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TITLE: -

Computer Application on Construction Works Payment Certification

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EXAMINER

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Abbreviations/ Definitions

→ FIDIC
- FEDERATION INTERNATIONALE DES INGENIEURS-CONSEILS (FIDIC) General contract condition

→ MoWUD
- MINISTRY OF WORKS AND URBAN DEVELOPMENT STANDARD CONDITIONS OF CONTRACT FOR CONSTRUCTION OF CIVIL WORK PROJECTS

→ PPA
- Public Procurement Agency

→ BOQ
- Bill Of Quantity

→ CPC
- Construction Payment Certification

→ Ms
- Microsoft

→ VB
- Visual Basic

→ Syntax
- Codes used to give orders to a computer in a statement form the set of rules that define the combinations of symbols that are considered to be correctly structured programs in that language. The syntax of a language defines its surface form.[1] Text-based programming languages are based on sequences of characters, while visual programming languages are based on the spatial layout and connections between symbols (which may be textual or graphical).

→ Ms-SQL server
- Microsoft **SQL** (officially pronounced /□□skju□□□l/ like "S-Q-L" but is often pronounced /□si□kwəl/ like "Sequel"), often referred to as **Structured Query Language**, is a database computer language designed for managing data in relational database management systems (RDBMS), and originally based upon relational algebra.

→ ConMIS
- Construction Management Information System

Abstract

The construction industry is one of the largest industries influencing the country's economic status. In Ethiopia the construction industry is mostly blamed of the extended time and cost. Out of the many reasons for the elongation of time, lack of proper management system is the prominent one. And the proper management system consists of automating routine works and focusing on the unstructured challenges. Payment certificate processing is one of the tasks that need automation in a computerized system.

This paper work tries to show the theoretical background of payment certification. Asses the trend of payment processing and identify the critical tasks that necessarily be performed and the ones that can be omitted. Based on the assessment, the study introduces a new chart that proposes the way payment certification shall be processed. The new chart of activity flow, if computerized, can reduce the time wasted on payment certificate processing. To demonstrate the proposed idea model software is developed and tested.

Finally the paper tries to show the implication of the findings on the concerned parties.

Part One:

Chapter I- *Introduction*

1.1 General

Construction is unquestionably one of the most significant industry contributing to all developed and developing countries economy in terms of gross domestic product and employment (C.E, 2009). It is where much of the country's budget is allocated next to ministry of agriculture in Ethiopian context. The industry by its nature is the most complex and multidisciplinary field of practice, the reason why it has different stakeholders. It is the way through which infrastructure and development facilities are fulfilled as a product of the different sectors of the industry. Broadly, the major classification in construction industry can be categorized in to *Building construction, Highway and streets, Municipal and Utility, heavy and rail road construction, water works construction and specialty construction* based on the service it gives.

As a multi disciplinary and a development facilitating industry, construction has different stakeholders contributing and influencing it. Each stakeholder has its unique role in the construction process. Among the contractual stakeholders the following three are the major ones;

→ ***Employer*** (private or government): - initiate investment ideas and fund the project. The employer as a client is contractually obliged to make payments and receive the product, has the right to change the scope of the work, approves payment certificate.

→ ***Consultant*** (a professional or group of professionals of design, project management etc): - consult the client on the investment idea and during construction, act on behalf of the client. Contractually obliged to inspect and supervise the work process. Has the right to give order to the contractor, certifies payment certification.

→ ***Contractor*** (individual or organization): - brings the clients need to reality by constructing the proposed design idea, contractually obliged to complete the works in accordance with the specification agreed upon, has the right to apply for payment for works completed, and demands the consultant's certification and the client's approval in order to be entitled for payment.

Payment in any production and/or service rendering industry is like fuel for engine. In construction, payment certification involves different levels of tasks. The tasks are routine and involve calculations. Before the actual payment certification is performed it is these routine tasks that make payment certificate preparation tedious and takes much of the time. If there had been a means to automate these tasks by means of computer aided system, the time and the paper works and also the error that might result from calculations would have been eliminated. Therefore this study tries to seek solutions for these problems.

1.2 Objective of the study

The main objective of this thesis work is to: -

- Show the trend of payment certificate preparation process
- Introduce a computerized system that will result in:
  - Reduced time and paper works spent on payment certificate preparation by automating the tasks
  - Facilitate ease of data processing and handling
  - Increased accuracy of the calculations involved

1.3 Scope of the study

The scope of this thesis work is limited to analyzing the trends used to prepare payment certificate in the construction industry. Show the drawbacks and recommend a better systematic way of doing it by applying computerized system. The trend analysis was done on sample building construction and did not considered any other sectors of the construction industry.

1.4 Limitations

Time was the main constraint that restrained the writers of this thesis work from performing detailed analysis. It would also have been possible to introduce a better and more sophisticated computer system that can give aid on more of the tasks involved in CPC preparation.

1.5 Organization of the study

Part one:

Chapter one-Introduction

→ Deals with the general introduction of the construction industry as a whole. The types of the construction sector and the stakeholders are discussed. The objectives, scope, limitations and organizations of the study are also discussed in this chapter.

Chapter Two-Methodology

→ Describes the methods used to conduct the thesis. The flow of activities in conducting the study, the techniques employed in data collection, the way data was analyzed is discussed.

Chapter Three-Literature review

→ Shows the general contractual and legal basis for payment and the related concept as in FIDIC and MoWUD. The chapter also discuses payment related issues from publications of other scholars. The steps followed in payment certificate preparation and sample formats utilized in payment certification are included. The descriptions about what Visual Basic is, advantages, and the specific features used for our purpose are discussed in detail.

Part Two: Discussion and Analysis

Chapter IV- *Focus Group Discussion* Result

→ Discuses the results based on the Focus Group Discussion. The topics discussed on, the participants profile, and the responses for every topic are discussed.

Chapter V- *Desk* Study; *CPC Preparation by applying computerized system*

→ Shows the payment certificate preparation process by using particularly developed software. The activity flows in the CPC preparation by using the model software are shown in chart. The features of the software are also shown in photos captured from the model software.

Part Three:

Chapter VI- Conclusion and Recommendation

→ Summarizes the results from the focused group discussion and desk study
→ Concludes from the results based on the principle of payment certificate preparation as stated on the conditions of contract.
→ Recommends on the advantages of using particularly developed software for construction payment certificate preparation.
→ Discusses on the implications of the finding of the study on different parties.

Chapter II *Methodology*

2.1 General

The flow of activity in this study starts from the proposal idea. To continue the thesis writing, the first job was to collect data by using different techniques. The techniques used to gather data for this thesis work are of two types: Focused group discussion and Desk study. The procedures followed to come up with the conclusion can be summarized in the following diagram. The activities shown are discussed next to the diagram.

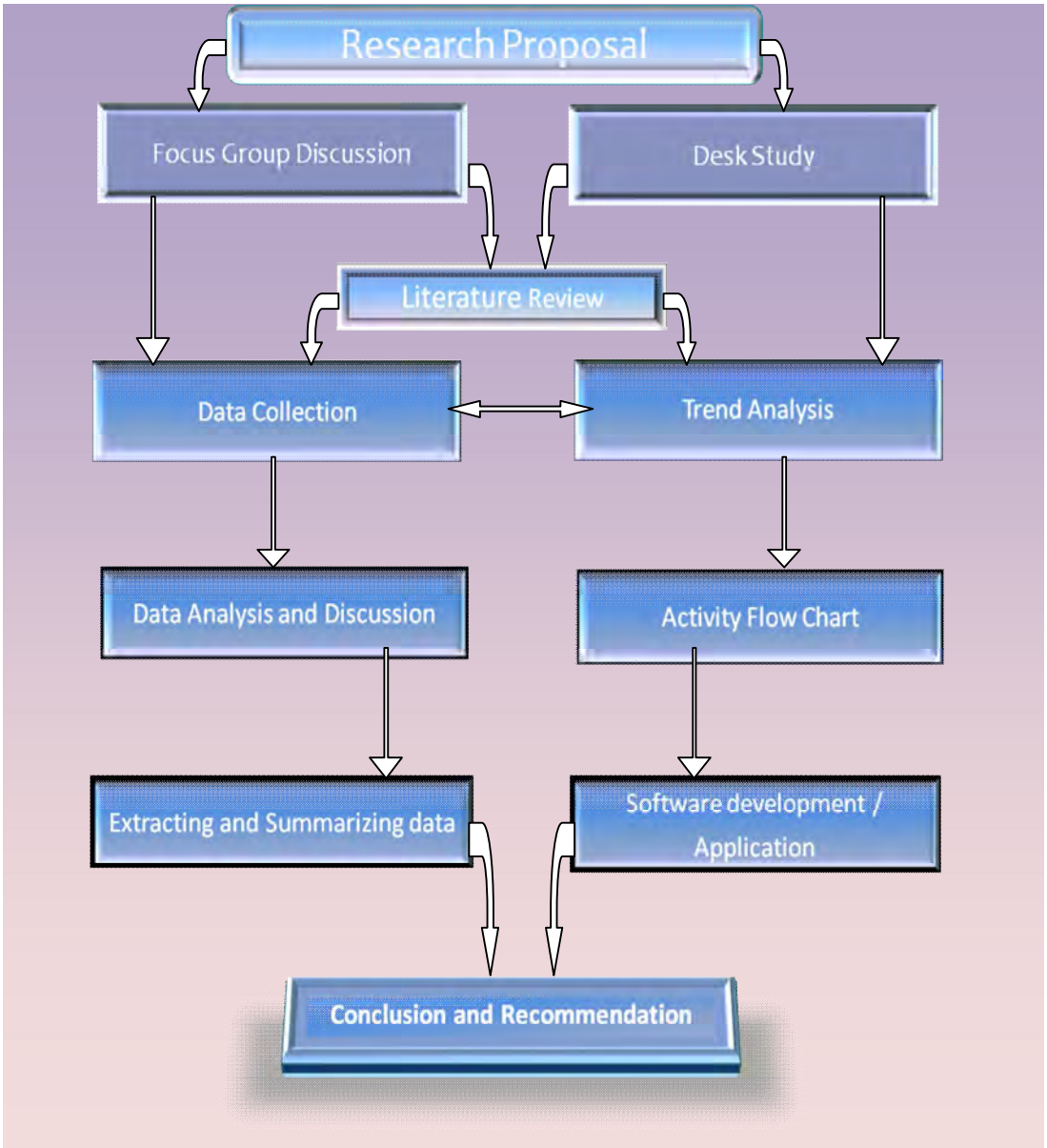


FIGURE 1 RESEARCH METHODOLOGY

2.2 Research proposal

The proposal which was submitted earlier, showed the basis for the study work. The scope and objectives of the study are stated on the research proposal. The procedures to be followed were also stated and the study work was done accordingly.

2.3 Focus group discussion

From the focus group discussion data was gathered by using open ended interview questions and discussing on them. In combination with the literature review results the data were analyzed and discussed. The results were also combined with the results from trend analysis and model software application (desk study). Then the results are used as an aggregate for the development of activity flow chart which is utilized to be an input for writing the software program. The results are also used for the thesis writing.

