M	O	R	WR	RWU	RUF	RUC
A	Cost control is done at the end of the project by comparing the total payments with the total expenditures.										
B	Cost control is done by comparing monthly payments with expenditures and financial obligation for the same period.										
C	Cost control is done by comparing the expenses of each item or group of items with earned value of these items.										
D	Cost control is done in unit price basis for both estimated and actual costs.										

N	Necessary	NSW	Some what necessary			NN	Not Necessary
M	Mostly	O	Occasionally			R	Rarely
WR	Without Recording	RWUF	Recording without using forms	RUF	Recording using forms	RUCF	Recording using computerized forms

13. Please give your opinion about the effect of the following obstacles for not using a cost control system in your company.
Please tick (X) opposite to the appropriate selection.

No	Using Obstacles	Very High	High	Moderate	Low	Very Low
A	Non realization the importance of cost control system.					
B	Non existence of conviction in implementing cost control system.					
C	Non-desire in implementing cost control system .					
D	The belief that implementing cost control system costs more than what can be saved of implementing it.					
E	The preexisting belief that the increase in cost is mainly due to the surrounding situations, so there is little benefit of implementing cost control system.					
F	Non availability of the technical staff for cost monitoring and cost analysis.					
G	Most of previously executed projects have no increase in cost; so there is no need of applying cost control system.					
H	The resistance of implementation either from site engineers or from project managers.					
I	Non existence of local software specialized in cost control.					

14. Please give your opinion in the necessity of using, actual usage and the method of usage the tools and techniques specialized in the cost control system:

Please tick (X) opposite the appropriate selection.

Classification	No.	Tools and Techniques	Necessity Degree			Usage Range			Usage Method			
			N	NSW	NN	M	O	R	WR	RWUF	RUF	RUCF
A (General)	1	The daily record of actual executed quantities.										
	2	The weekly record of actual executed quantities.										
	3	The monthly record of actual executed quantities.										
	4	The variance between the actual costs and the estimated costs is expressed in absolute values.										
	5	The variance between the actual costs and the estimated costs is expressed as a percentage value.										
	6	The project manager follows up the corrective action steps.										
	7	Keeping the cost information of previous executed projects to be used as feedback for cost estimating of future projects.										
	8	Measuring of remaining quantities to estimate cost at completion according to the new information.										
B (Material)	1	Comparing delivered quantities to site with materials invoice.										
	2	Inspection of the quality of delivered materials to be sure that they are as specified.										
	3	Comparing the quantity of delivered materials to site with quantities certified in monthly payments.										
	4	Comparing actual quantity used with quantities estimated in the cost estimate.										
C (Labor)	1	Comparing actual costs for labor with estimated costs in the cost estimate.										
	2	Comparing the productivity rate for labor with the estimated rates in the cost estimate										
	3	Comparing the actual daily wage of labors with the estimated wages in the cost estimate										
D (Equipment)	1	Comparing the total (operating + owning) costs of owned equipment with the renting cost of similar equipment.										
	2	Comparing the actual costs of equipment with the estimated costs in the cost estimate.										

N	Necessary	NSW	Some what necessary			NN	Not Necessary
M	Mostly	O	Occasionally			R	Rarely
WR	Without Recording	RWUF	Recording without using forms	RUF	Recording using forms	RUCF	Recording using computerized forms

15. Please give your opinion in the necessity of using and the actual usage of the procedures specialized in the cost control system:

Please tick (X) adjacent the appropriate selection.

Classification	No.	Procedures	Necessity Degree			Usage Range		
			N	NSW	NN	M	O	R
A (General)	1	Notification of project engineer to top management in cases of significant increase in the actual costs of some items.						
	2	Investigate about the causes that lead to significant increase in the actual cost.						
	3	Taking immediate corrective action to control the significant increase in the cost of the items.						
	4	Cost control is concentrated on big value items.						
	5	Trying to reduce project duration to minimize site overhead.						
	6	Controlling costs using cash flow S - curve						
B (Material)	1	Existence of stock management system in the company to the different projects.						
	2	Investigate about the causes of the increase in material costs than the estimated costs.						
	3	Taking action to adjust the increase in material cost in cases that permit.						
	4	Changing the supplier when the material price increases in cases that permit.						
C (Labor)	1	Taking action to adjust the increase in labor cost in cases that permit.						
	2	Making agreements with labor to work a specified quantity in a predetermined time and cost.						
D (Eqe)	1	Trying to grouping the items which have the same equipment at the same time to reduce cost.						
C (Subcontract.)	1	Subcontracting parts of a project to control the costs of these parts.						
	2	Subcontracting parts of a project to concentrate on cost control other parts of the project.						

N	Necessary	NSW	Some what necessary	NN	Not Necessary
M	Mostly	O	Occasionally	R	Rarely

16. Please determine the necessity degree of the following factors in the success and efficiency of implementing cost control system.
Please tick (X) adjacent the appropriate selection

Item	Implementing success factors	Very High	High	Moderate	Low	Very Low
1	The logical and balanced cost estimate.					
2	The availability of qualified technical staff for cost monitoring and its allocation on different items.					
3	The early taking corrective actions to control project costs.					
4	The early implementation of corrective action to control project costs.					
5	The precise follow up for implementation of corrective action to control costs.					
6	Top management commitment in cost control through offering opportunities to attend training courses to technical staff.					
7	Implementing a system of incentives for employees in cases of executing the project within the established budget.					

17. Evaluate the expected benefit of implementing cost control system.
Please tick (X) adjacent the appropriate selection

Item	Expected Benefit	Very High	High	Moderate	Low	Very Low
1	Accurate determining the items which actual costs exceed apparently its estimated costs.					
2	Accurate determining the causes which lead the increase in items costs to take corrective action.					
3	Determining the responsibilities of company's employees.					
4	Increasing employees' competence.					
5	Increasing competitive capability of the firm.					
6	Helping in estimating variation orders.					
7	Helping in logical estimate of claims.					
8	Provide accurate information as feedback for future estimates.					

Annex 4

Overview of Cost Control Software Packages

This annex illustrates an overview of software packages related to cost control. It should be noted that there are numerous software packages specialized in cost control on Internet. The followings are some of the reviewed software packages.

A4.1 Oishii

The Project Cost Control System (Oishii) is a software application that has been developed specially to provide instant access information about a project's cost status. It provides a tool to effectively define, manage, and control costs from project inception to completion. It has been specifically designed for the construction industry to support project management practices.

The Project Cost Control System (Oishii) is designed to easily integrate with other accounting software while supporting the needs of project management. Data is stored in an Access database making it easy to retrieve from other applications.

With the Project Cost Control System you can:

- Create and manage budgets,
- Detailed variations to the budgets and orders,
- Enter orders and supplier information,
- Record all invoices received and track payments,
- Easily cross reference between budget estimate and actual,
- Generate reports on budgets, budget variations, orders, order variations, invoices and payments.
- Manage cash flow.

The Project Cost Control System (Oishii) supports the project management function by ensuring that the project manager has instant access to all information about a project's costs, orders and supplier accounts within one environment. It provides easy cross-referencing between budget estimate and actual, orders, invoices and payments to allow project mangers to control budgets and total costs.

A4.2 ARTMIS CostView

Artemis CostView is a powerful application for project cost planning, control and earned value management reporting. CostView provides complete project, contract and financial management, as well as analysis and reporting.

Features:

- Enterprise cost planning and control.
- Online cost data and variance analysis.
- Full Earned Value Management (EVMS).
- Compliant project control and reporting.
- Optional Job Server for large volume data processing and reporting.
- Integration with other Artemis Views applications.

CostView planning and budgeting provides the following benefits:

- Visibility of weekly and / or monthly direct cost, overheads, general and administrative expenses.
- Visibility of cost and schedule integration in a work package.
- Summary information for selected accounts.
- Complete control of budget changes.
- Ability to set tolerance threshold against cost performance for "management by exception".
- Visibility of historical project data to estimate future cost profiles and labor hours.

Also, CostView offers analysis and reporting features which include the followings:

- Ability to input and/or generate weekly or monthly earned values.
- Access to weekly and monthly variance reports.
- Online variance analysis to document impacts and corrective actions.
- Identification of statistical trends based on performance to date extrapolated to show the most likely Estimate-at-Completion.

A4.3 QPR Cost Control Software

QPR Cost Control software is a powerful and effective Activity Based Costing System. It offers the company with a solid basis for profitable business management and development. QPR helps the user to understand the real cost structure of his company and identify how his business really works. QPR gives you a comprehensive picture on how your resources are being spent. It brings resources and activities to a decision-making level. QPR gives you the information you need to make decisions about the most profitable path for your business.

With the powerful QPR Cost Control software, you can:

- Create comprehensive activity costing models to illustrate the current status of the project.
- Structure and support a company wide implementation of activity based costing.
- Ready made reports provide you with the relevant information for effective decision-making.
- Identify which costs your resources in the project are consuming and in which process they are working.
- Analyze the profitability of the project activities.
- Discover which activities and resources that are cost consuming. How much these activities need control?

A4.4 ERGON IRIS

ERGON IRIS software is software specialized in project management & cost control for construction companies.

ERGON IRIS produces reports in different formats, allowing summaries and recaps of all primary and all carrier shares. It even includes accounts payable and receivable information.

Furthermore the software applications cover the following domains:

- On-site cost control & project management.
- Mechanical equipment resource control and management.
- Inventory - storage management.
- Accounting, fixed assets, bills & drafts etc.
- Payroll & personnel administration.

A4.5 E-festos Cost Control Software

E-Festos cost control software is the leading cost control system for the construction industry. E-Festos covers all managerial, financial and cost control needs of your construction company by tracking every simple action in headquarters or in the construction sites. It provides seamless information exchange between every person connected to your company.

E-festos software is a modern ERP (Enterprise Resource Planning) system, specially designed for construction companies. Construction is a very particular sector, not only because of the uniqueness of each project, but also because of the complexity of the construction activities.

E-festos was developed taking into account all this complexity. Its design philosophy, which focuses on cost centers, allows construction companies to cost-effectively increase revenue, while decreasing construction costs.

The ERP system e-festos is:

- **Specialized:** It has been specially designed for the construction industry.
- **Secure:** It provides access rights at multiple levels, in order to assure security and privacy of data.
- **Expandable:** It allows scaling your operation and adding functionality while you run your business your way.
- **User friendly:** Simple and user friendly interface makes it easy to use even by novice users.
- **Flexible:** It can be easily integrated into the operational environment of every company.
- **Integrated:** It integrates all business procedures and provides a unified operation mode.

A4.6 Cost Controller Software

Cost controller software is designed specifically for contractors, project managers and cost engineers. It tracks project expenses tied to user-defined cost categories. The reports produced are budgeted, actual, committed and forecasted costs. It also indicates variances and alerting for over and under budget activities before it's too late. Cost controller is an indispensable tool for maximizing your profits.