2.4 Desk study

The desk study is done through assessing the trend of payment certificate preparation in Sample Construction Company and by applying the model software. Then every steps used in the traditional method of payment certificate preparation were recorded and studied carefully. After reviewing the significance of each activity involved and identifying the most critical task, a new activity flow chart is developed. The new chart included the tasks that are believed to be critical and ignored those that are not. The model software functions in accordance with the new activity flow chart.

2.5 Literature review

The literature review is mainly based on the conditions of contract; FIDIC, MoWUD and PPA. Clauses related to payment issues are discussed in detail. Other related publications on payment certification by different scholars are also discussed. The literature review here is not only used to show the related publications, but also as a basis for the generalization for the conclusion part. The reason why the generalization was based on the literature review is that the literature review itself is based on the conditions of contract, and the conditions of contract are the basis for any activity under contract including payment certification. Therefore the study conclusion had to comply with clauses on the conditions of contract as the conditions of contract are the basis for every contractual work.

2.6 Data collection

In addition to the information gathered from the focused group, data was collected from different sources. The main sources of data are contractors and consultants, and other organizations in the construction industry like the software developing companies for commercial purpose have also contributed. The techniques used were mainly interviews and archives.

2.7 Data Analysis and discussion/ summary

The data collected was analyzed by deduction in a qualitative manner. The discussion was done by comparing the basic principles stated on the conditions of contract specifically FIDIC, MoWUD and PPA with the practice. The main points from the discussion were summarized to be used as conclusion.

2.8 Trend Analysis

The practice of payment certificate processing was carefully studied. The importance of every step was critically discussed, and the information gathered was used as an input for analysis and discussion to be compared with the principle.

2.9 Activity flow chart

The chart was developed by modifying the trend of payment processing. The modification was possible because some of the tasks executed by human action can be automated to be done by the computer application. In the chart different arrows were used to show the flow of command and data. Some activities cannot be felt by humans but only the computer does. The user only feeds the basic input data into the computer, and sees the end result which is the report. The reports comply with the basic requirements of payment processing.

2.10 Model Software development / Application

To demonstrate the advantages of using computer application, model software was developed and checked by applying to real project. The payment was previously processed by the traditional way. The inputs and outputs were the same but the difference in the processing has drastically reduced the time spent on payment processing in the usual way.

2.11 Conclusion and recommendation

After passing through all the steps discussed above the writers of this study have come up with conclusions and recommendations. The conclusions are the combinations of the summaries from the trend analysis and the focused group discussions. The recommendation has shown the implication of the study in the industry and other concerned institutes.

Chapter III *Literature Review*

3.1 General

'Cash flow is the blood line for any kind of industry be it production or service rendering.' (Construction management web site; www.constructionmanagementguide.org) Payment is a gate valve of cash flow to control the flow in a discrete manner. In construction, payment is done on a contractual basis; every scenario related to payment issues is bind with clauses on different conditions of contract.

3.2 Construction payment certification

Contract for construction works consists of two major parts; promissory (the work) and consideration (the payment). Payment in construction is made for different reasons (*Advance payment*; to support a contractor mobilize the necessary resources to the construction site, *interim payment;* for every completed work according to the agreement and the agreement may include the minimum amount of work to be completed in order for the contractor to be entitled for payment, *liquidated damage;* compensation for damages due to either party's fault, etc). Different standard conditions of contract have stated in their clauses about the way payments shall be treated in different situations. Under the next topic some of the clauses related to payment certification are discussed as stated in FIDIC 1987, revised in 1992 and Standard Conditions of Contract MoWUD DECEMBER, 1994.

3.2.1 **Basic concepts of payment certification as stated on conditions of contract**

Payment certification process has three distinct but interrelated sequential stages to pass through. Application for interim payment, payment certification and payment approval are the stages. The three contractual stakeholders; the Contractor, the Consultant and the Employer are the parties that act to let the process pass through the stages respectively.

Interim Payment Application

'The Contractor shall submit to the Engineer after the end of each month six copies, each signed by the Contractor's representative...' (FIDIC Clause 60.1 and MoWUD clause 60, (1)) This is the point where the payment certificate preparation process starts. The contractor applies for payment by summiting a monthly statement to the consultant's representative (Engineer). The application shows the amount of work that the contractor assumes himself to be entitled, which includes: -

→ The quantities and value of the permanent work executed on Site.

→ The value of materials on Site intended to form part of the permanent work together with supporting invoices.

→ The value of temporary work, as included in the Bill of Quantities and completed on Site.
→ An amount reflecting any changes in cost.
→ Amounts approved in respect of day works executed up to the end of the month in question.
→ The monthly statements shall be in an approved form and shall comprise an original and one copy, each duty signed by the contractor.

This is the reason why a contractor needs to have a means of processing the measured quantity. And as the quantifying process entails detailed manipulations there is always a desire that arises from the job. The desire being accuracy, speed, relentlessness, ease of previous data retrieval, organized data storage system etc can be attained through application of computerized.

Interim Payment Certification

The statement in order to be approved by the Employer demands prior certification by the representative of the consultant (Engineer). The Engineer after checking and agreeing upon the contents of the statement that the contractor stated, will certify within 28 days or 30 days as stated on FIDIC and MoWUD respectively. For ease of this specific task, computer application is the most important tool. Arithmetic errors are never expected to happen ones correct measurements are fed. The contractor after discussion with the Engineer if decides to make changes on the input data still the fastest way of doing this demands a computer help. The engineer after checking the statement, if orders some changes to be made, he can make the rest to remain without any change, if computerized system is used. This helps the Engineer to avoid rechecking the item of works that are not changed and only focus on the works he ordered, because only he can make change on the restricted ones.

The amount stated on the monthly statement is not directly forwarded to the Employer for approval rather is subject to some modes of deductions. As FIDIC Clause 60.2 and MoWUD Clause 60, 2 stated there is a need for calculating the deductions with some specified percentage. This calculation if needed to be free of error and reduce the time spent on the process it shall be automated so that the computer automatically performs the required tasks.

'The Engineer may by any Interim Payment Certificate make any correction or modification in any previous Interim Payment Certificate…' (FIDIC Clause 60.4 and MoWUD clause 60, (5)) One of the advantages of using computer application for the payment certification is that it allows us to have a well organized data base system so that we can retain back up of every document. The Engineer can any time retrieve the previous data and modify if computerized database system is used. The modifications can also be incorporated easily with the rest of the data.

Interim Payment Approval

This is the final stage for payment certification to be completed. The Employer is the one who has the power to finalize the process by approving the issuance of the payment. As stated on FIDIC Clause 60.10 the Employer has 28 day to approve and issue interim payment and 56 days for final payment. The contractor, if not paid within the 28 or 56days of interval, can claim for liquidated damage due to delayed payment. The delayed payment when released after the specified interval on the standard conditions will be subjected to interest considerations.

The client/Employer can manage and approve the payment process easily and automatically. The computerized system if automated properly can take control of every consideration including the claims.

3.2.2 **Project payment certificate preparation steps/process**

Payment certificate preparation process is always initiated by the contractor's application for payment. The application is submitted through monthly statement which consists of the quantity of work completed, the amount of that quantity the client is supposed to issue and other details. But the ***first step*** to all the processes is taking off.

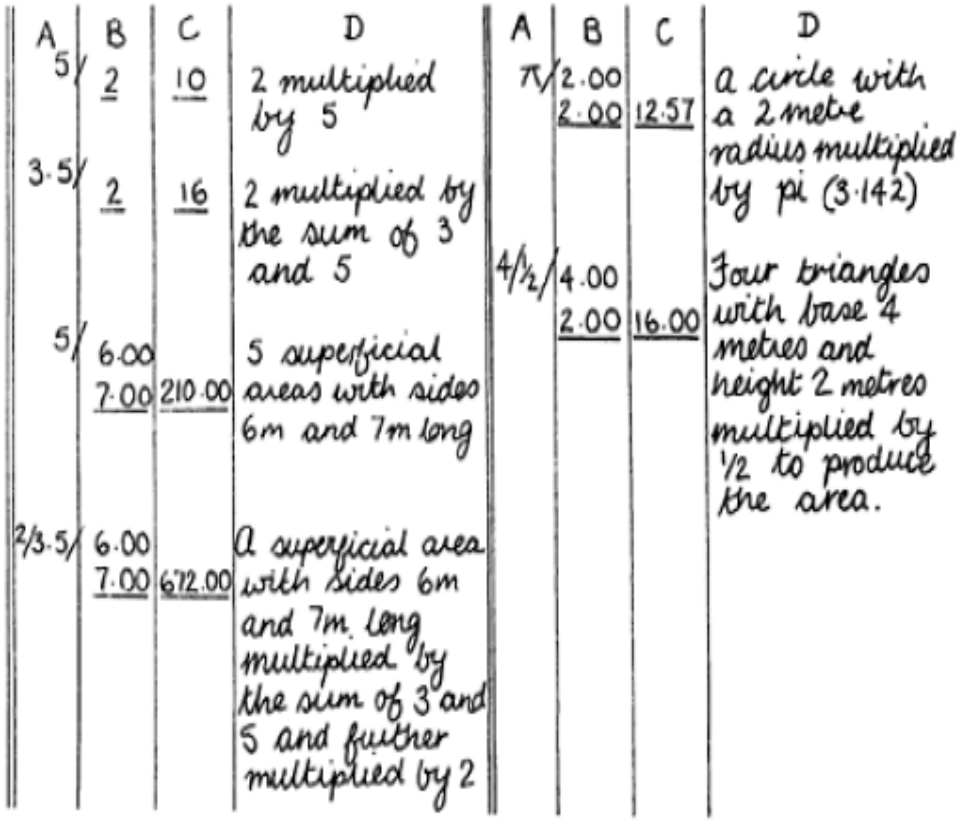
'Until comparatively recently, the person preparing the Bill of Quantities—the 'taker-off'— had a limited choice of how to convert the information on the drawings into a Bill of Quantities. Traditionally the systems followed a procedure of:

Taking off - measuring from the drawings and entering the dimensions on to specially ruled dimension paper,

Squaring – calculating and totaling the lengths, areas and volumes of the dimensions,

Abstracting - collecting the totals from the dimension paper on to an abstract to produce a final total for each individual description,

Sample Take off Sheet



A	B	C	D
5/	2	10	2 multiplied by 5
3.5/	2	16	2 multiplied by the sum of 3 and 5
5/	6.00 7.00	210.00	5 superficial areas with sides 6m and 7m long
2/3.5/	6.00 7.00	672.00	A superficial area with sides 6m and 7m. long multiplied by the sum of 3 and 5 and further multiplied by 2

A	B	C	D
π/	2.00 2.00	12.57	a circle with a 2 metre radius multiplied by pi (3.142)
4/½/	4.00 2.00	16.00	Four triangles with base 4 metres and height 2 metres multiplied by ½ to produce the area.

(Taking Off Quantities: Civil Engineering-First edition 1995, reprinted in the Taylor & Francis e-Library 2005 p11-18)

→ The letters on the Take Off sheet sample; A, B, C and D are place holders for this particular case and what they represent is discussed next: -

A: Times- a multiplier column

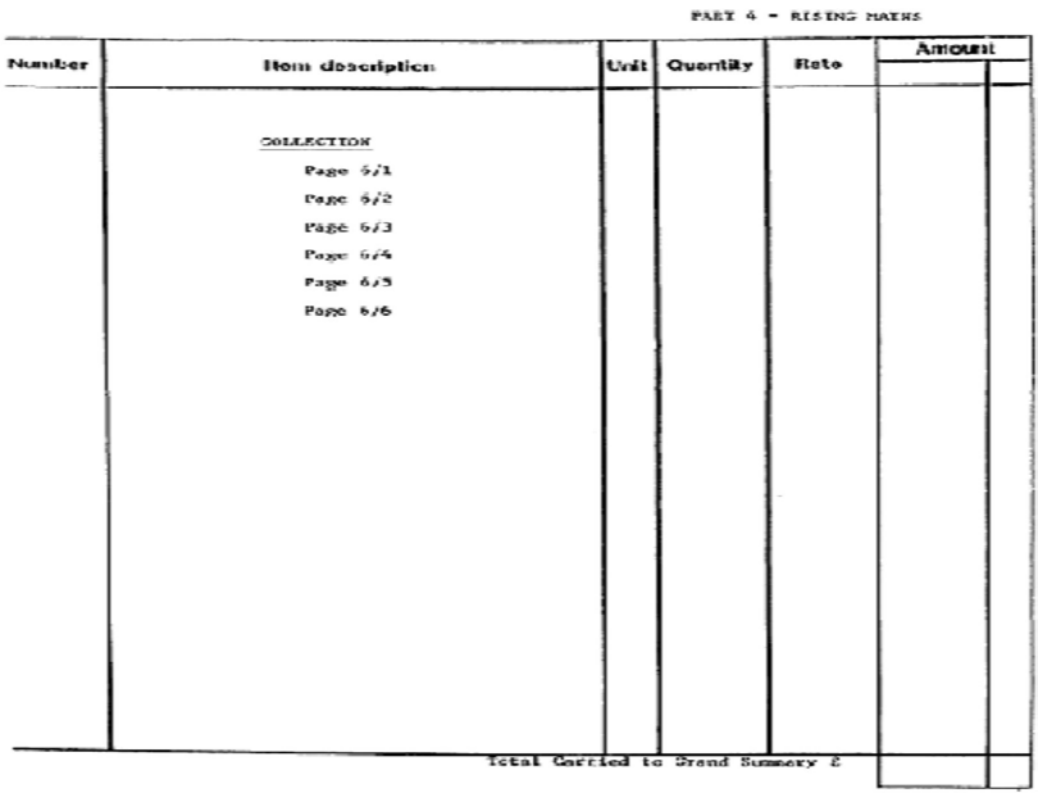
B: Dim- a column for dimensions; Length, Width, Height

C: Sqr- (squaring) a column for products of the dimensions on the left column

D: Description- a column for description of the trade of works, every detail for a given task is written here

Billing - reproducing the items from the abstract on to bill paper in draft form ready for typing.'

Sample Bill of Quantity



PART 4 - RISING MAINS

Number	Item description	Unit	Quantity	Rate	Amount	
	COLLECTION					
	Page 6/1					
	Page 6/2					
	Page 6/3					
	Page 6/4					
	Page 6/5					
	Page 6/6					
	Total Carried to Grand Summary 2					

(Taking Off Quantities: Civil Engineering-First edition 1995, reprinted in the Taylor & Francis e-Library 2005 p11-18)

The second step is to summarize all the amounts on the bill of quantity by its respective trade of work. The summary is built up of columns that show item no. of the work, its description, contract amount, and amount of the work executed previously and also the current amount of work executed. Depending on the size of work grand summary might be used to summarize the work in blocks or other means of generalizing.

The final step to complete the preparation process is to bring the total of the summary to the payment certificate format. The format therefore consists of the contract amount, amount of work executed, deductions, previous payments, the balance to be paid to the contractor and detailed descriptions of the project. There is also a space left for confirmation of the preparer, certifier and approver.

Sample Payment Certificate Format

Page _____

Payment Certificate Sheet

Certificate of Payment No. : _____

Date: _____

Project: _____
Contract No: _____
Contract Date: _____
Owner: _____
Contractor: _____
Location: _____

	Amount (Curr)
Main Contract	
Supp. Contract	
Contract Change No. 1	
Contract Change No.2	
Contract Change No.3	
Total Sum	

As per attached measurements and priced bill of quantities, the value of works executed and / or material supplied and net sum due to the contractor to date is:

Previous Payments		
PC. No.	Date	Amount
Advance		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Total Exc. VAT		

		Amount
Total Sum due to the Contractor		
Deductions		
Previous Payments		
Rebate (… %)		
Retention (5 % of exc.)		
Penalty		
Advance Repayment		
Others		
Total Deductions		
Net Sum Due to the Contractor		
15 % VAT		
Net Sum including VAT		

We Certify that the Contractor is now entitled to the sum of _____
_____

_____ _____ _____
Certified Approved Seal

Wubishet Jekale Mengesha (Dr.Eng) (April 2006) Procurement & Contract Management

3.2.3 Types of payment certificate

The construction industry is a big family of different sectors that produce different infrastructural facilities. The factors that resulted in some of the slight difference among the sectors are method of production, materials and equipments involved. The

intended function of the infrastructure is a compelling reason for the selection of those factors. However when it comes to payment certificate preparation the main difference lies on the item of works which is related to the factors discussed above. But the steps followed are the same and also the formats serve the same purpose with slight difference in appearance.

3.3 Visual Basic software

3.3.1 General

In the globalized world of our time the planet has started acting like a simple village where everything is easily heard of, and communication through the planet requires minimum cost and time than it used to. This has come true because of the development of information communication technology. In the civilized world the involvement of computers in everyday life has vital role to ease the difficulties in life. Computers, with some limitations of humanity have many advantages over humans. Computers process data much faster than humans do, the accuracy, relentlessness, speed and capacity of memory is also no comparable. As long as we give them the correct input data or unless they are attacked by malicious programs (virus, warm…) computers never make mistakes. The other advantage computers have is that we can set programs that they obey as a rule. Once we set the program they should follow, every time we order them, they know what to do and without negligence they will get it done. Software is a means through which we can give orders to the computer. And the computer also commands its hardware through its respective software. It's also by the help of softwares that we set a program for the computer to follow.

3.3.2 What is Visual Basic software

A computer despite the advantages explained earlier, is just a machine. It requires commands and work procedures to accomplish the intended work. Until now there is no better way of telling the computer what/how to do, than programming language. It is the only way that we can show our computer about the work procedures as the computer doesn't understand human language. Visual Basic is one of the programming languages commonly used in recent days.

'Visual Basic is a development tool that you can use to build software applications that perform useful work …using Visual Basic, you can create applications for the windows operating system, the web, …the most important advantage of Visual Basic is that it has been designed to increase productivity in your daily development work...' (Microsoft_ Visual Basic_ 2008 step by step by Michael Halvorson)

3.3.3 Advantages of Visual Basic Software

There are different types of programming languages currently in use, among them Visual Basic is the most popular. '… Visual Basic makes it much, much easier to write professional -grade windows- and internet-based applications that compete on an equal play field with Visual C++, and C# and Java applications. And the beauty of Visual Basic is that it is much

easier to learn than other programming tools…' (Microsoft_ Visual Basic_ 2008 step by step by Michael Halvorson)

It is not mandatory to be professional programmer to use Visual Basic, but only some basic understanding. There are books on the market that teach the basics of Visual Basic. This helps professionals in other field of practice to develop suitable software that can fulfill their professional need.

3.3.4 **Specific Features of VB Used in this Project**

- ✓ **Integrated Database System**

  VB can be easily integrated with Ms-SQL server so doesn't require working on other applications like Ms-Excel and Ms-Access. The advantage of Ms-SQL over MS-Excel or Ms-Access is its features of high integrity, security and performance. It is possible to work on VB and store/retrieve data right from there to Ms-SQL. This facilitates easier data management system; one of the compelling reasons to use specifically developed software.

- ✓ **Formulas/Calculations**

  VB enables to include formulas that can be used in calculating the required function. The formulas used in payment processing are easily included in the syntaxes of VB programming. This eliminates the need for checking arithmetic errors by the certifier. And avoids writing and/or copying/pasting of formulas when ever payment is prepared.

- ✓ **User Account Separations**

  Authorizations and access controls are possible in VB. This feature is also applied in the model software to separate the privileges of a contractor and/or the consultant/client to protect some information/data that is believed to remain relatively permanent. These include item rate, basic project information, contract amounts etc, that demand negotiation between the contractor and the client/consultant if there arises a need for change.

- ✓ **Data input/output Interfaces**

  It is possible to make friendly user interfaces by using forms. Forms are templates that enable the programmer to create windows application software in an easier way. It is the way through which the user communicates to the computer. In the model software different forms that are specific to the payment certification are used to let the user give an order to the computer.

Part Two:

Chapter IV- *Focus Group Discussion* Result

4.1 General

There are a number of ways to collect data for a given thesis work. Focused group discussion is one of the most popular techniques. 'A **focus group** is a form of qualitative research in which a group of people are asked about their perceptions, opinions, beliefs and attitudes … Questions are asked in an interactive group setting where participants are free to talk with other group members' (From Wikipedia, the free encyclopedia, http://en.wikipedia.org/wiki/Focus_group) Then the responses from the participants are recorded carefully. The writers of this thesis work have selected potential sample population from the construction industry and formed mini focus groups on different times. The need for making mini groups on different times was basically due to the difference between the working time and area of the respondents. The issues raised were limited in the Ethiopian context. The summaries of issues raised and the responses are shown under the next topic. Later on under the last chapter of this paper the summaries are used as an input for conclusion.

4.2 Main points, participants and their profiles

→ The table below shows the main points discussed on, these points are not the only ones but are the major ones.

Topic	Reason for selecting of the topic
Uses of payment certificate software	To identify the uses/benefits of the software from practical experience
Types of payment certificate processing software in use	To see how familiar the construction industry is with the software world
Extent of use over time	To asses if there is a growth of demand for software application
Usage and Size of project	To asses if there is limitation of software applications with project size,
Availability of Software trainings	To know how much aware the industry is, about the advantages of using particular softwares

Draw backs of the traditional way of payment certificate processing	To identify the problem, look for solutions and include the solution in the model software

→ The participants of the focus group discussion and their profiles are shown in the next table. For the sake of uniformity, participants name is not included for the reason that some respondents are not willing.

Participants	**Educational Level**	**Years of experience/ Position/ Current status**
P-1	Building Engineering Dip.	27 /Site/Office Engineer, Project Manager/ Deputy Manager
P-2	Building Engineering Dip. Currently enrolled in CoTM B.Sc.	5, Site Engineer/,
P-3	Building Engineering Dip. Currently enrolled in CoTM B.Sc.	6 , Site Engineer/,
P-4	CoTM Graduate B.Sc.	4, Office Engineer
P-5	CoTM Graduate B.Sc.	3, Site Engineer, Office Engineer, Owns Private Company
P-6	CoTM Graduate B.Sc.	2, Office Engineer,
P-7	CoTM Graduate B.Sc.	1, Office Engineer, Project Engineer
P-8	Water Engineering B.Sc.	4 years in construction as site Engineer, project coordinator

4.3Application of payment certificate software in Ethiopia

The process of payment certification is composed of sequential activities that demand great attention. The process involves calculations and considerations of different factors. The calculations involved make the process laborious and tedious.