Cost controller provides the tools to effectively manage project costs from start to close out. Project expenditures can be estimated with confidence and integrated with scheduling tools to effectively forecast cash flow and commitments.

COST Controller Main Features:

- Real time data at your fingertips.
- Budget, actual, committed and forecasted costs.
- Greater efficiency in managing project costs.
- Designed to manage change orders.
- Work Breakdown Structure promotes cost retrieval and tracking at any level.
- Cost information can be presented in a graphical format.
- Detailed Variance reports.

A4.7 CCC Cost Control Software

The collection of input data for this software is done on weekly basis. Collection of data falls under the following categories:

- Daily paid labor wages.
- Material quantities and process.
- Equipment hire costs.
- Monthly paid labor cost.

The reports produced from this software are:

- **Monthly cost reports.**

  These reports comprise of a set of hierarchical reports to suit various levels of management. These reports are:

  - Work package report: (It is the lowest level in the cost report).
  - Work Package Summary Report: (It is prepared for each Task by listing all work packages within the task).
  - Task Summary Report: (It is prepared for the project as a whole by listing each task to provide overall project's tasks).
  - Overall Task Summary Report: This report is submitted to higher management to indicate the overall project status.

- **Other reports.**
    - Material Commitment Report.
    - Sub-Contract Commitment Report.
    - Project Profit and Loss Report.
    - Unit Cost / Rate Report.

A4.8 RPM project cost control

RPM project cost control system is a crucial factor in the success of many projects. It is totally integrated with Accounting time tracking system.

Key element of cost control system.

- Monitoring of subcontracts and purchasing orders.
- Monitoring and tracking of change orders.
- Analysis of cost-to-date data.
- Review of material invoices.
- Provide summary reports.

A4.9 PRISM Project Manager Software

PRISM Project Manager is an innovative project management information system designed and developed by professional project managers and project control engineers, especially for Engineering and Construction projects.
With PRISM Project Manager you can plan, and control a project through all project phases including planning, engineering, procurement, construction and startup.

Features and Benefits

- Multi-project software.
- Multi-user concurrent access with built-in security.
- Brief project capabilities for enterprise wide reporting of multiple projects.
- Multi-currency for international projects.
- User defined data coding structure makes the system ideal for any size or type of project.
- Direct links to your financial or accounting packages can be established.
- Powerful report writing capabilities.

Main Functions

With PRISM Project Manager you can:

- Import and consolidate estimates from your estimating software for developing the project baseline budget.
- Import schedule dates from your scheduling software.
- Integrate your cost and schedule data into Control Account for quantifying accomplishments and assessing progress and performance.
- Import actual and committed cost data from your financial or accounting system.
- Link schedule activities to the estimate, control account, purchase order, and equipment lists.

A4.10 Build Superfast Cost Control

Build Superfast software helps in identifying the cost saving and the cost overrun when compared to estimate of the project for the completed quantum of work. The comparison can be viewed globally for all projects together or zoom up the minute component level for a selected project.

The software reports generated are:

- Purchase order register and pending purchase order.
- Delivery register and pending delivery register.
- Material Transfer Register.
- Sub contractor / Labor bill Register.
- Stock Statement.
- Cost center-Estimate Vs Actual (Quantity and Cost).
- Consolidated Material Quantity and Cost Analysis.

Special features of the Software

- Password and Rights Level.
- Voucher number re-generation.
- Report generation on any printer.
- Export facility to other windows applications.

Annex 5

استبيان لتقييم برنامج الحاسوب الخاص بضبط تكلفة المشاريع (CCS)

السادة شركة / _____

مرفق لسيادتكم نسخة عن برنامج ضبط التكلفة الذي تم تطويره ليلبـــي متطلبـات شـــركات المقـــاولات المحلية في مجال ضبط التكلفة لمشاريع التشييد.

يرجى من سيادتكم اختبار البرنامج في مشروع (أو بعض فعاليات مشروع) من المشاريع التي تقومـــون بتنفيذها و من ثم تعبئة الاستبيان من أجل التحقق من كفاءة البرنامج, حيث أن رأيكم وملاحظاتكم علـــى البرنامج مهمة لتقييمه.

السؤال الأول: طرق إدخال المعلومات والتقنيات التي يوفرها البرنامج:

يرجى إبداء رأيكم بمدى موافقتكم عن التقنيات التي يوفرها البرنامج وذلك بوضع علامة (X) أمام الخيار المناسب

الرقم	المعلومات والتقنيات	موافق جدا	موافق	موافق بدرجة متوسطة	موافق بدرجة ضعيفة	غير موافق
١	طريقة إدخال المعلومات الخاصة بالمشروع مناسبة.					
٢	طريقة إدخال المعلومات الخاصة ببنود المشروع مناسبة.					
٣	سهولة الحصول على المعلومات الخاصة بكمية المواد وتكلفتها.					
٤	سهولة الحصول على المعلومات الخاصة بانتاجية العمالة واجرتها.					
٥	سهولة الحصول على المعلومات الخاصة بانتاجية المعدات واجرتها.					
٦	تقرير ضبط التكلفة للمواد يستعرض المعلومات بطريقة جيدة.					
٧	تقرير ضبط التكلفة للعمالة يستعرض المعلومات بطريقة جيدة.					
٨	تقرير ضبط التكلفة للمعدات يستعرض المعلومات بطريقة جيدة.					
٩	تقرير ضبط التكلفة لمقاولي الباطن يستعرض المعلومات بطريقة جيدة.					
١٠	الطرق الخاصة بتقدير التكلفة المتوقعة للكميات المتبقية مناسبة.					
١١	يتم إدخال المعلومات الخاصة بالتكلفة غير المباشرة بطريقة مناسبة.					
١٢	التقرير الخاص بالتكلفة غير المباشرة يستعرض المعلومات باسلوب جيد.					
١٣	التقرير الخاص بالتكلفة للأعمال المتبقية يستعرض المعلومات بوضوح.					
١٤	التعامل مع البرنامج سهل ولا يحتاج لوقت للتدريب عليه.					
١٥	طريقة فرز البيانات الأسبوعية مناسبة وواضحة.					
١٦	البرنامج مناسب لتطبيقه للمشاريع الكبيرة نسبيا بقطاع غزة.					

السؤال الثاني: ما هي في رأيك المميزات الرئيسية التي يعرضها برنامج ضبط التكلفة؟

- _____
- _____
- _____

السؤال الثالث: ما هي الصعوبات التي واجهتك في استخدام البرنامج؟

- _____
- _____
- _____

السؤال الرابع: ما هي المقترحات التي ترى من المفيد ادخالها على البرنامج؟

- _____
- _____
- _____

السؤال الخامس: يرجى من سيادتكم إضافة أي تعليق على البرنامج لم يتم طرحه في الأسئلة السابقة.

- _____
_____
- _____
_____
- _____
_____
- _____
_____

الباحث

م/ هاشم سكيك

Annex 6

Evaluation Questionnaire for Cost Control Software (CCS)

Dear Contractor: _____

Attached is a soft copy for cost control software which is developed to satisfy local contracting companies needs in construction cost control field.
Please, operate and test this software in a project or (some items in a project) which is executed now by your company. Then, fill this questionnaire to evaluate this software. Your opinion and notes are helpful to evaluate this software.

Question 1: Methods of data entry and the techniques offered by the software

Please give your opinion about the data entry and the techniques offered by the software by choosing the appropriate selection.

No.	**Techniques and Data Entry**	Strongly Agree	Agree	Moderate Agree	Slightly Agree	Disagree
1	The method of entering project data is appropriate.					
2	The method of entering project items data is appropriate.					
3	Actual material data (Quantity + Price) is easily obtained.					
4	Actual labor data (Productivity + Wage) is easily obtained.					
5	Actual plant data (Productivity + Rate) is easily obtained.					
6	Material cost control report illustrates cost data well.					
7	Labor cost control report illustrates cost data well.					
8	Equipment cost control report illustrates cost data well.					
9	Subcontract cost control report illustrates cost data well.					
10	Methods of predicting cost to complete for remaining quantities are appropriate.					
11	The method of entering indirect cost data is appropriate.					
12	Indirect cost control report illustrates data in a good style.					
13	Cost at completion report illustrates data in a good style.					
14	The software is easy and does not need a large time to be familiar with it.					
15	The classification and sorting of the weekly cost reports are appropriate.					
16	The software is applicable in the relatively large project in Gaza Strip.					

Question 2: What are the main advantages the cost control software offers?

- _____
- _____
- _____

Question 3: What are the difficulties which face you in using this software?

- _____
- _____
- _____

Question 4: What are the suggestions you find useful to add to the software?

- _____
- _____
- _____

Question 5: Please give any comments on this software which are not previously stated.

- _____
- _____
- _____

Researcher

Eng. Hashem Skaik

Annex 7

Illustrating Example

This example is used to clarify the process of using cost control software **CCS** which is developed by the researcher. The illustrating example consists of a sample project comprising of six items with a duration of six weeks.

There are two types entered in this software which are the estimated data and the actual data. The estimated data is prepared during estimating process and it is entered only at the first week of executing an item. This estimated data is shown in pages (147-149) and the actual data is shown in pages (150-158).

After entering the above data, the output reports are shown in pages from (159-170). These reports are:

- Cost Control Summary Report.
- Component Cost Control Reports (This week).
  - Material cost control report (This Week).
  - Labor cost control report (This Week).
  - Equipment cost control report (This Week).
  - Subcontract cost control report (This Week).
- Component Cost Control Reports (Up-to-date).
  - Material cost control report (Up-to-date).
  - Labor cost control report (Up-to-date).
  - Equipment cost control report (Up-to-date).
  - Subcontract cost control report (Up-to-date).
- Cost at Completion Report.
- Indirect Cost Report

Part A: Estimated Data

Item Code 3100		B 250 for Foundations					
Materials Estimated Quantity and Purchasing Price							
Material	Code	Material Name	Unit	EUQ (Unit/ m^3)	Waste (%)	EUP ($)	($/$m^3$)
	110	B 250 Concrete	m^3	1.0	3.0	51.0	
	210	Steel Reinforcement	kg	50.0	3.0	0.42	
	910	Fixing wire	kg	4.0	4.0	0.50	
	Material Estimated Unit Cost						**76.24**
Labor	**Labor Estimated Productivity and Crew Wage**						
							($/$m^3$)
	Estimated Daily Productivity (EDP)			16.0 m^3			
	Estimated Daily Wage / Crew (EDW)			240.0 $			
	Labor Estimated Unit Cost						**15.0**
Sub Contract	**Sub Contract Estimated Unit Cost**						
							($/$m^3$)
	Sub Contract Type			Bituminous Paint			
	Sub Contract Unit Price			5.0			
	Activity Duration			15 days			
	Sub Contract Estimated Unit Cost						**5.0**
Total Estimated Unit Cost (Direct Cost)							**96.24**

Item Code 3200		B 300 for Columns					
Materials Estimated Quantity and Purchasing Price							
Material	Code	Material Name	Unit	EUQ (Unit/ m^3)	Waste (%)	EUP ($)	($/$m^3$)
	120	B 300 Concrete	m^3	1.0	5.0	53.0	
	210	Steel Reinforcement	kg	100.0	3.0	0.42	
	910	Fixing wire	kg	5.0	4.0	0.50	
	Material Estimated Unit Cost						**101.51**
Labor	**Labor Estimated Productivity and Crew Wage**						
							($/$m^3$)
	Estimated Daily Productivity / Crew (EDP)			6 m^3			
	Estimated Daily Wage / Crew (EDW)			150 $			
	Labor Estimated Unit Cost						**25.0**
Total Estimated Unit Cost (Direct Cost)							**126.51**

EUQ (Estimated Unit Quantity).
EUP (Estimated Unit Purchasing Price).
EDP (Estimated Daily Productivity).
EDW (Estimated Daily Wage / Crew).

Item Code 3300	B 300 Concrete 30 cm for Ribbed Slabs

Materials Estimated Quantity and Purchasing Price

	Code	Material Name	Unit	EUQ (Unit/ m^2)	Waste (%)	EUP ($)	($/$m^2$)
Material	120	B 300 Concrete	m^3	0.20	3.0	53.0	
	210	Steel Reinforcement	kg	20.0	3.0	0.42	
	510	Ribbed Block 20 cm	No.	4.5	3.0	0.45	
	910	Fixing wire	kg	1.5	0.0	0.60	
	Material Unit Cost						**22.56**

	Labor Estimated Productivity and Crew Wage		
			($/$m^2$)
Labor	Estimated Daily Productivity / Crew (EDP)	50.0 m^2	
	Estimated Daily Wage / Crew (EDW)	200.0 $	
	Labor Unit Cost		**4.0**
Total Estimated Unit Cost (Direct Cost)			**26.56**

Item Code 3400	Hollow Block 20 cm for Wall

Materials Estimated Quantity and Purchasing Price

	Code	Material Name	Unit	EUQ (Unit/ m^2)	Waste (%)	EUP ($)	($/$m^2$)
Material	520	Block 20 cm	No.	12.0	3.0	0.45	
	610	Cement	kg	5.0	3.0	0.10	
	620	Lime	kg	3.0	3.0	0.13	
	Material Unit Cost						**6.48**

	Labor Estimated Productivity and Crew Wage		
			($/$m^2$)
Labor	Estimated Daily Productivity (EDP)	60 m^2	
	Estimated Daily Wage / Crew (EDW)	90 $	
	Labor Unit Cost		**1.5**
Total Estimated Unit Cost (Direct Cost)			**7.98**

EUQ (Estimated Unit Quantity)
EUP (Estimated Unit Purchasing Price)
EDP (Estimated Daily Productivity).
EDW (Estimated Daily Wage / crew).

Item Code 3500	Base Course 25 cm for School Yard and Access Road

Purchasing Price Materials Estimated Quantity and

	Code	Material Name	Unit	EUQ (Unit/ m^2)	Waste (%)	EUP ($)	($/$m^2$)
Material	710	Base Course	m^3	0.25	3.0	25.0	
	Material Unit Cost						6.44

	Labor Estimated Productivity and Crew Wage		
			($/$m^2$)
Labor	Estimated Daily Productivity / Crew (EDP)	200.0 m^2	
	Estimated Daily Wage / Crew (EDW)	180.0 $	
	Labor Unit Cost		0.90

	Equipment Estimated Daily Productivity and Rental Price					
	Code	Equipment Name	Unit	EDP	ERR	($/$m^2$)
Equipment	50	Bulldozer	No	200	150	
	51	Grader	No	400	200	
	51	Compactor	No	300	150	
	52	Water Tank	No	400	60	
	Equipment Unit Cost					1.90
(Total Estimated Unit Cost (Direct Cost						9.24

Item Code 3600	Interlock 8 cm for School Yard and Access Road

Purchasing Price Materials Estimated Quantity and

	Code	Material Name	Unit	EUQ (Unit/ m^3)	Waste (%)	EUP ($)	($/$m^3$)
Material	720	Interlock 8 cm	m^2	1.0	2.0	6.6	
	730	Sand	m^3	0.06	10.0	5.0	
	Material Unit Cost						7.06

	Sub Contract Estimated Unit Cost		
			($/$m^3$)
Sub Contract	Sub Contract Type	Interlock Paving (Labor Work)	
	Sub Contract Unit Price	1.25	
	Activity Duration	15 days	
	Sub Contract Unit Cost		1.25
Total Estimated Unit Cost (Direct Cost)			8.31

EUQ (Estimated Unit Quantity)
EUP (Estimated Unit Purchasing Price)
EDP (Estimated Daily Productivity)
EDW (Estimated Daily Wage / crew).
ERR (Estimated Daily Rental Rate)

Part B: Actual Project Data

Al- AAA Contracting Company		Project Budget	**$ 500 000**
Tel: 2810000		Project Duration	**250 days**
	Construction of Gaza School		
	Cost Weekly Report		
Date 20/09/03			**Week No. 1**

B 250 for Foundations

Item Description

Item Code	**3100**		
Committed Quantity	450.0	m^3	
Up to-date executed quantity	250.0	m^3	On going

Materials

Code	Material Name	Unit	Quantity Used	Unit Price $
110	Concrete	m^3	258.5	53.5
210	Steel Reinforcement	kg	13100	0.45
910	Fixing wire	kg	700	0.60

Labor

No. of Crews	12
Crew Daily Wage	240 $ / day

Sub contract

Subcontract Type	Isolation Paint
Subcontract Unit Cost	5.0
Subcontract Duration	7 days

Al- AAA Contracting Company	Project Budget **$ 500 000**
Tel: 2810000	Project Duration **250 days**

Construction of Gaza School

Cost Weekly Report

Date 27/09/03 | **Week No. 2**

B 250 for Foundations

Item Description

Item Code	**3100**		
Committed Quantity	450.0	m^3	
Up to-date executed quantity	450.0	m^3	Finished

Materials

Code	Material Name	Unit	Quantity Used	Unit Price $
110	Concrete	m^3	205.0	53.0
210	Steel Reinforcement	kg	10400.0	0.45
910	Fixing wire	kg	500	0.60

Labor

No. of Crews	10	
Crew Daily Wage	260 $ / day	

Sub contract

Subcontract Type	Isolation Paint	
Subcontract Unit Cost	5.0	
Subcontract Duration	7 days	

B 300 for Columns

Item Description

Item Code	**3200**		
Committed Quantity	160.0	m^3	
Up to-date executed quantity	60.0	m^3	On going

Materials

Code	Material Name	Unit	Quantity Used	Unit Price $
120	Concrete B 300	m^3	65.0	55.5
210	Steel Reinforcement	kg	6500.0	0.45
910	Fixing wire	kg	300.0	0.60

Labor

No. of Crews	12	
Crew Daily Wage	160 $ / day	

Al- AAA Contracting Company	Project Budget **$ 500 000**
Tel: 2810000	Project Duration **250 days**

Construction of Gaza School

Cost Weekly Report

Date 04/10/03 | **Week No. 3**

B 300 for Columns

Item Description

Item Code	**3200**		
Committed Quantity	160.0	m^3	
Up to-date executed quantity	110.0	m^3	On going

Materials

Code	Material Name	Unit	Quantity Used	Unit Price $
120	Concrete B 300	m^3	53.0	55.0
210	Steel Reinforcement	kg	5300.0	0.45
910	Fixing wire	kg	200.0	0.60

Labor

No. of Crews	12	
Crew Daily Wage	160 $ / day	

B 300 for Slabs

Item Description

Item Code	**3300**		
Committed Quantity	2000.0	m^2	
Up-to-date executed quantity	650.0	m^2	On going

Materials

Code	Material Name	Unit	Quantity Used	Unit Price $
120	Concrete B 300	m^3	138.0	55.0
210	Steel Reinforcement	kg	13600.0	0.45
510	Ribbed Block	No.	2900.0	0.50
910	Fixing wire	kg	700.0	0.60

Labor

No. of Crews	14	
Crew Daily Wage	200 $ / day	

Al- AAA Contracting Company
Tel: 2810000

Project Budget **$ 500 000**
Project Duration **250 days**

Construction of Gaza School
Cost Weekly Report

Date 04/10/03 | **Week No. 3**

Hollow Block 20 cm for Walls

Item Description

Item Code	**3400**		
Committed Quantity	2000.0	m^2	
Up to-date executed quantity	800.0	m^2	On going

Materials

Code	Material Name	Unit	Quantity Used	Unit Price $
520	Block 20 cm	No.	10200	0.50
610	Cement	kg	4000	0.13
620	Lime	kg	2000	0.13

Labor

No. of Crews	15	
Crew Daily Wage	85 $ / day	

25 cm base course for yard & access road

Item Description

Item Code	**3500**		
Committed Quantity	4500.0	m^2	
Up-to-date executed quantity	1500.0	m^2	On going

Materials

Code	Material Name	Unit	Quantity Used	Unit Price $
710	Base Course	m^3	390.0	26.0

Labor

No. of Crews	10	
Crew Daily Wage	200 $ / day	

Equipment

Code	Equipment Name	Number of Equipment (This week)	Rental Rate ($)
50	Bulldozer	8	160
51	Grader	4	200
52	Compactor	5	150
53	Water tank	6	60

Al- AAA Contracting Company		Project Budget	**$ 500 000**
Tel: 2810000		Project Duration	**250 days**
	Construction of Gaza School		
	Cost Weekly Report		
Date 11/10/03			**Week No. 4**

B 300 for Columns

Item Description

Item Code	**3200**		
Committed Quantity	160.0	m^3	
Up to-date executed quantity	150.0	m^3	Finished

Materials

Code	Material Name	Unit	Quantity Used	Unit Price $
120	Concrete B 300	m^3	43.0	54.0
210	Steel Reinforcement	kg	4250.0	0.44
910	Fixing wire	kg	175.0	0.60

Labor

No. of Crews	10	
Crew Daily Wage	170 $ / day	

B 300 for Slabs

Item Description

Item Code	**3300**		
Committed Quantity	2000.0	m^2	
Up to-date executed quantity	1250.0	m^2	On going

Materials

Code	Material Name	Unit	Quantity Used	Unit Price $
120	Concrete B 300	m^3	125.0	54.5
210	Steel Reinforcement	kg	12500.0	0.44
510	Ribbed Block	No.	2650.0	0.48
910	Fixing wire	kg	600.0	0.58

Labor

No. of Crews	12	
Crew Daily Wage	200 $ / day	

Al- AAA Contracting Company		Project Budget	**$ 500 000**
Tel: 2810000		Project Duration	**250 days**