These days many companies use Microsoft excel to ease the calculations. However if a software that is particularly prepared for this purpose is used, it would have been easy to automate the work. In this regard let us see the case of Ethiopia based on the responses from the participants of the focused group discussion.

4.3.1 Uses of payment certificate software

Software has a vital importance on payment certificate preparation. The use of software is particularly on quantification of the work executed. The quantification task involves taking measurement and calculating of the linear length, areas, volumes, weights, numbers, etc of the work. These tasks if assigned to specific software and automatically manipulated:

→ The time spent during manual calculation would be drastically reduced

→ Arithmetic errors would completely be avoided

→ The data processing and handling will be easily done

→ The application of Ms Excel is making advantage over the manual calculation. But Excel needs formulas for every manipulation and setting the formulas is not easy.

→ Specifically developed softwares do not need any formulas to be set at all. By just selecting from the available menus, the only thing the user needs to do is feed the inputs the rest is the computers task.

4.3.2 Types of payment certificate processing software in use

Most companies use Ms Excel to process payment certificate preparation. But there are some companies that developed particular softwares.

→ GTZ has developed software for own use that gives aid in controlling projects under GTZIS.

→ There is also commercially available software; ConMIS

4.3.3 Extent of use over time

Sometime earlier payment certificate processing was done manually but these days Ms-Excel is becoming familiar in most companies. Even if there are some softwares available on market which are particularly developed to be used in construction, they are not being fully utilized by the industry. There are factors that hinder the industry from becoming familiar with these softwares. The conservative behavior of the industry, lack of awareness, affordability issues are among the factors.

4.3.4 Usage and Size of project

Softwares can be used in projects of any size but bigger projects are more advised to have a tradition of applying software in their projects. This is due to the increased complexity of projects with their size.

4.3.5 Availability of Software trainings

The importance of software application in projects is inevitable but for companies to be familiar with softwares and apply in every necessary step there must be a paradigm shift. To make this, awareness workshops and software trainings need to be available in an easier and accessible manner. Currently Synergy a company that owns the ConMIS software offers trainings about ConMIS. But yet much needs to be done.

Chapter V- *Desk* Study; *CPC Preparation using computer aided system*

5.1 Software based payment certification

5.1.1 General

There are works that need to be done only by human action. In construction where planning and executing usually does not coincide, the challenges that resulted the deviation need critical thinking, the need for managerial team.
But for routine tasks that come again and again it's a good practice to automate them in a more productive manner. With this regard the writers of this thesis work highly recommend the payment certificate preparation process to be automated. To demonstrate how the automation could have been done sample software is developed. The flow of tasks and logical linkage of the database are shown here under.

5.1.2 Activity flow Chart

Payment certificate preparation process is a whole sum of different activities. The activities are linked together in accordance with their logical sequence. In the traditional way of preparing payment certificate the link has longer linear corridor of activities to pass through. It has a one to one relation between activities and every activity a room for a person to make wrong or right.

But in the case of software application we only have a single activity, to feed the input data. The rest of the activities are linked to each other in the database with a radial and one-to-many relation. The initial input has direct relation with the final output through central database. This makes the process easier and faster.

The user does not participate in the calculation means that the computer does. But the activities to be performed need to be set for the computer by means of programming. The programming used followed the activities done during payment certificate preparation.
In quantification the syntax used is to let the software calculate the linear length, area, volume, weight, no., pieces as an output.

In the bill of quantity the activity involved is to calculate the amount by multiplying the results in the detailed measurement with its respective rate. And the summaries are nothing but abstract of the bill of quantity.

The program set for the payment certificate lets the computer to bring all the necessary information in a summarized form. The data in the general information, contract amount, current amount of work done, percentage of deductions including VAT, amount of previous payment, are brought together on the payment certificate format and the manipulation is done automatically with proper formulas set with the syntax. The following diagram shows the logical link between activities. Activities that

would require the user's action are here just reports. The four types of arrows represent the flow of commands and data. The two bolder arrows represent the user interface; the user gives commands and obtains end results. The other two arrows represent the flow of data from and to database. Only summary from payment certificate is taken back to the database as previous payment.

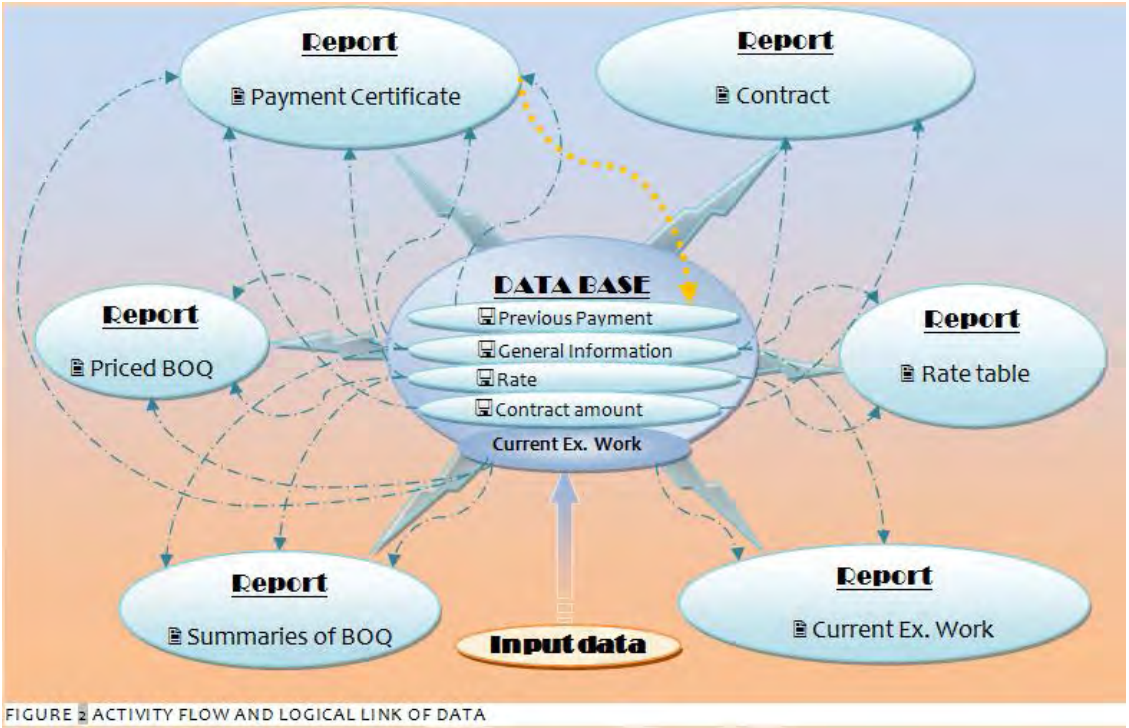


FIGURE 2 ACTIVITY FLOW AND LOGICAL LINK OF DATA

Legend:-

	Logical link; information flow from data base to report
	Summarized data, back to data base and used as an input for future data processing
	User interface
	Data Input and command line

5.1.3 Inputs/ Out puts for the soft ware

The tasks involved in payment certificate preparation are of sequential manner. In the manual or application of Ms Excel the sequences are strictly followed. But in the case of software application it is not necessary to obey the sequential order. Only the following three steps are followed. The first and the second steps are only done at the first instance of payment certificate preparation. For the payments that successively follow, only step three is repeatedly done. This is one of the advantages for saving time by eliminating unnecessary routine steps.

i. ***The first step*** in payment certificate preparation by the automated system is to record permanent information. The permanent information contains details about the location, contract amount, contract no., project start/finish date, name of the client, consultant, contractor etc. This permanent information is the details that we desire to include on the reports of take off sheets, bill of quantity, summaries of bill of quantities, payment certificate, and other reports that the software can produce.

ii. ***The second step*** is to record the temporarily permanent details which includes contract bill of quantity and its respective rate.

iii. ***The last step*** is taking/ recording measurements. The measurements taken are fed into the software with its respective input dialog box. The software automatically produces the required result as area, volume, weight etc. The user does not need to calculate or tell the computer the required result.

After completing data recording as an input, the user can just see any of the required reports without its traditional sequence. The user doesn't need to take part in the processing. That is the machine's duty! The inputs, processing, outputs scenario can be summarized in the following diagram.

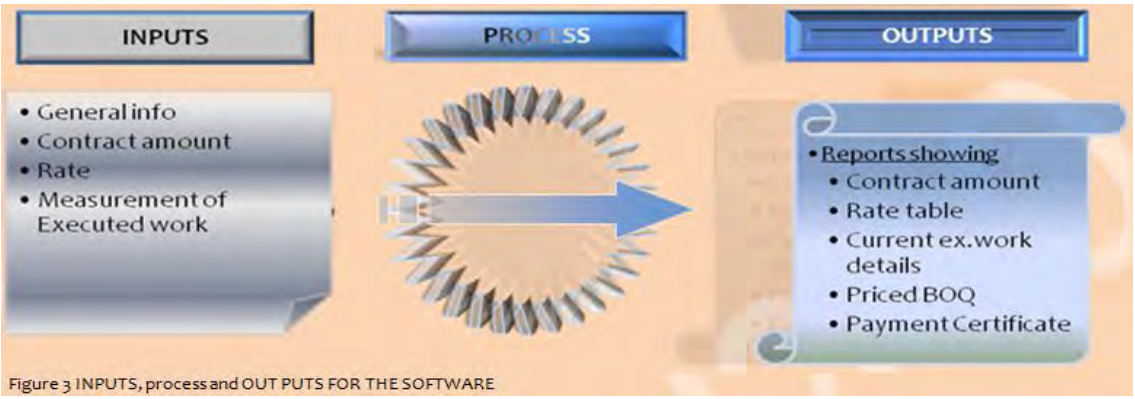
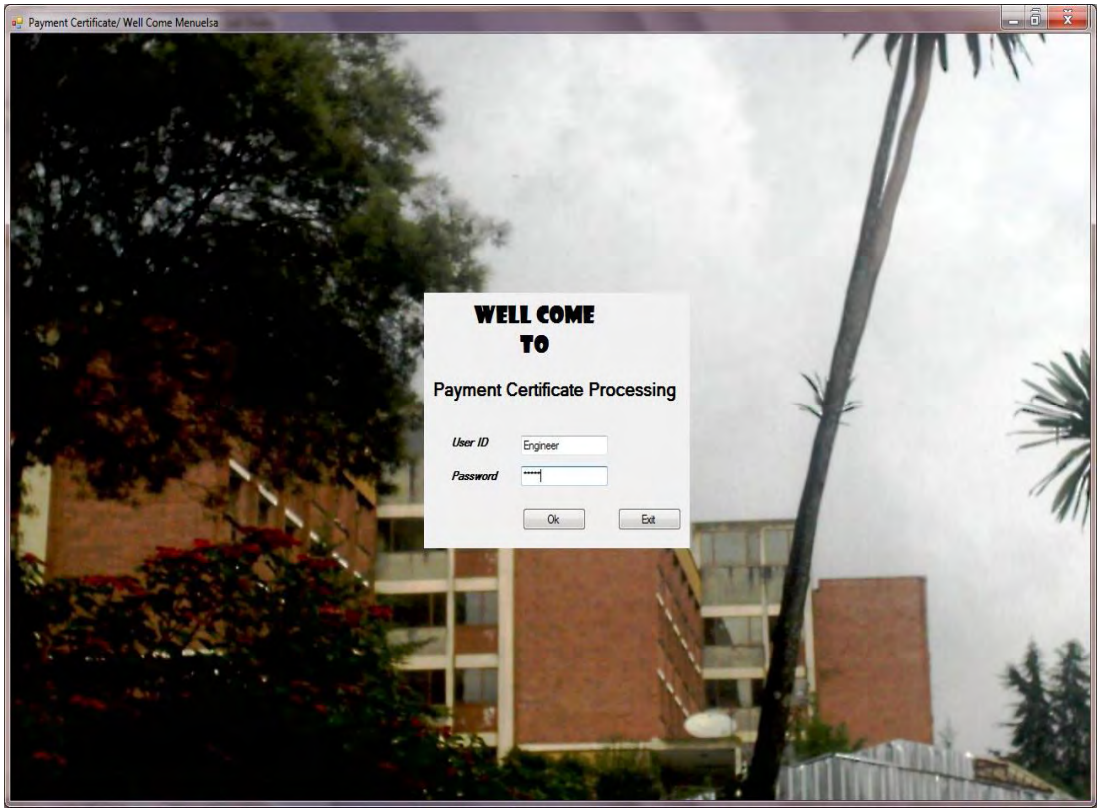


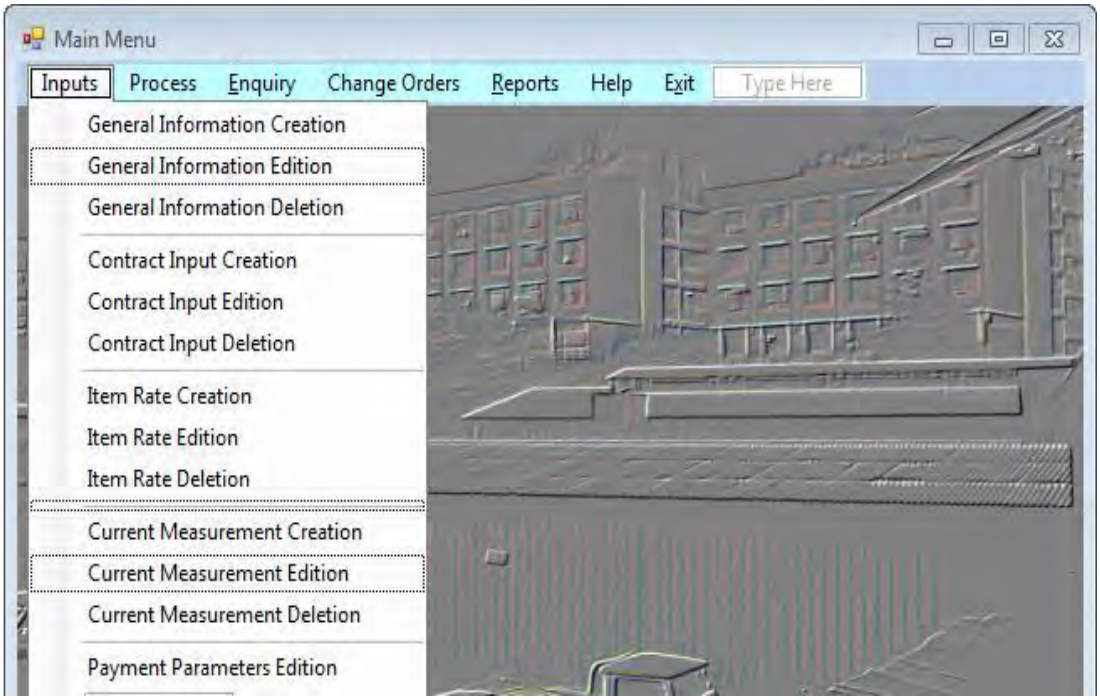
Figure 3 INPUTS, process and OUT PUTS FOR THE SOFTWARE

5.2 Features of the software

✓ VB enables the separation of user. This helps to manage the privileges of the users by allowing and limiting access. This window shows the way users are logged in to be identified by the computer. The contractor and the consultant will have different user name and pass word to log in as their authority differs.

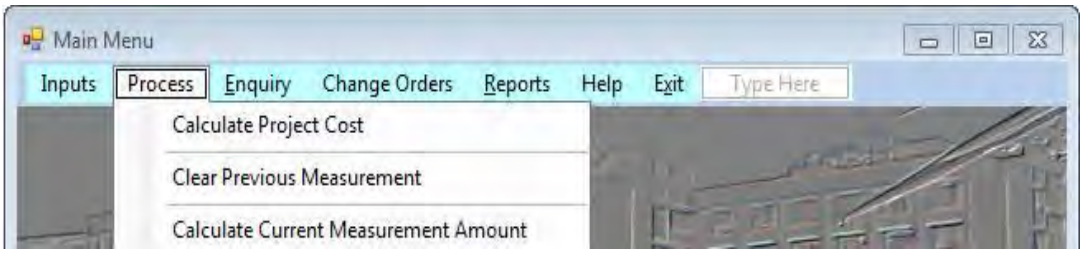


- ✓ This window is where the software displays all of the available menus. We can pick a task from the drop down menus. The menus have different purposes and the software offers different options. For example the *input* menu has the purpose of recording data so the software provides us with the options to create, edit and delete the input data. The input records include general information, contract amount, item rate, current measurement, payment parameters. The parameters are the values of the deductions like retention, penalties, advance repayment and rebates.

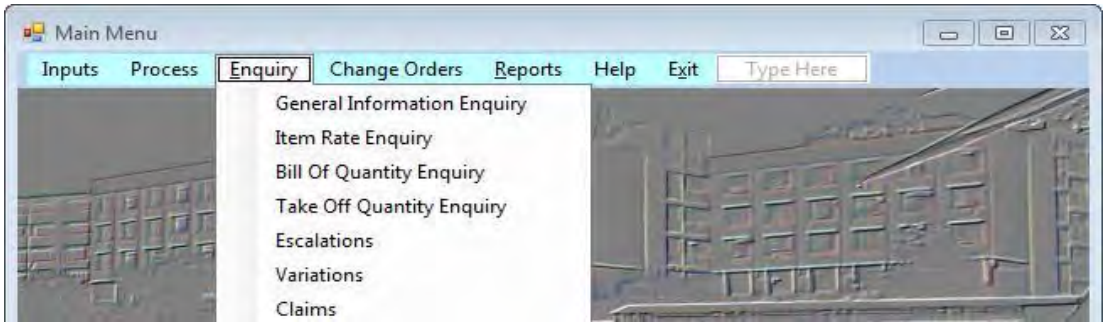


- ✓ The process menu enables us to proceed on calculation. If we recorded a new data for the first time, we need to click on 'Calculate Project Cost' to set the contract amount. Then we can record a new measurement data and click on 'Calculate Current Measured Amount' to process payment certification.

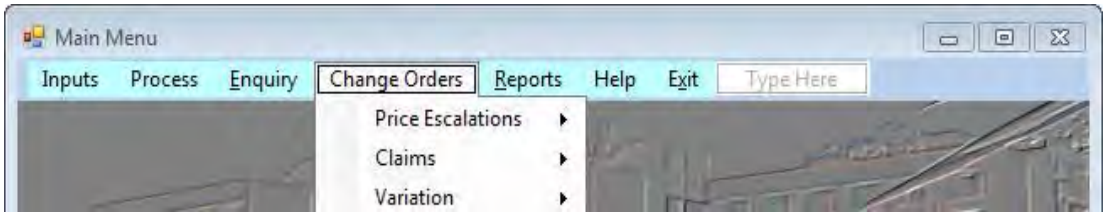
- ✓ To process the second and all the rest of the payment certification, we need to clear the current data by clicking 'Clear Previous Measurement' so that the computer records the summary of the current payment certificate as previous and prepares a space for the new process.



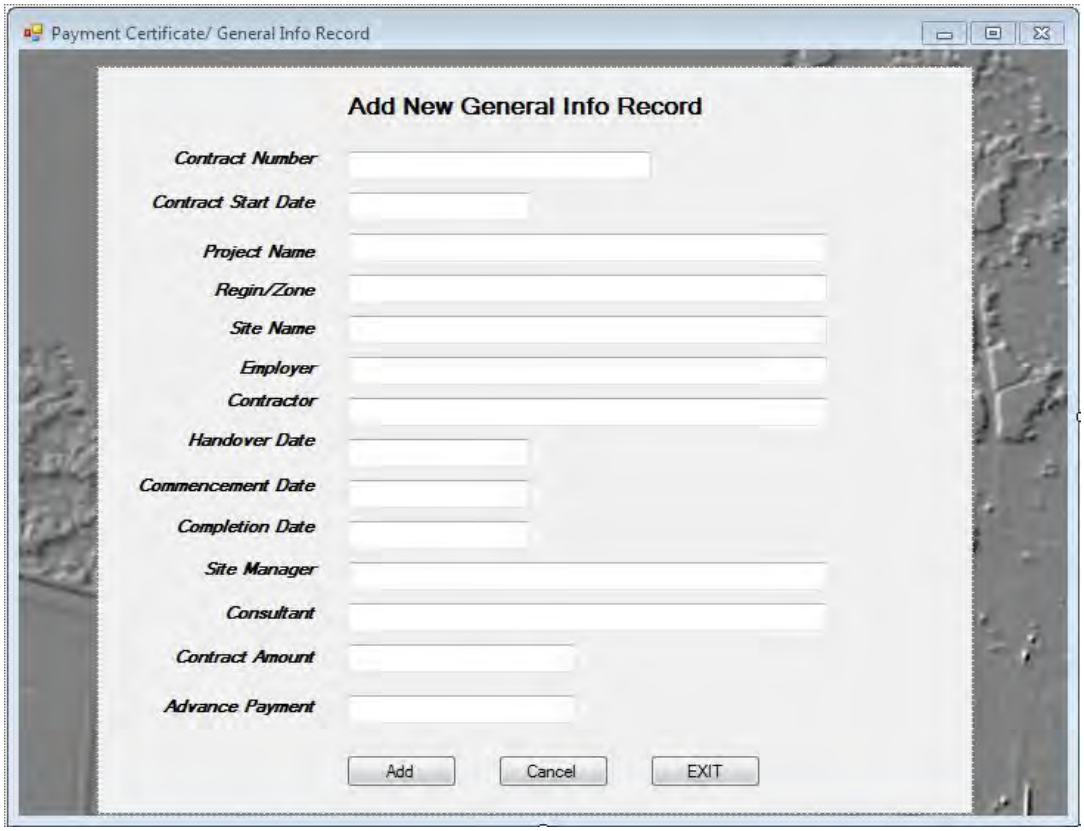
- ✓ Enquiry menu enables us to see all the recorded data in a non editable form. The data to be displayed are General Information, Item Rate, Bill of Quantity, Current Measurement, Price Escalation Details, Variation Orders and Claims.