Construction of Gaza School

Cost Weekly Report

Date 11/10/03 | **Week No. 4**

Hollow Block 20 cm for Walls

Item Description

Item Code	3400		
Committed Quantity	2000.0	m^2	
Up to-date executed quantity	1400.0	m^2	On going

Materials

Code	Material Name	Unit	Quantity Used	Unit Price $
520	Block 20 cm	No.	7450.0	0.48
610	Cement	kg	3000	0.12
620	Lime	kg	1200	0.13

Labor

No. of Crews	10	
Crew Daily Wage	90 $ / day	

25 cm base course for yard & access road

Item Description

Item Code	**3500**		
Committed Quantity	4500.0	m^2	
Up-to-date executed quantity	3000.0	m^2	On going

Materials

Code	Material Name	Unit	Quantity Used	Unit Price $
710	Base Course	m3	380.0	25.0

Labor

No. of Crews	8	
Crew Daily Wage	180 $ / day	

Equipment

Code	Equipment Name	Number of Equipment (This week)	Rental Rate ($)
50	Bulldozer	7	150
51	Grader	3	200
52	Compactor	4	150
53	Water tank	6	60

Al- AAA Contracting Company
Tel: 2810000

Project Budget **$ 500 000**
Project Duration **250 days**

Construction of Gaza School

Cost Weekly Report

Date 18/10/03 | **Week No. 5**

B 300 for Slabs

Item Description

Item Code	**3300**		
Committed Quantity	2000.0	m^2	
Up to-date executed quantity	1850.0	m^2	Finished

Materials

Code	Material Name	Unit	Quantity Used	Unit Price $
120	Concrete B 300	m^3	123.0	54.5
210	Steel Reinforcement	kg	12000.0	0.44
510	Ribbed Block	No.	2650.0	0.49
910	Fixing wire	kg	600.0	0.58

Labor

No. of Crews	11
Crew Daily Wage	200 $ / day

25 cm base course for yard & access road

Item Description

Item Code	**3500**		
Committed Quantity	4500.0	m^2	
Up to-date executed quantity	4500.0	m^2	On going

Materials

Code	Material Name	Unit	Quantity Used	Unit Price $
710	Base Course	m^3	380.0	25.0

Labor

No. of Crews	7
Crew Daily Wage	180 $ / day

Equipment

Code	Equipment Name	Number of Equipment (This week)	Rental Rate ($)
50	Bulldozer	6	150
51	Grader	3	200
52	Compactor	4	150
53	Water tank	6	60

Al- AAA Contracting Company Tel: 2810000		Project Budget Project Duration	**$ 500 000** **250 days**
	Construction of Gaza School Cost Weekly Report		
Date 18/10/03			**Week No. 5**

Interlock Tiles 8 cm						
Item Description	Item Code		**3600**			
	Committed Quantity		4500.0	m^2		
	Up to-date executed quantity		1000.0	m^2	On going	
Materials	Code	Material Name	Unit	Quantity Used	Unit Price $	
	720	Interlock tiles 8 cm	m^2	975.0	6.75	
	730	Sand	m^3	80.0	6.0	
Sub contract		Subcontract Type	Interlock Paving (Labor Work)			
		Subcontract Unit Cost	1.4			
		Subcontract Duration	7			

Al- AAA Contracting Company		Project Budget	**$ 500 000**
Tel: 2810000		Project Duration	**250 days**

Construction of Gaza School

Cost Weekly Report

Date 25/10/03 | **Week No. 6**

Hollow Block 20 cm for Walls

Item Description

Item Code	**3400**		
Committed Quantity	2000.0	m^2	
Up to-date executed quantity	2000.0	m^2	On going

Materials

Code	Material Name	Unit	Quantity Used	Unit Price $
520	Block 20 cm	No.	7350.0	0.47
610	Cement	kg	2800.0	0.11
620	Lime	kg	1100.0	0.13

Labor

No. of Crews	9
Crew Daily Wage	90 $ / day

Interlock Tiles 8 cm

Item Description

Item Code	**3600**		
Committed Quantity	4500.0	m^2	
Up to-date executed quantity	2000.0	m^2	On going

Materials

Code	Material Name	Unit	Quantity Used	Unit Price $
720	Interlock tiles 8 cm	m^2	995.0	6.75
730	Sand	m^3	80.0	6.0

Sub contract

Subcontract Type	Interlock Paving (Labor Work)
Subcontract Unit Cost	1.4
Subcontract Duration	7

Al - AAA Company

Address : Gaza

Construction of Gaza School

Tel No.: 2810000

Fax No.: 2820000

Cost Control Summary Report

Item Code	Item Description	Unit	Material Unit Cost		Labor Unit Cost		Equipment Unit Cost		Subcontract Unit Cost		Total Unit Cost			% Of Variance		Value Of Variance	
			This period	Up-to-date	This period	Up-to-date	This period	Up-to-date	This period	Up-to-date	Estimated	This period	Up-to-date	This period	Up-to-date	This period	Up-to-date
	Week No. 1 (29/08/2003 - 06/09/2003)																
3100	B 250 Concrete for Foundations	m3	80.58	80.58	11.52	11.52	0.00	0.00	5.00	5.00	96.16	97.10	97.10	0.98	0.98	234.55	234.55
	Week No. 2 (06/09/2003 - 13/09/2003)																
3100	B 250 Concrete for Foundations	m3	79.22	79.98	13.00	12.18	0.00	0.00	5.00	5.00	96.16	97.23	97.15	1.11	1.03	212.84	447.39
3200	B 300 RC for Columns	m3	111.88	111.88	32.00	32.00	0.00	0.00	0.00	0.00	126.51	143.88	143.88	13.73	13.73	1041.90	1041.90
	Week No. 3 (13/09/2003 - 20/09/2003)																
3200	B 300 RC for Columns	m3	108.40	110.30	38.40	34.91	0.00	0.00	0.00	0.00	126.51	146.80	145.20	16.04	14.78	1014.50	2056.40
3300	B 300 RC for Slabs	m2	23.97	23.97	4.31	4.31	0.00	0.00	0.00	0.00	26.56	28.28	28.28	6.48	6.48	1118.76	1118.76
3400	Hollow Block 20 cm for Walls	m2	7.35	7.35	1.59	1.59	0.00	0.00	0.00	0.00	7.98	8.94	8.94	12.10	12.10	772.04	772.04
3500	Bsae Course for Yard and Road	m2	6.76	6.76	1.33	1.33	4.69	4.69	0.00	0.00	9.24	12.78	12.78	38.35	38.35	5313.75	5313.75
	Week No. 4 (20/09/2003 - 27/09/2003)																
3200	B 300 RC for Columns	m3	107.43	109.53	42.50	36.93	0.00	0.00	0.00	0.00	126.51	149.93	146.46	18.51	15.77	936.60	2993.00
3300	B 300 RC for Slabs	m2	23.22	23.61	4.00	4.16	0.00	0.00	0.00	0.00	26.56	27.22	27.77	2.50	4.57	399.05	1517.81
3400	Hollow Block 20 cm for Walls	m2	6.82	7.12	1.50	1.55	0.00	0.00	0.00	0.00	7.98	8.32	8.68	4.28	8.74	204.78	976.82
3500	Bsae Course for Yard and Road	m2	6.33	6.55	0.96	1.15	3.96	4.32	0.00	0.00	9.24	11.25	12.02	21.82	30.09	3023.75	8337.50

Al - AAA Company

Tel No.: 2810000

Construction of Gaza School

Address : Gaza

Fax No.: 2820000

Materieal Cost Control Report (This week)

Item Code	Item Description	Unit	Estimated (Quantity + Price)				Actual (Quantity + Price)					Quantity Variance		Purchase Variance		% of Variance	Value of Variance
			Unit Q	Quantity Estimate	Unit Purchase	Unit Cost	Executed Q	Unit Q	Quantity Used	Unit Purchase	Unit Cost	Absolute	%	Absolute	%		
	Week No. 1 (29/08/2003 - 06/09/2003)																
3100	**B 250 Concrete for Foundations**	**m3**				**76.16**	**250.0**				**80.58**					**5.80**	**1104.55**
110	B 250 Concrete	m3	1.03	257.5	51.00	52.53		1.03	258.5	53.50	55.32	1.00	0.39	2.50	4.90		697.25
210	Steel Reinforcement	kg	51.50	12875.0	0.42	21.63		52.40	13100.0	0.45	23.58	225.00	1.75	0.03	7.14		487.50
910	Fixing wire	kg	4.00	1000.4	0.50	2.00		2.80	700.0	0.60	1.68	-300.40	-30.03	0.10	20.00		-80.20
	Week No. 2 (06/09/2003 - 13/09/2003)																
3100	**B 250 Concrete for Foundations**	**m3**				**76.16**	**200.0**				**79.22**					**4.02**	**612.84**
110	B 250 Concrete	m3	1.03	206.0	51.00	52.53		1.02	205.0	53.00	54.32	-1.00	-0.49	2.00	3.92		359.00
210	Steel Reinforcement	kg	51.50	10300.0	0.42	21.63		52.00	10400.0	0.45	23.40	100.00	0.97	0.03	7.14		354.00
910	Fixing wire	kg	4.00	800.3	0.50	2.00		2.50	500.0	0.60	1.50	-300.32	-37.52	0.10	20.00		-100.16
3200	**B 300 RC for Columns**	**m3**				**101.51**	**60.0**				**111.88**					**10.21**	**621.90**
120	B 300 Concrete	m3	1.05	63.0	53.00	55.65		1.08	65.0	55.50	60.13	2.00	3.17	2.50	4.72		268.50
210	Steel Reinforcement	kg	103.00	6180.0	0.42	43.26		108.33	6500.0	0.45	48.75	320.00	5.18	0.03	7.14		329.40
910	Fixing wire	kg	5.20	312.0	0.50	2.60		5.00	300.0	0.60	3.00	-12.00	-3.85	0.10	20.00		24.00
	Week No. 3 (13/09/2003 - 20/09/2003)																
3200	**B 300 RC for Columns**	**m3**				**101.51**	**50.0**				**108.40**					**6.79**	**344.50**
120	B 300 Concrete	m3	1.05	52.5	53.00	55.65		1.06	53.0	55.00	58.30	0.50	0.95	2.00	3.77		132.50
210	Steel Reinforcement	kg	103.00	5150.0	0.42	43.26		106.00	5300.0	0.45	47.70	150.00	2.91	0.03	7.14		222.00
910	Fixing wire	kg	5.20	260.0	0.50	2.60		4.00	200.0	0.60	2.40	-60.00	-23.08	0.10	20.00		-10.00
3300	**B 300 RC for Slabs**	**m2**				**22.56**	**650.0**				**23.97**					**6.27**	**918.76**
120	B 300 Concrete	m3	0.21	133.9	53.00	10.92		0.21	138.0	55.00	11.68	4.10	3.06	2.00	3.77		493.30
210	Steel Reinforcement	kg	20.60	13390.0	0.42	8.65		20.92	13600.0	0.45	9.42	210.00	1.57	0.03	7.14		496.20
510	Ribbed Block 20 cm	No.	4.64	3012.7	0.45	2.09		4.46	2900.0	0.50	2.23	-112.75	-3.74	0.05	11.11		94.26
910	Fixing wire	kg	1.50	975.0	0.60	0.90		1.08	700.0	0.60	0.65	-275.00	-28.21	0.00	0.00		-165.00