- ✓ In the change order menu we can record data that not part of the contract. These data may arise from changes in the environment. The data includes price escalations, claims due to different cases, variation orders. It is also possible to edit and/or delete these records when necessary. These data are stored separately in the database however their summary will be included in the payment certificate report.

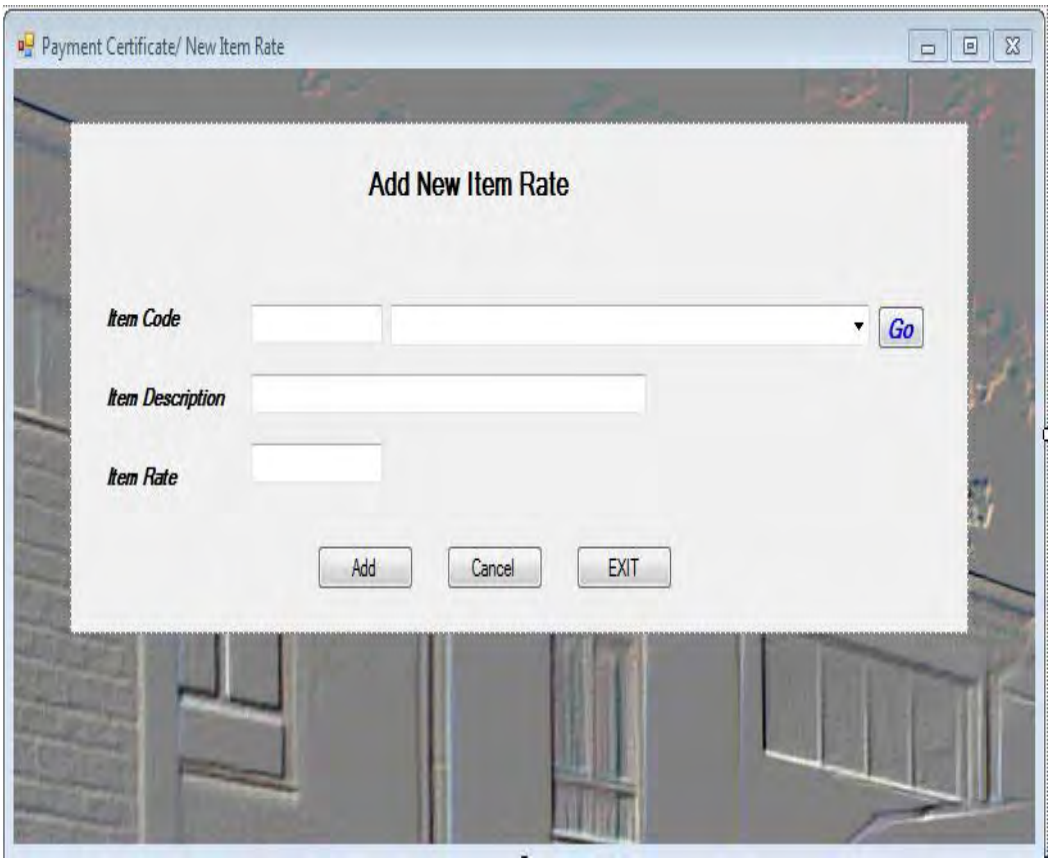


- ✓ In the input menu the General information record dialog box looks like in this form. Basically there is no difference in form b/n recording, editing and deleting the info.

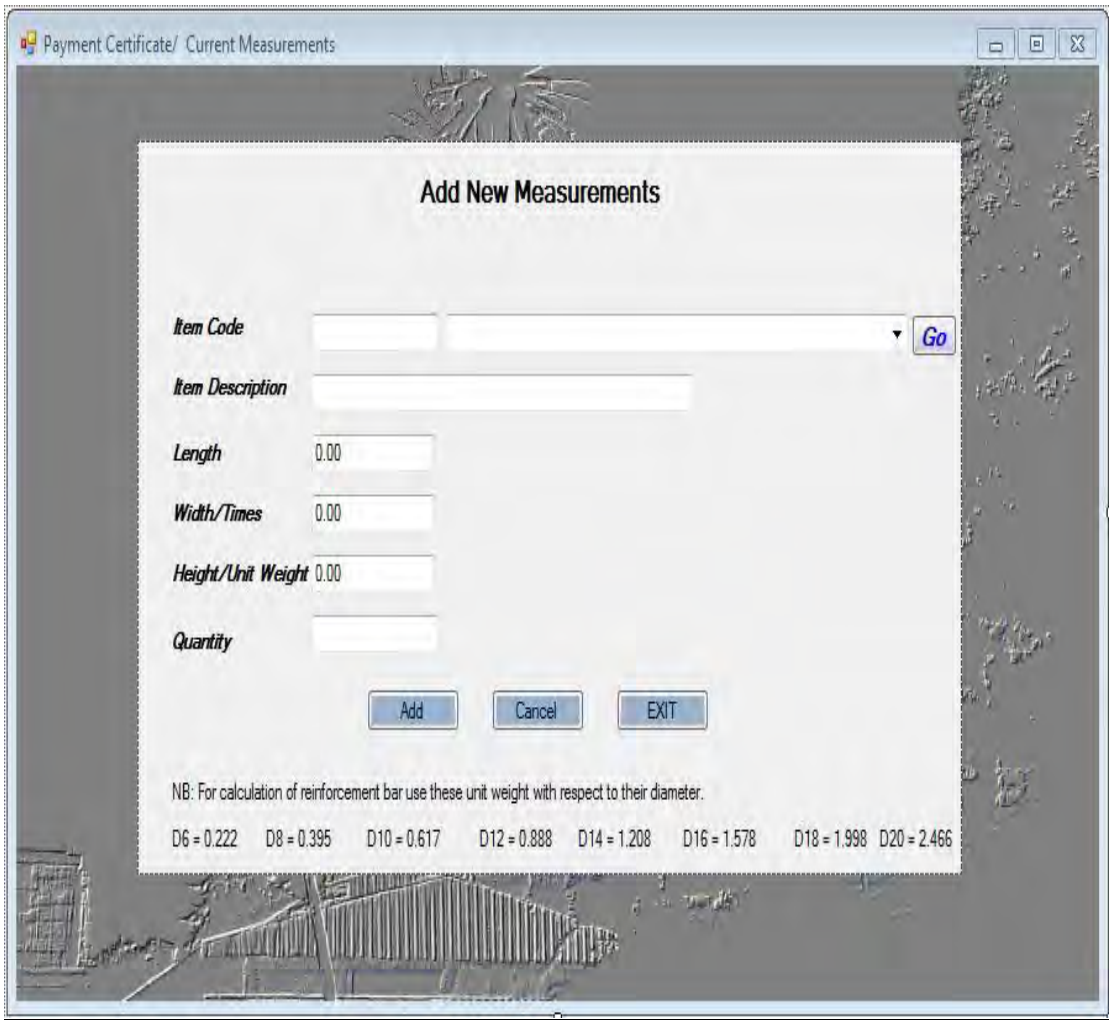


- ✓ To record the contract amount the select from the input menu contract amount creation

The following window will be displayed with the heading 'Add New Bill of Quantity'. After entering the required data in the dialog boxes, click Add to proceed and Exit to return to the main menu. The input menu also provides the option to edit and/ or delete the input data. The same procedure works for item rate too. The user interface window is shown next to the Bill of Quantity window. The form has a heading ' Add New Item Rate'.



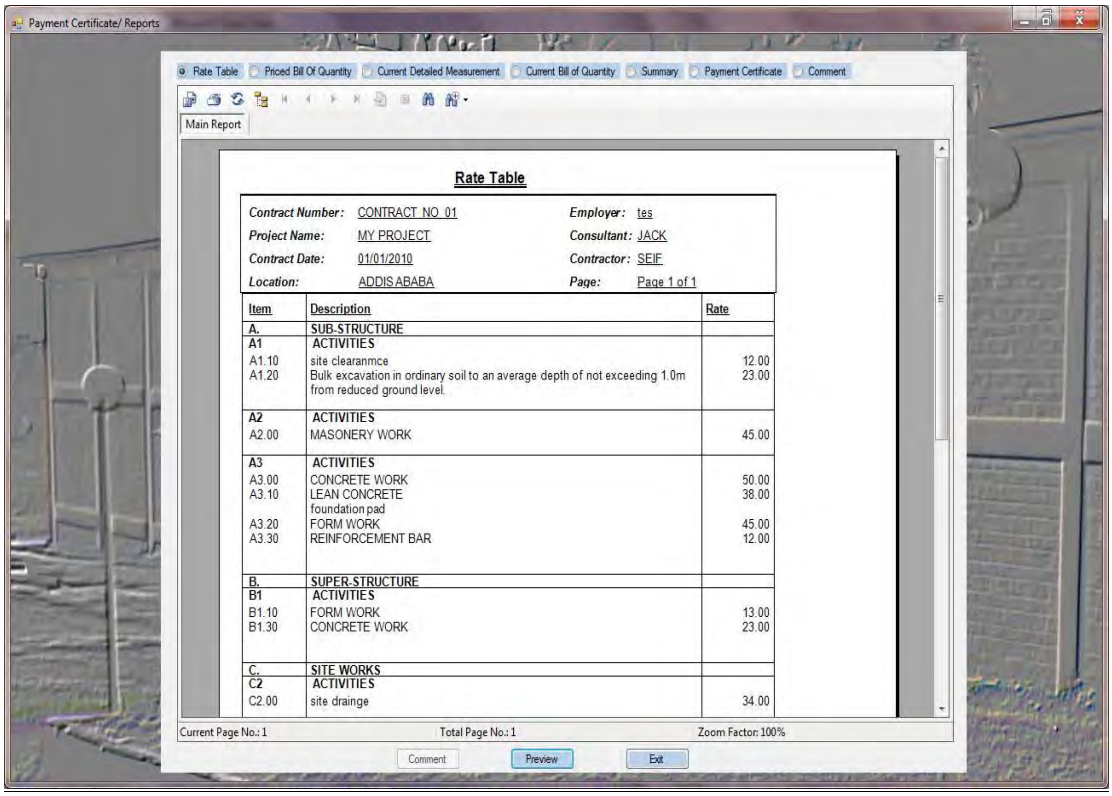
- ✓ To process payment certification the only routine thing to do is to take measurement. The measurement taken is entered in the dialog boxes of the form shown below with the heading 'Add New Takeoff Quantity'. The work can be selected by using the drop down from the contract bill of quantity. The item code and the description for the work immediately appear. Then enter the measurement with its respective dialog boxes. To enter value for linear length only one dimension is required, for area two and volume four dimensions are required. The software calculates and displays the result with its respective label on the report.
- ✓ To calculate the quantity of reinforcement bar, enter the total length of the bar, the total number of bars its respective unit weight. This form needs further development to calculate quantity of reinforcement bar readily, however unit weight constants are provided here on the form to ease the process at this level.