Al - AAA Company **Address : Gaza**

Construction of Gaza School

Tel No.: 2810000 **Fax No.: 2820000**

Labor Cost Control Report (This week)

Item Code	Item Description	Unit	Bill Q	Estimated			This Period (Actual)					% of Variance		Cost Variance	
				productivity unit / day	Wage $ / day	Unit Cost $ / unit	Executed Q	No. of crews	Productivity unit / day	Wage $ / day	Unit Cost $ / unit	Product.	Wage	%	Value
	Week No. 2 (06/09/2003 - 13/09/2003)														
3200	B 300 RC for Columns	m3	160.0	6.0	150.0	25.0	60.0	12.0	5.00	160.0	32.00	-16.67	6.67	28.00	420.00
	Week No. 3 (13/09/2003 - 20/09/2003)														
3200	B 300 RC for Columns	m3	160.0	6.0	150.0	25.0	50.0	12.0	4.17	160.0	38.40	-30.56	6.67	53.60	670.00
3300	B 300 RC for Slabs	m2	2000.0	50.0	200.0	4.0	650.0	14.0	46.43	200.0	4.31	-7.14	0.00	7.69	200.00
3400	Hollow Block 20 cm for Walls	m2	2000.0	60.0	90.0	1.5	800.0	15.0	53.33	85.0	1.59	-11.11	-5.56	6.25	75.00
3500	Bsae Course for Yard and Road	m2	4500.0	200.0	180.0	0.9	1500.0	10.0	150.00	200.0	1.33	-25.00	11.11	48.15	650.00
	Week No. 4 (20/09/2003 - 27/09/2003)														
3200	B 300 RC for Columns	m3	160.0	6.0	150.0	25.0	40.0	10.0	4.00	170.0	42.50	-33.33	13.33	70.00	700.00
3300	B 300 RC for Slabs	m2	2000.0	50.0	200.0	4.0	600.0	12.0	50.00	200.0	4.00	0.00	0.00	0.00	0.00
3400	Hollow Block 20 cm for Walls	m2	2000.0	60.0	90.0	1.5	600.0	10.0	60.00	90.0	1.50	0.00	0.00	0.00	0.00
3500	Bsae Course for Yard and Road	m2	4500.0	200.0	180.0	0.9	1500.0	8.0	187.50	180.0	0.96	-6.25	0.00	6.67	90.00
	Week No. 5 (27/09/2003 - 03/10/2003)														
3300	B 300 RC for Slabs	m2	2000.0	50.0	200.0	4.0	600.0	11.0	54.55	200.0	3.67	9.09	0.00	-8.33	-200.00
3500	Bsae Course for Yard and Road	m2	4500.0	200.0	180.0	0.9	1500.0	7.0	214.29	180.0	0.84	7.14	0.00	-6.67	-90.00
3600	Interlock 8 cm for Yard and Roads	m2	4500.0	0.0	0.0	0.0	1000.0	0.0	0.00	0.0	0.00	0.00	0.00	0.00	0.00

Al - AAA Company

Address : Gaza

Tel No. : 2810000

Fax No.: 2820000

Equipment Cost Control Report (This week)

Item Code	Item Description	Unit	Bill Q	Estimated			This Period (Actual)					% Of Variance		Cost Vriance	
				Productivity unit / day	Rental Rate $ / day	Unit Cost $ / unit	Executed Q	No. of Equip.	Productivity unit / day	Rental Rate $ / day	Unit Cost $ / unit	Productivity	Renta Rate	%	Value
	Week No. 3 (13/09/2003 - 20/09/2003)														
3500	**Bsae Course for Yard and Road**	**m2**	**4500.0**			**1.90**	**1500.0**				**4.69**			**146.67**	**4180.0**
50	Bulldozer	No.		200.0	150.0			4	46.88	160.0		-76.56	6.67		
51	Grader	No.		400.0	200.0			1	375.00	200.0		-6.25	0.00		
52	Compactor	No.		300.0	150.0			1	300.00	150.0		0.00	0.00		
53	Water Tank	No.		400.0	60.0			1	250.00	60.0		-37.50	0.00		
	Week No. 4 (20/09/2003 - 27/09/2003)														
3500	**Bsae Course for Yard and Road**	**m2**	**4500.0**			**1.90**	**1500.0**				**3.96**			**108.42**	**3090.0**
50	Bulldozer	No.		200.0	150.0			2	107.14	150.0		-46.43	0.00		
51	Grader	No.		400.0	200.0			3	166.67	200.0		-58.33	0.00		
52	Compactor	No.		300.0	150.0			1	375.00	150.0		25.00	0.00		
53	Water Tank	No.		400.0	60.0			4	62.50	60.0		-84.38	0.00		
	Week No. 5 (27/09/2003 - 03/10/2003)														
3500	**Bsae Course for Yard and Road**	**m2**	**4500.0**			**1.90**	**1500.0**				**1.64**			**-13.68**	**-390.0**
50	Bulldozer	No.		200.0	150.0			1	250.00	150.0		25.00	0.00		
51	Grader	No.		400.0	200.0			1	500.00	200.0		25.00	0.00		
52	Compactor	No.		300.0	150.0			1	375.00	150.0		25.00	0.00		
53	Water Tank	No.		400.0	60.0			1	250.00	60.0		-37.50	0.00		

Al - AAA Company

Address : Gaza

Construction of Gaza School

Tel No.: 2810000

Fax No.: 2820000

Subcontract Cost Control Report (This week)

Item Code	Item Description	Unit	Bill Quantity	Executed Quantity	Estimated		This Period (Actual)		% of Variance		Value of Varaiance
					Unit Cost	productivity	Unit Cost	Productivity	Unit Cost	Productivity	
	Week No. 1 (29/08/2003 - 06/09/2003)										
3100	B 250 Concrete for Foundations	m3	450.0	250.0	5.0	30.0	5.00	35.71	0.00	19.05	0.0
	Week No. 2 (06/09/2003 - 13/09/2003)										
3100	B 250 Concrete for Foundations	m3	450.0	200.0	5.0	30.0	5.00	28.57	0.00	-4.76	0.0
	Week No. 5 (27/09/2003 - 03/10/2003)										
3600	Interlock 8 cm for Yard and Roads	m2	4500.0	1000.0	1.2	300.0	1.00	142.86	-20.00	-52.38	-250.0
	Week No. 6 (03/10/2003 - 10/10/2003)										
3600	Interlock 8 cm for Yard and Roads	m2	4500.0	1000.0	1.2	300.0	1.00	142.86	-20.00	-52.38	-250.0

Al - AAA Company **Address : Gaza**

Construction of Gaza School

Tel No.: 2810000 **Fax No.: 2820000**

Materieal Cost Control Report (Up-to-date)

Item Code	Item Description	Unit	Estimated (Quantity + Price)				Up-to-date					Quantity Variance		Purchase Variance		% of Variance	Value of Variance
			Unit Q	Quantity Estimated	Unit Purchase	Unit Cost	Executed Q	Unit Q	Quantity Used	Unit Purchase	Unit Cost	Absolute	%	Absolute	%		
	Week No. 1 (29/08/2003 - 06/09/2003)																
3100	**B 250 Concrete for Foundations**	**m3**				**76.16**	**250.0**				**80.58**					**5.80**	**1104.55**
110	B 250 Concrete	m3	1.03	257.50	51.00	52.53		1.03	258.50	53.50	55.32	1.00	0.39	2.50	4.90		697.25
210	Steel Reinforcement	kg	51.50	12875.0(	0.42	21.63		52.40	13100.0(	0.45	23.58	225.00	1.75	0.03	7.14		487.50
910	Fixing wire	kg	4.00	1000.40	0.50	2.00		2.80	700.00	0.60	1.68	-300.40	-30.03	0.10	20.00		-80.20
	Week No. 2 (06/09/2003 - 13/09/2003)																
3100	**B 250 Concrete for Foundations**	**m3**				**76.16**	**450.0**				**79.98**					**5.01**	**1717.39**
110	B 250 Concrete	m3	1.03	463.50	51.00	52.53		1.03	463.50	53.28	54.88	0.00	0.00	2.28	4.47		1056.25
210	Steel Reinforcement	kg	51.50	23175.0(	0.42	21.63		52.22	23500.0(	0.45	23.50	325.00	1.40	0.03	7.14		841.50
910	Fixing wire	kg	4.00	1800.72	0.50	2.00		2.67	1200.00	0.60	1.60	-600.72	-33.36	0.10	20.00		-180.36
3200	**B 300 RC for Columns**	**m3**				**101.51**	**60.0**				**111.88**					**10.21**	**621.90**
120	B 300 Concrete	m3	1.05	63.00	53.00	55.65		1.08	65.00	55.50	60.12	2.00	3.17	2.50	4.72		268.50
210	Steel Reinforcement	kg	103.0(	6180.00	0.42	43.26		108.33	6500.00	0.45	48.75	320.00	5.18	0.03	7.14		329.40
910	Fixing wire	kg	5.20	312.00	0.50	2.60		5.00	300.00	0.60	3.00	-12.00	-3.85	0.10	20.00		24.00
	Week No. 3 (13/09/2003 - 20/09/2003)																
3200	**B 300 RC for Columns**	**m3**				**101.51**	**110.0**				**110.30**					**8.65**	**966.40**
120	B 300 Concrete	m3	1.05	115.50	53.00	55.65		1.07	118.00	55.28	59.30	2.50	2.16	2.28	4.29		401.00
210	Steel Reinforcement	kg	103.0(	11330.0(	0.42	43.26		107.27	11800.0(	0.45	48.27	470.00	4.15	0.03	7.14		551.40
910	Fixing wire	kg	5.20	572.00	0.50	2.60		4.55	500.00	0.60	2.73	-72.00	-12.59	0.10	20.00		14.00
3300	**B 300 RC for Slabs**	**m2**				**22.56**	**650.0**				**23.97**					**6.27**	**918.76**
120	B 300 Concrete	m3	0.21	133.90	53.00	10.92		0.21	138.00	55.00	11.68	4.10	3.06	2.00	3.77		493.30
210	Steel Reinforcement	kg	20.60	13390.0(	0.42	8.65		20.92	13600.0(	0.45	9.42	210.00	1.57	0.03	7.14		496.20
510	Ribbed Block 20 cm	No.	4.64	3012.75	0.45	2.09		4.46	2900.00	0.50	2.23	-112.75	-3.74	0.05	11.11		94.26
910	Fixing wire	kg	1.50	975.00	0.60	0.90		1.08	700.00	0.60	0.65	-275.00	-28.21	0.00	0.00		-165.00
3400	**Hollow Block 20 cm for Walls**	**m2**				**6.48**	**800.0**				**7.35**					**13.45**	**697.04**
520	Block 20 cm	No.	12.36	9888.00	0.45	5.56		12.75	10200.0(	0.50	6.38	312.00	3.16	0.05	11.11		650.40
610	Cement	kg	5.15	4120.00	0.10	0.52		5.00	4000.00	0.13	0.65	-120.00	-2.91	0.03	30.00		108.00
620	Lime	kg	3.09	2472.00	0.13	0.40		2.50	2000.00	0.13	0.33	-472.00	-19.09	0.00	0.00		-61.36

Al - AAA Company

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Construction of Gaza School

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Fax No.: 2820000

Labor Cost Control Report (Up-to-date)

Item Code	Item Description	Unit	Bill Q	Estimated			Up-to-date					% of Variance		Cost Variance	
				productivity unit / days	Wage $ / day	Unit Cost $ / unit	Executed Q	No. of crews	Productivity unit / day	Wage $ / day	Unit Cost $ / unit	Product.	Wage	%	Value
	Week No. 2 (06/09/2003 - 13/09/2003)														
3200	B 300 RC for Columns	m3	160.0	6.0	150.0	25.00	60.0	12.0	5.00	160.00	32.00	-16.67	6.67	28.00	420.00
	Week No. 3 (13/09/2003 - 20/09/2003)														
3200	B 300 RC for Columns	m3	160.0	6.0	150.0	25.00	110.0	24.0	4.58	160.00	34.91	-23.61	6.67	40.80	1090.00
3300	B 300 RC for Slabs	m2	2000.0	50.0	200.0	4.00	650.0	14.0	46.43	200.00	4.31	-7.14	0.00	7.69	200.00
3400	Hollow Block 20 cm for Walls	m2	2000.0	60.0	90.0	1.50	800.0	15.0	53.33	85.00	1.59	-11.11	-5.56	6.25	75.00
3500	Bsae Course for Yard and Road	m2	4500.0	200.0	180.0	0.90	1500.0	10.0	150.00	200.00	1.33	-25.00	11.11	48.15	650.00
	Week No. 4 (20/09/2003 - 27/09/2003)														
3200	B 300 RC for Columns	m3	160.0	6.0	150.0	25.00	150.0	34.0	4.41	162.94	36.93	-26.47	8.63	50.53	1790.00
3300	B 300 RC for Slabs	m2	2000.0	50.0	200.0	4.00	1250.0	26.0	48.08	200.00	4.16	-3.85	0.00	3.85	200.00
3400	Hollow Block 20 cm for Walls	m2	2000.0	60.0	90.0	1.50	1400.0	25.0	56.00	87.00	1.55	-6.67	-3.33	3.13	75.00
3500	Bsae Course for Yard and Road	m2	4500.0	200.0	180.0	0.90	3000.0	18.0	166.67	191.11	1.15	-16.67	6.17	27.41	740.00
	Week No. 5 (27/09/2003 - 03/10/2003)														
3300	B 300 RC for Slabs	m2	2000.0	50.0	200.0	4.00	1850.0	37.0	50.00	200.00	4.00	0.00	0.00	-0.21	0.00
3500	Bsae Course for Yard and Road	m2	4500.0	200.0	180.0	0.90	4500.0	25.0	180.00	188.00	1.04	-10.00	4.44	16.05	650.00
3600	Interlock 8 cm for Yard and Roads	m2	4500.0	0.0	0.0	0.00	1000.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

.l - AAA Company

Address : Gaza

Construction of Gaza School

el No.: 2810000

Fax No: 2820000

Equipment Cost Control Report (Up-to-date)

Item Code	Item Description	Unit	Bill Q	Estimated			Up-to-date					% Of Variance		Cost Variance	
				Productivity unit / day	Rental Rate $ / day	Unit Cost $ / unit	Executed Q	No. of Equip.	Productivity unit / day	Rental Rate $ / day	Unit Cost $ / unit	Productivity	Rental Rate	%	Value
	Week No. 3 (13/09/2003 - 20/09/2003)														
3500	**Bsae Course for Yard and Road**	**m2**	**4500.0**			**1.90**	**1500.0**				**4.69**			**146.67**	**4180.00**
50	Bulldozer	No.		200.0	150.0			4	46.88	160.00		-76.56	6.67		
51	Grader	No.		400.0	200.0			1	375.00	200.00		-6.25	0.00		
52	Compactor	No.		300.0	150.0			1	300.00	150.00		0.00	0.00		
53	Water Tank	No.		400.0	60.0			1	250.00	60.00		-37.50	0.00		
	Week No. 4 (20/09/2003 - 27/09/2003)														
3500	**Bsae Course for Yard and Road**	**m2**	**4500.0**			**1.90**	**3000.0**				**4.32**			**127.54**	**3635.00**
50	Bulldozer	No.		200.0	150.0			6	65.22	156.96		-67.39	4.64		
51	Grader	No.		400.0	200.0			4	230.77	200.00		-42.31	0.00		
52	Compactor	No.		300.0	150.0			2	333.33	150.00		11.11	0.00		
53	Water Tank	No.		400.0	60.0			5	100.00	60.00		-75.00	0.00		
	Week No. 5 (27/09/2003 - 03/10/2003)														
3500	**Bsae Course for Yard and Road**	**m2**	**4500.0**			**1.90**	**4500.0**				**3.43**			**80.47**	**2293.33**
50	Bulldozer	No.		200.0	150.0			7	86.54	156.15		-56.73	4.10		
51	Grader	No.		400.0	200.0			5	281.25	200.00		-29.69	0.00		
52	Compactor	No.		300.0	150.0			3	346.15	150.00		15.38	0.00		
53	Water Tank	No.		400.0	60.0			6	125.00	60.00		-68.75	0.00		

Al - AAA Company

Address : Gaza

Construction of Gaza School

Tel No.: 2810000

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Subcontract Cost Control Report (Up-to-date)

Item Code	Item Description	Unit	Bill Quantity	Executed Quantity	Estimated		Up-to-date		% of Variance		Value of Varaiance
					Unit Cost	Productivity	Unit Cost	Productivity	Unit Cost	Productivity	
	Week No. 1 (29/08/2003 -		06/09/2003)								
3100	B 250 Concrete for Foundations	m3	450.0	250.0	5.0	30.0	5.00	35.71	0.00	19.05	0.00
	Week No. 2 (06/09/2003 -		13/09/2003)								
3100	B 250 Concrete for Foundations	m3	450.0	450.0	5.0	30.0	5.00	32.14	0.00	7.14	0.00
	Week No. 5 (27/09/2003 -		03/10/2003)								
3600	Interlock 8 cm for Yard and Roads	m2	4500.0	1000.0	1.2	300.0	1.00	142.86	-20.00	-52.38	-250.00
	Week No. 6 (03/10/2003 -		10/10/2003)								
3600	Interlock 8 cm for Yard and Roads	m2	4500.0	2000.0	1.2	300.0	1.00	142.86	-20.00	-52.38	-250.00

Al - AAA Company

Address : Gaza

Construction of Gaza School

Tel No.: 2810000

Fax No.: 2820000

Cost at Completion Report

Item Code	Item Description	Unit	Bill Quantity	Estimated Unit Cost	Estimated Cost	Executed Quantity	Remaining Quantity	Actual Unit Cost	Forecasted Unit Cost	Actual Cost	Cost to Complete	Cost At Compleation	Variance Absolute	Variance %
	Week No. 1 (29/08/2003 - 06/09/2003)													
3100	B 250 Concrete for Foundations	m3	450.00	96.16	43272.36	250.00	200.00	97.10	101.00	24274.75	20200.00	44474.75	1202.39	2.78
													1202.39	
	Week No. 2 (06/09/2003 - 13/09/2003)													
3100	B 250 Concrete for Foundations	m3	450.00	96.16	43272.36	450.00	0.00	97.24	103.50	43756.75	0.00	43756.75	484.39	1.12
3200	B 300 RC for Columns	m3	150.00	126.51	18976.50	60.00	90.00	143.88	123.00	8632.50	11070.00	19702.50	726.00	3.83
													1210.39	
	Week No. 3 (13/09/2003 - 20/09/2003)													
3200	B 300 RC for Columns	m3	150.00	126.51	18976.50	110.00	40.00	145.50	130.00	16004.50	5200.00	21204.50	2228.00	11.74
3300	B 300 RC for Slabs	m2	1850.00	26.56	49128.14	650.00	1200.00	28.28	28.00	18380.00	33600.00	51980.00	2851.86	5.80
3400	Hollow Block 20 cm for Walls	m2	2000.00	7.98	15957.40	800.00	1200.00	8.94	8.75	7155.00	10500.00	17655.00	1697.60	10.64
3500	Bsae Course for Yard and Road	m2	4500.00	9.24	41568.75	1500.00	3000.00	12.78	6.60	19170.00	19800.00	38970.00	-2598.75	-6.25
													4178.71	
	Week No. 4 (20/09/2003 - 27/09/2003)													
3200	B 300 RC for Columns	m3	150.00	126.51	18976.50	150.00	0.00	147.16	125.00	22074.50	0.00	22074.50	3098.00	16.33
3300	B 300 RC for Slabs	m2	1850.00	26.56	49128.14	1250.00	600.00	27.76	27.00	34704.81	16200.00	50904.81	1776.67	3.62
3400	Hollow Block 20 cm for Walls	m2	2000.00	7.98	15957.40	1400.00	600.00	8.67	8.00	12137.63	4800.00	16937.63	980.23	6.14
3500	Bsae Course for Yard and Road	m2	4500.00	9.24	41568.75	3000.00	1500.00	12.02	10.30	36050.00	15450.00	51500.00	9931.25	23.89
													15786.15	

Al - AAA Company **Address : Gaza**

Construction of Gaza Hospital

Tel No.: 2810000 **Fax No.: 2820000**

Indirect Cost Control Report

Project Name : Construction of Gaza Hospital

No.	Element Description	Unit	Estimated No.	Estimated Unit Cost	Actual No. Used	Actual Unit Price	% Of Variance	Value Of Variance
	Month 1							
1	Rented Car	No.	1.00	500.00	1.00	525.00	4.76	25.00
2	Jawwal Cards	No.	6.00	25.00	8.00	25.00	25.00	50.00
3	Engineer	No.	1.00	600.00	1.00	650.00	7.69	50.00
4	Foremen	No.	1.00	500.00	1.00	550.00	9.09	50.00
5	General Expenses	Job	1.00	1250.00	1.00	1750.00	28.57	500.00
	Total of month 1							**675.00**
	Month 2							
6	Rented Car	No.	1.00	500.00	1.00	550.00	9.09	50.00
7	Jawwal Cards	No.	6.00	25.00	7.00	25.00	14.29	25.00
8	Engineer	No.	1.00	600.00	1.00	650.00	7.69	50.00
9	Foremen	No.	1.00	500.00	1.00	550.00	9.09	50.00
10	General Expenses	Job	1.00	1250.00	1.00	1600.00	21.88	350.00
	Total of month 2							**525.00**