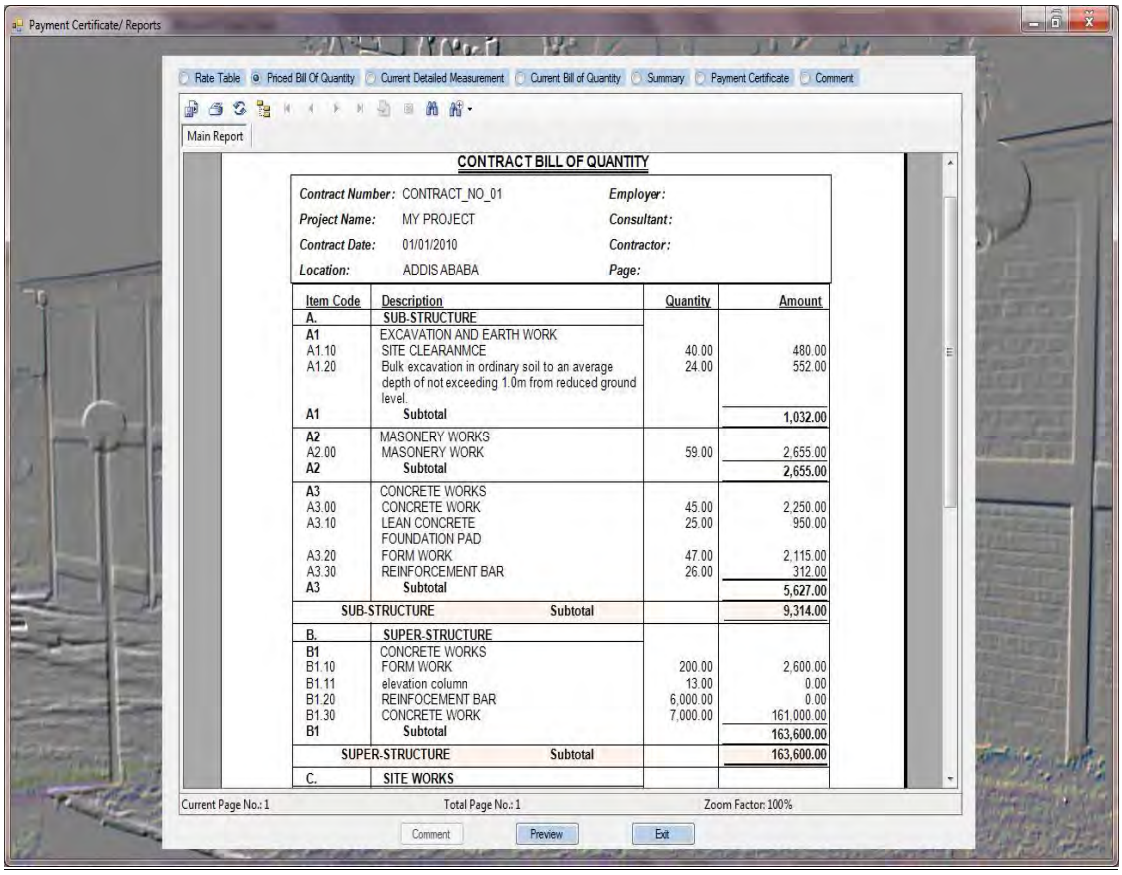


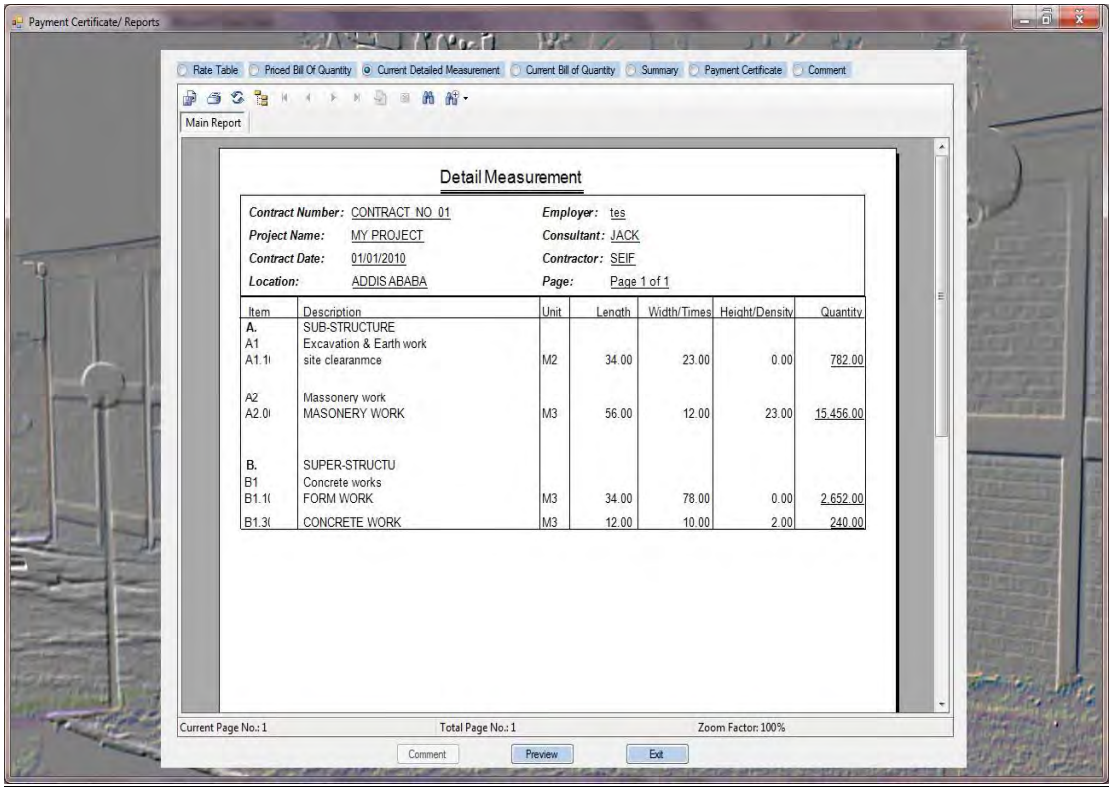
- ✓ Every report the user desires to see is a single step away from the data entry stage. After entering the data for the current work executed the user can directly go to the report menu and see any of the required reports. Unlike the traditional way where flow of work has a linear head to tail relation, the radial centralized system in the software enables the user to access the database freely without any sequential step.

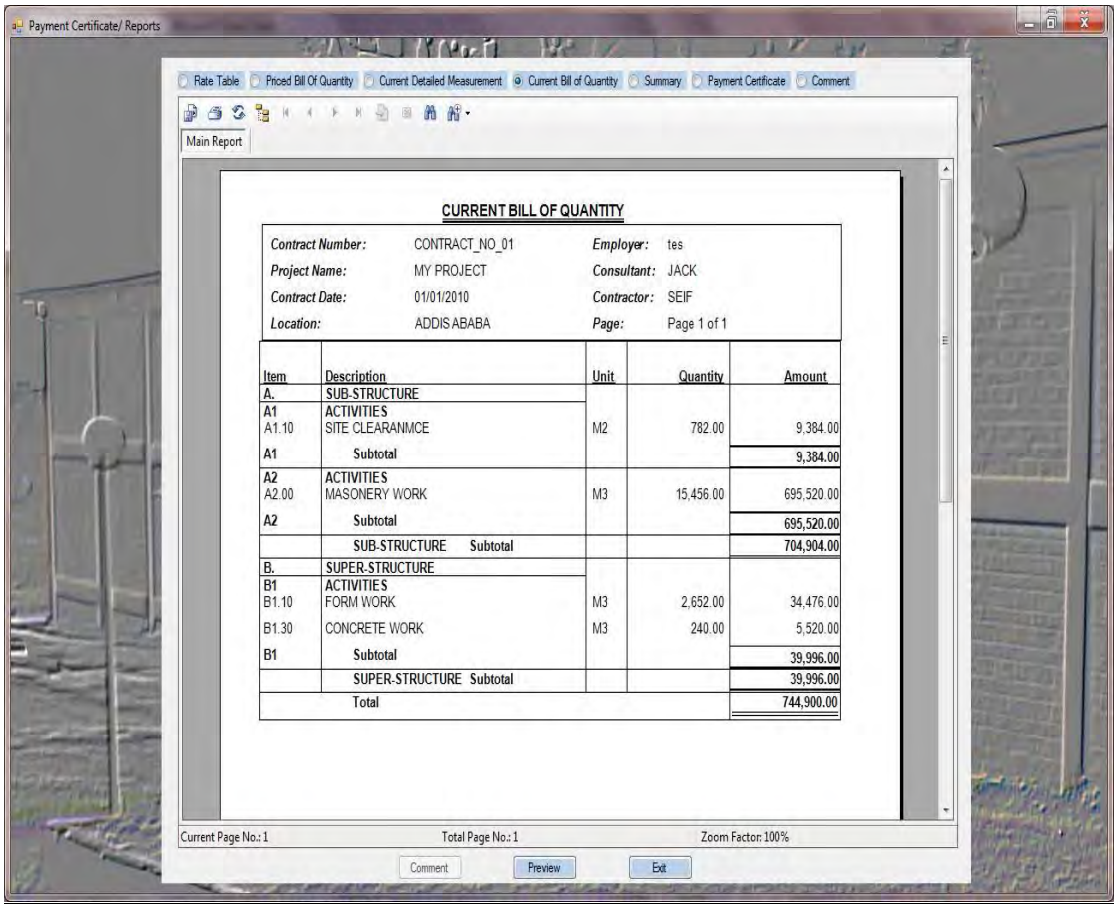
- ✓ To see the reports; click on the report menu and select the type of report to view, then click Preview to see the printable report. The reports include rate table, Contract BOQ, Current Detail Measurement, Current Bill of Quantity, Summary, Payment Certificate Report and Comment.

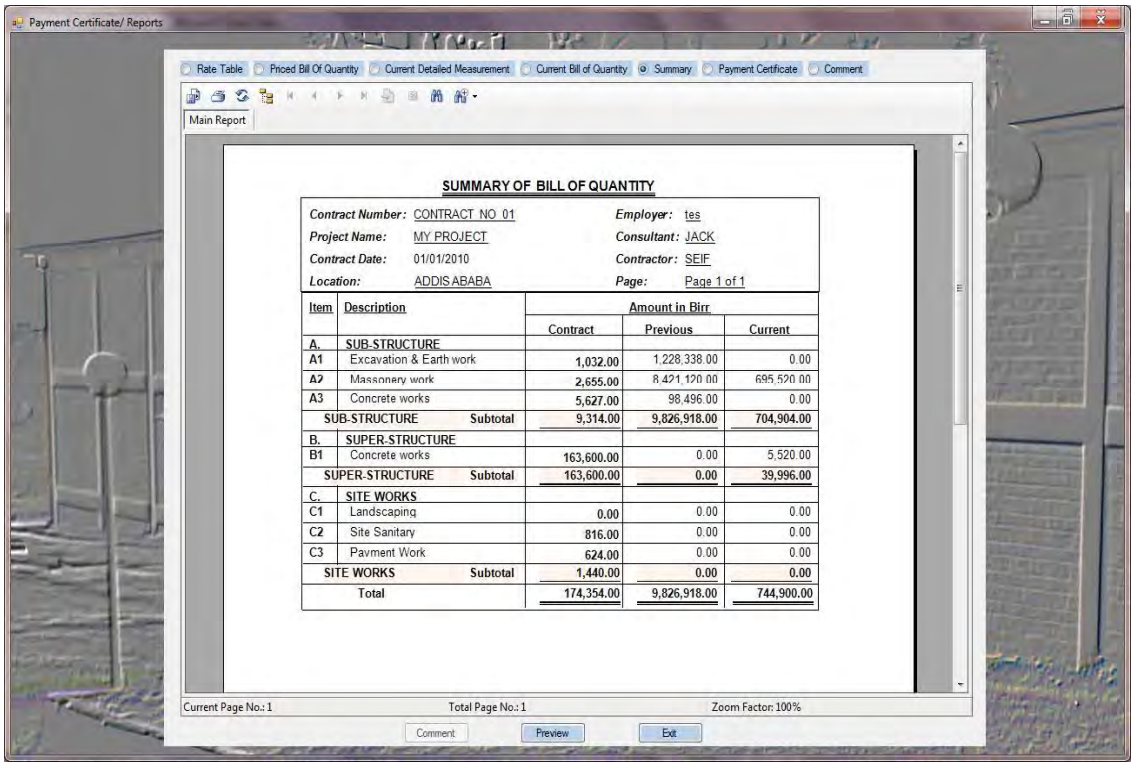
- ✓ Unlike the traditional way, rate has separate self contained data input and report preview. This is due to the centralized radial referencing system. The rate is stored in the central database so that every report can take the necessary data from it when ever needed.