Appendix 8

Distribution of t at different probability values

DF	Probability			
	0.5	0.1	0.05	0.01
1	1.000	6.314	12.706	63.657
2	0.816	2.920	4.303	9.925
3	0.765	2.353	3.182	5.841
4	0.74	2.132	2.776	4.604
5	0.727	2.015	2.571	4.032
6	0.718	1.943	2.447	3.707
7	0.711	1.895	2.365	3.499
8	0.706	1.860	2.306	3.355
9	0.703	1.833	2.262	3.250
10	0.700	1.812	2.228	3.169
11	0.697	1.796	2.201	3.106
12	0.695	1.782	2.179	3.055
13	0.694	1.771	2.160	3.012
14	0.692	1.761	2.145	2.977
15	0.691	1.753	2.131	2.947
16	0.690	1.746	2.120	2.921
17	0.689	1.740	2.110	2.898
18	0.688	1.734	2.101	2.878
19	0.688	1.729	2.093	2.861
20	0.687	1.725	2.086	2.845
21	0.686	1.721	2.080	2.831
22	0.686	1.717	2.074	2.819
23	0.685	1.714	2.069	2.807
24	0.685	1.711	2.064	2.797
25	0.684	1.708	2.060	2.787
26	0.684	1.706	2.056	2.779
27	0.684	1.703	2.052	2.771
28	0.683	1.701	2.048	2.763
29	0.683	1.699	2.045	2.756
30	0.683	1.697	2.042	2.750
40	0.681	1.684	2.021	2.704
60	0.679	1.671	2.000	2.660
120	0.677	1.658	1.980	2.617

Source: Naoum, 1998

Annex 9

Cost Control Software (CCS)

Main Features

CCS is an innovative cost control software designed and developed for the construction contracting companies. It has been designed to provide instant access to cost information about the project cost status. It is a tool to effectively define, manage, and control costs from project start to completion.

CCS is designed to accommodate the needs of Gaza Strip contracting companies who are interested to attain a cost control software which suits the local circumstances. **CCS** aims to improve the cost control practice of Gaza Strip contractors. **CCS** is the first local computerized cost control system for construction contractors.

CCS helps in identifying the cost saving or cost overrun when comparing the actual costs with the estimated costs of the project. The comparison can be viewed globally for the project items or zoom up to cost components of the project comprising the items. These cost components are material, labor, equipment, and subcontract.

CCS is tested and evaluated by professional contractors. The evaluation process indicates that **CCS** is satisfactory for local contractors and could be applied to the different types of construction projects.

CCS is developed using Visual Basic language to facilitate the transfer of information from on field to another. Also, Visual Basic enables the user to deal with an environment that he is familiar with it.

CCS is not restricted to specific cost codes. Any consistent cost code consisting from three to five digits is accepted for the project items. For material and equipment codes it is sufficient to use two digits or more.

The data needed to feed **CCS** consists of two types:

The first is the estimated data for all cost components. Some of these data are:

- Material (Quantity, Waste percentage, and Unit purchasing price).
- Labor (Productivity and Daily wage).
- Equipment (Productivity and Rental rate).
- Subcontract (Unit cost and Contract duration).
- Indirect costs (Estimated number and Unit cost).

These data are entered once in the beginning of the project.

The second type is the actual data which are collected weekly for all cost components (material, labor, equipment, and subcontract) and collected monthly for indirect costs.

CCS helps contracting companies to keep on top of project costs by allowing them to generate and view reports when needed. These reports are:

- Cost control summary report.
- Material cost control report (This week & up-to-date).
- Labor cost control report (This week & up-to-date).
- Equipment cost control report (This week & up-to-date).
- Subcontract cost control report (This week & up-to-date).
- Cost at completion report.
- Indirect cost report.

The above reports are produced weekly except the indirect cost report which is produced monthly.

The above reports have the property of viewing the items which have a considerable value or percentage of overrun or underrun to generate "management by exception" reports. This can be done by selecting the value and percentage of cost variance which the user needs to present. These values are entered in the Control Limit screen.

CCS can predict the final cost of the project (Cost at Completion) with four scenarios. Within **CCS**, there are four methods to calculate the forecasted cost (cost to complete). For every cost component, the user can choose the method he finds appropriate to complete the project.

At any time the user has many options to add, update, and delete any item or any component comprising the item. This can be done through the different buttons which have multi options within the software.

CCS has the capability to handle many projects at the same period. Also, it allows the user to handle different projects with different currencies. Moreover, there is a special password for every project to restrict unauthorized accessibility to any project data.

CCS serves the cost estimators when they need to estimate future projects which have similar items. They could use the up-to-dated unit cost, unit quantity, productivity and other indicators for the different cost components.

Annex 10

Cost Control Software (CCS)

User Manual

CONTENTS

Cost Control Software (CCS)

User Manual

1. Overview

The Cost Control Software (**CCS**) is a software that is specifically designed for the local construction contractors to support cost control practices. **CCS** has been developed to provide instant access to information about the project's cost status. It effectively defines, manages, and controls costs from project inception to completion of construction activities.

A major prerequisite to implement **CCS** is a detailed cost estimate for all bill of quantity items. If the company has cost estimate software, the user can import cost estimates from it for developing the project cost baseline. The detailed cost estimate may be created directly in this system, or may be electronically imported from other cost estimating systems, spreadsheets, or databases.

The second requirement for **CCS** is the weekly input quantity and cost data for project items. This data represents the actual executed quantities and costs spent on different project items for all cost components such as materiel, labor, equipment, and subcontract.

2. Getting Started

After installing the Cost Control Software **CCS**, it can be operated by opening it from *Program* › *Project1* File.

3. Entering Company Information

- Click on ***Company Information*** on ***File*** menu.
- Fill the information related to your company in the company Information Screen. These information will appear on the top of software reports.
- Save these data by clicking on ***Save*** button.
- You can clear or cancel entered data by clicking on ***Cancel*** & ***Save*** buttons.

4. Entering Project Information

- Click on ***add a new project*** on ***File*** menu.
- Fill the project information in the screen like the *project name*, *project code*, *project budget*, *project start date*, and *project duration*.
- Save these data by clicking on ***Save*** button.
- You can clear or cancel entered data by clicking on ***Cancel*** & ***Save*** buttons.

5. Selecting a Project

- Click on ***show all projects*** under the ***File*** menu.
- Choose the needed project on the shown list.
- The project name appears on the bottom of the screen and then the **Project Screen** opens.
- In this screen, the project name is shown and the week number of the designated project is presented also.
- Click on "***Next***" button on enter the project-input data after clicking on.

6. Entering Project Items

The Bill of Quantity items must be coded in order to distinguish the project items. In Palestine, the item codes are not generally used. Up to preparing a universal local coding system for construction, each contracting company could choose a simple coding system for project items, materials, and equipment.

- In the "***Item Description screen***", fill *week number*, *item code*, *item description*, *bill quantity*, and its unit.
- If you need to restore these information, you need only to fill item code, and then all of the above information is viewed on the screen.
- Fill the weekly up-to-date executed quantity.
- The actual quantity executed this week is automatically calculated.
- Choose if the item is finished in this week or still on going.

7. Entering Item Cost Components

After entering the project items data, the user should begin entering the cost components related to each item. These cost components are related to material, labor, equipment, and subcontract. This can be done by pressing on *Next* button in the previous screen.

7. 1 Entering Materials Data

- Click on the "*Next*" button to open material screen.
- Choose if there are material costs to be controlled by clicking on *Yes* or *No*.
- A sub screen is opened in the bottom of the main material screen.

In the material screen, the user is requested to enter two types of data about materials.

Estimated material data

- The estimated data is entered only once at the first week of executing an item.
- This estimated data can be entered by the user or can be transferred electronically from any cost estimating software or spreadsheet.
- The estimated data includes:
  - Material Code and Material Name
  - Material Unit.
  - Estimated Unit Quantity (EUQ).
  - Estimated Percentage of Waste.
  - Estimated Unit Purchasing Price.

Actual material data

In the Material data screen the actual weekly material entered data are:

  - The actual quantities of materials used in this week.
  - The unit purchasing price.
- Click on "Save M" button to save this material.
- Begin entering the second material for the same item.
- Up-date, Delete or Clear material data by the buttons on the screen.

7.2 Labor Data Entry

- Click on the "*Next*" button to begin entering labor cost data.
- Choose if there is labor cost by choosing Yes or No options.
- If you choose yes, a sub screen opens.

Estimated Labor data

- Enter the estimated productivity rate for each crew (unit/day). It will remain fixed until item completion
- Enter the estimated daily wage per each crew ($/day). It will remain fixed until item completion

Actual Labor data

In the Labor data screen the actual material entered data are:

- The number of crews needed to finish the executed quantity this week.
- The actual daily wage.

7.3 Equipment Data Entry

- Click on the "*Next*" button to begin entering equipment cost data.
- Answer the question about if there is equipment cost.
- If you choose yes, a sub screen opens.

Estimated Equipment data

- Enter Equipment code and Equipment name.
- Enter Estimated equipment productivity / day when executing this item.
- Enter the estimated daily rental rate.

Actual Equipment data

In the Equipment data screen the actual material entered data are:

- The number of equipment used.
- The number of working days for each equipment.
- The daily rental rate.
- Enter the data for second equipment until finishing all the required equipment.
- Up-date, Delete or Clear equipment data by the buttons on the screen.

7.4 Subcontract Data Entry

- Click on the "***Next***" button to begin entering subcontract cost data.
- Answer the question about if there is subcontract cost.
- If you choose yes, a sub screen opens.

Estimated Subcontract data

- Enter the estimated unit cost for performing this subcontract.
- Enter the period needed to complete this subcontract.

Actual Subcontract data

- Enter the actual unit cost for this subcontracted item.
- Enter the actual number of working days in this item.

8. Saving Item Data

After entering the cost data related to all of materials, labor, equipment, and subcontract for an item, you need to save this data entry on project database file.

- Click on "***Save Item***" button.
- Follow the same procedures for other items.

9. Cost Forecast

- Click on "***Forecast***" command in "***File***" menu.
- Choose the item and the cost component related to material, labor, equipment, and subcontract. In this the item under investigating is shown at the top of this screen associated with the week number. For every cost component, there are four methods to forecast unit cost for the remaining quantities. These procedures are listed in this screen, and the user should select the method which he finds appropriate to complete the remaining quantities of project.

In **CCS**, there are provisions for four methods to calculate the forecasted cost.

- Choose the appropriate method for estimating the remaining costs.

These methods are summarized as follows:

- The remaining quantities will be executed according to estimated costs.
- The remaining quantities will be executed according to the Actual costs.
- The remaining quantities will be executed according to the average of the estimated unit cost and the actual unit cost.
- The final method is left to the project manager judgment.

In the forecast screen, the forecasted unit cost is automatically calculated and shown in the cell adjacent to its method for the first three methods. For the fourth method, the user should fill the figure he finds appropriate for the remaining quantities.

10. Selective Reports

- The items which have a significant cost overrun can highlighted and isolated in a selective report which shows only the items having a significant cost overrun or underrun.
- Enter the absolute value and percentage limits which he finds that below or above these limits, those items need more investigations.

11. Cost Reports

Click on "***Reports***" in the "***File***" *menu*.

Choose the required report in the sliding screen. These reports are:

- **Cost Control Summary Report.**
- **Component Cost Control Reports (This week).**
  - Material cost control report (This Week).
  - Labor cost control report (This Week).
  - Equipment cost control report (This Week).
  - Subcontract cost control report (This Week).
- **Component Cost Control Reports (Up-to-date).**
  - Material cost control report (Up-to-date).
  - Labor cost control report (Up-to-date).
  - Equipment cost control report (Up-to-date).
  - Subcontract cost control report (Up-to-date).
- **Cost at Completion Report.**
- **Indirect Costs Report.**

Cost control summary report

The first three columns of this report represent item code, item description, and item unit. The next eight columns represent the four cost components which are materials, labor, equipment, and subcontract. For each cost component, there is a pair of columns. One represents this week unit cost, and the second represents up-to-date unit cost. The subsequent three columns represent the estimated total unit cost, the actual

total unit cost for this week, and the up-to-date actual total unit cost. The following two columns represent the percentage of cost variance for this week and up-to-date. The variance here is referred to the estimated cost. The final two columns represent the value of cost variance for each item in this week and up-to-date. The variance has a positive sign for unfavorable performance and a negative sign for good performance.

Material cost control report (This week)

The first three columns give information about each item which are: item code, item description, and the unit of this item. The next four columns show the estimated unit quantity including the percentage of waste, the estimated quantity, the unit purchasing price for each material, and the estimated unit cost for each material.

The next five columns show the actual executed quantity in this week, the actual unit quantity, the quantities of materials used, the actual unit purchasing price for each material used, and the actual unit cost for each material comprising this item. The following two columns show the variances in material quantities. One of these two columns represents the variance between the estimated quantity and the actual quantity used as an absolute value and the other column shows it in a percentage value. The next are the price variance columns expressed as an absolute value and as a percentage value. The final two columns in this report are the materials cost variance expressed as a percentage and as an absolute value.

Labor cost control report (This week)

The first four columns of the Labor cost control report represent information about the item such as item code, item description, unit, and bill quantity. The next three columns illustrate estimated values for daily productivity rate per crew, estimated daily wage, and estimated labor unit cost. The third column in this group represents the estimated labor unit cost which is the product of dividing productivity rate by daily wage. The next five columns represent actual labor data for this week. These columns show the executed quantity in this week, the number of crews needed to finish this quantity, the actual productivity for executing this quantity (which is produced by dividing the executed quantity by the number of crews), the actual daily wage per crew, and the actual labor unit cost. The next two columns represent the percentage of variance in crew productivity and in daily wage. The final two columns represent the labor cost variance expressed as a percentage and as an absolute value.

An important note in this report is that the negative sign for the productivity variance indicates unfavorable performance contrary to other figures in the different reports.

Equipment cost control report (This week)

The equipment cost control report shows the basic information for the item under study in the first four columns. These are item code, item description, unit, and bill quantity. The next three columns show the estimated values for the productivity rate for each equipment in this item, daily renting rate, and the estimated unit cost for all equipment used. The next five columns show actual values for the executed quantity in this week, the number of equipment used in this week, the actual productivity rate (which is produced by dividing the executed quantity by the number of equipment used), the actual renting rate, and the actual equipment unit cost. The subsequent two columns show the variance in the productivity rate, and the daily renting rate for each equipment expressed as a percentage value. The final two columns in this report show the value of variance in equipment cost for this item expressed as a percentage value and in absolute value.

Subcontract cost control report (This week)

The first four columns in the subcontract report show item code, item description, unit, and bill quantity. The next column shows the executed quantity in this week. The subsequent two columns show the estimated unit cost and the estimated productivity predicted to execute this type of work. The next two columns show the actual unit cost and the actual productivity in executing this week quantity. The subsequent two columns show the percentage in variance in unit cost and in productivity rate. The final column represents the value of variance in executing this subcontracted item.

Material cost control report (Up-to-date)

This report is like this-week material cost control report, except that the values in the report are for up-to-date quantities and prices. These values show the up-to-date used quantities, the up-to-date unit quantity, and the up-to-date unit-purchasing price for each material. The up-to-date quantity is the total of the quantities of used materials.
The rest of this report presents the quantity variances and price variances in both absolute and percentage values. The final two columns show the up-to-date cost variance for each item expressed as a percentage and as an absolute value.

Labor cost control report (Up-to-date)

Besides the basic information for each item and the estimated value for labor cost, the up-to-date labor cost control report shows the up-to-date executed quantities, the total number of crews needed to execute these quantities, the corresponding crew productivity, the average of the daily wage, and the associated unit cost for the up-to-date period. The next three columns show the percentage of variance in productivity, wage, and unit cost. The last column shows the up-to-date value of variance.

Equipment cost control report (Up-to-date)

In this report, the total number of different equipment needed to execute the up-to-date quantity is shown. Also, the average of the productivity rate and the average rental rate of each equipment is established. From these data, the equipment unit cost for each item is calculated. Also, this report shows the percentage of variance for the up-to-date productivity, renting rate, and unit cost. The final column of this report shows the value of variance of the equipment component to this item.

Subcontract cost control report (Up-to-date)

This report is similar to this week subcontract cost control report except that the data for the unit cost and the productivity rate are the average of the previous weeks taking into account the weighted average of the executed quantities each week.

Cost at Completion Report

In this report, the first four columns show basic information about an item such as: item code, item description, unit, and bill quantity. The following two columns show the estimated unit cost and the estimated cost for bill quantity. The subsequent two columns show the up-to-date executed quantity and the remaining quantity up-to-date. The following two columns show the up-to-date actual unit cost, and the forecasted unit cost for the remaining quantity. The subsequent three columns show the actual cost, the forecasted cost (cost to complete), and the cost at completion for each item when it is completed according to the new situation. The final two columns show the variance between the estimated cost and the cost at completion expressed as an absolute value and as percentage.

12 Indirect Cost Control

- Click on the "***Add indirect cost***" command under "***File***" menu, then the "***indirect cost***" screen opens.
- Fill each of the indirect cost requirements in addition to its measurement unit.
- Fill the estimated number of the indirect cost elements and its estimated unit cost.
- Fill the actual number of indirect cost elements actually used.
- Fill the actual unit cost of indirect cost elements actually used.

Note: Controlling indirect costs is done at the end monthly.

Indirect Costs Report

In this report, the first three columns show the serial number, the list of indirect cost elements and the unit of measurement for each element. The following two columns show the estimated required numbers and the estimated unit cost for each unit of the indirect cost elements. The subsequent two columns show the actual used number and its actual unit cost. The final two columns represent the cost variance in the indirect cost elements as a percentage in one column, and as an absolute value in the second one. At the end of each month, the total value of indirect cost variances is shown.

13. Others

Show Last Week Items

- Click on Last Week Items button. All the items in the last week will be shown.

Printing Reports

- Press on Print command in the ***File*** menu.
- Select the range of pages and number of copies you want to print.
- You can enlarge the reports by pressing on Zoom out button.

Refreshing software Data

- Highlight any item and click on refresh Project data.
- Change the data which are needed by pressing on refresh data.

Annex 11

A Sample Cost Coding System

The following cost coding system is a proposed cost coding system. It could be used in the developed cost control software **CCS**.

MASTER COST CONTROL CHART OF ACCOUNTS	
Code	**Item**
100 through 199	Labour
200 through 299	Material
300 through 399	Company owned plant
400 through 499	Subcontractors
500 through 599	Site establishment
600 through 699	Site office expense
700 through 799	Operating expenses
800 through 899	Plant hire
900 through 999	Overhead/profit

MASTER COST CONTROL CHART OF ACCOUNTS

Cost No.	Item	Cost No.	Item
-100 through 199	Labour	-400 through 499	Subcontracts
-101	Excavation Labour	-401	Plumbing
-102	Backfill Labor	-402	Mechanical
-103	Compaction Labor	-403	Fire proofing
-104 through 109	Unassigned	-404	Electrical
-110	Concrete forms	-405	Painter
-111	Stripping forms	-406	Roofing
-112	Shoring	-407 through 499	Unassigned
-113 through 114	Unassigned		
-115	Framing	-500 through 599	Site Establishment
-116	Sheeting		
-117 through 119	Unassigned	-501	Site office cabin
-120	Door frames	-502	Site office furniture
-121	Doors	-503	Site office equipment
-122	Windows	-504	Fencing
-123	Cabinets	-505 through 599	Unassigned
-124	Hardware		
-125 through 189	Unassigned	-600 through 699	Site Office Expenses
-190	Project Manager		
-191	Engineer	-601	Telephone
-192	Administrator	-602	Office Supplies
-193 through 199	Unassigned	-603 through 699	Unassigned
-200 through 299	Materials	-700 through 799	Operating Expenses
-201	Forms framing	-701	Temporary toilets
-202	Form plywood	-702	Drinking water
-203 through 214	Unassigned	-703	Temporary water
-215	Framing	-704	Temporary electrical
-216	Sheeting	-705	Tools
-217 through 219	Unassigned	-706	Deliveries
-220	Door frames	-707 through 799	Unassigned
-221	Doors		
-222	Windows	-800 through 899	Plant Hire
-223	Cabinets		
-224	Hardware	-801	Excavation equipment
-225 through 229	Unassigned	-802	Cranes
-230	Form hardware	-803	Compressors
-231	Framing hardware	-804	Trucks
-232	Nails	-805 through 899	Unassigned
-233 through 299	Unassigned		
-300 through 399	Company Plant	-900 through 999	Overhead & Profit
-301	Hoists	-901	Bonds
-302	Dumpers	-902	Insurance
-303	Vibrators	-903	Legal
-304 through 399	Unassigned	-904	Warranty reserve
		-905 through 997	Unassigned
		-998	Indirect overhead
		-999	Profit