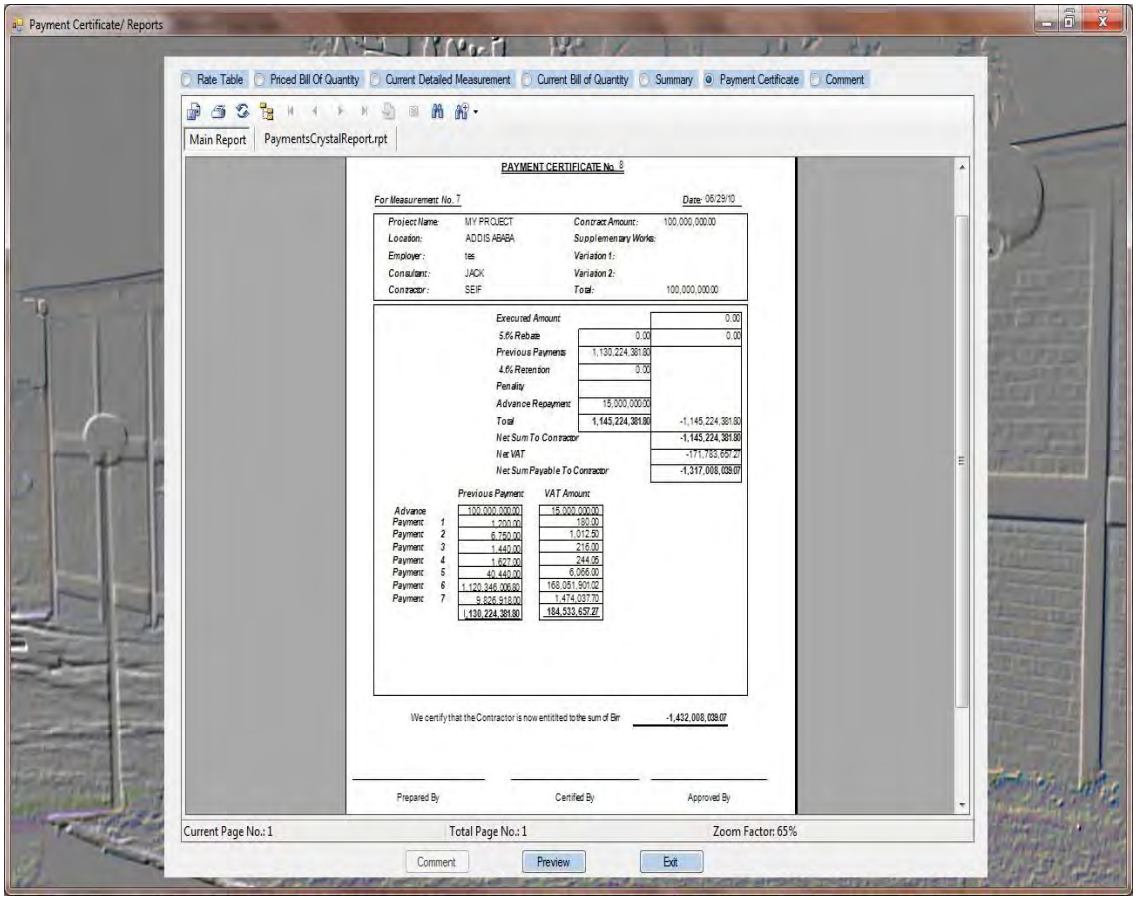

Payment Certificate/ Reports
Rate Table
Priced Bill Of Quantity
Current Detailed Measurement
Current Bill of Quantity
Summary
Payment Certificate
Comment
Main Report
Rate Table
Contract Number: CONTRACT NO 01
Employer: tes
Project Name: MY PROJECT
Consultant: JACK
Contract Date: 01/01/2010
Contractor: SEIF
Location: ADDIS ABABA
Page: Page 1 of 1
Item | Description | Rate
A. SUB-STRUCTURE
A1 ACTIVITIES
A1.10 site clearanmce 12.00
A1.20 Bulk excavation in ordinary soil to an average depth of not exceeding 1.0m from reduced ground level. 23.00
A2 ACTIVITIES
A2.00 MASONERY WORK 45.00
A3 ACTIVITIES
A3.00 CONCRETE WORK 50.00
A3.10 LEAN CONCRETE foundation pad 38.00
A3.20 FORM WORK 45.00
A3.30 REINFORCEMENT BAR 12.00
B. SUPER-STRUCTURE
B1 ACTIVITIES
B1.10 FORM WORK 13.00
B1.30 CONCRETE WORK 23.00
C. SITE WORKS
C2 ACTIVITIES
C2.00 site drainge 34.00
Current Page No.: 1
Total Page No.: 1
Zoom Factor: 100%
Comment
Preview
Exit


Payment Certificate/ Reports
Rate Table
Priced Bill Of Quantity
Current Detailed Measurement
Current Bill of Quantity
Summary
Payment Certificate
Comment
Main Report
CONTRACT BILL OF QUANTITY
Contract Number: CONTRACT_NO_01
Employer:
Project Name: MY PROJECT
Consultant:
Contract Date: 01/01/2010
Contractor:
Location: ADDIS ABABA
Page:
Item Code | Description | Quantity | Amount
A. SUB-STRUCTURE
A1 EXCAVATION AND EARTH WORK
A1.10 SITE CLEARANMCE 40.00 480.00
A1.20 Bulk excavation in ordinary soil to an average depth of not exceeding 1.0m from reduced ground level. 24.00 552.00
A1 Subtotal 1,032.00
A2 MASONERY WORKS
A2.00 MASONERY WORK 59.00 2,655.00
A2 Subtotal 2,655.00
A3 CONCRETE WORKS
A3.00 CONCRETE WORK 45.00 2,250.00
A3.10 LEAN CONCRETE FOUNDATION PAD 25.00 950.00
A3.20 FORM WORK 47.00 2,115.00
A3.30 REINFORCEMENT BAR 26.00 312.00
A3 Subtotal 5,627.00
SUB-STRUCTURE Subtotal 9,314.00
B. SUPER-STRUCTURE
B1 CONCRETE WORKS
B1.10 FORM WORK 200.00 2,600.00
B1.11 elevation column 13.00 0.00
B1.20 REINFOCEMENT BAR 6,000.00 0.00
B1.30 CONCRETE WORK 7,000.00 161,000.00
B1 Subtotal 163,600.00
SUPER-STRUCTURE Subtotal 163,600.00
C. SITE WORKS
Current Page No.: 1
Total Page No.: 1
Zoom Factor: 100%
Comment
Preview
Exit


Payment Certificate/ Reports
Rate Table
Priced Bill Of Quantity
Current Detailed Measurement
Current Bill of Quantity
Summary
Payment Certficate
Comment
Main Report
Detail Measurement
Contract Number: CONTRACT_NO_01
Employer: tes
Project Name: MY PROJECT
Consultant: JACK
Contract Date: 01/01/2010
Contractor: SEIF
Location: ADDIS ABABA
Page: Page 1 of 1
Item Description Unit Length Width/Times Height/Density Quantity
A. SUB-STRUCTURE
A1 Excavation & Earth work
A1.1(site clearanmce M2 34.00 23.00 0.00 782.00
A2 Massonery work
A2.0(MASONERY WORK M3 56.00 12.00 23.00 15,456.00
B. SUPER-STRUCTU
B1 Concrete works
B1.1(FORM WORK M3 34.00 78.00 0.00 2,652.00
B1.3(CONCRETE WORK M3 12.00 10.00 2.00 240.00
Current Page No.: 1
Total Page No.: 1
Zoom Factor: 100%
Comment
Preview
Exit


Payment Certificate/ Reports
Rate Table
Priced Bill Of Quantity
Current Detailed Measurement
Current Bill of Quantity
Summary
Payment Certificate
Comment
Main Report
CURRENT BILL OF QUANTITY
Contract Number: CONTRACT_NO_01
Employer: tes
Project Name: MY PROJECT
Consultant: JACK
Contract Date: 01/01/2010
Contractor: SEIF
Location: ADDIS ABABA
Page: Page 1 of 1
Item Description Unit Quantity Amount
A. SUB-STRUCTURE
A1 ACTIVITIES
A1.10 SITE CLEARANMCE M2 782.00 9,384.00
A1 Subtotal 9,384.00
A2 ACTIVITIES
A2.00 MASONERY WORK M3 15,456.00 695,520.00
A2 Subtotal 695,520.00
SUB-STRUCTURE Subtotal 704,904.00
B. SUPER-STRUCTURE
B1 ACTIVITIES
B1.10 FORM WORK M3 2,652.00 34,476.00
B1.30 CONCRETE WORK M3 240.00 5,520.00
B1 Subtotal 39,996.00
SUPER-STRUCTURE Subtotal 39,996.00
Total 744,900.00
Current Page No.: 1
Total Page No.: 1
Zoom Factor: 100%
Comment
Preview
Exit


Payment Certificate/ Reports
Rate Table
Priced Bill Of Quantity
Current Detailed Measurement
Current Bill of Quantity
Summary
Payment Certificate
Comment
Main Report
SUMMARY OF BILL OF QUANTITY
Contract Number: CONTRACT NO 01
Employer: tes
Project Name: MY PROJECT
Consultant: JACK
Contract Date: 01/01/2010
Contractor: SEIF
Location: ADDIS ABABA
Page: Page 1 of 1
Item | Description | Amount in Birr | Contract | Previous | Current
A. SUB-STRUCTURE
A1 Excavation & Earth work 1,032.00 1,228,338.00 0.00
A2 Massonery work 2,655.00 8,421,120.00 695,520.00
A3 Concrete works 5,627.00 98,496.00 0.00
SUB-STRUCTURE Subtotal 9,314.00 9,826,918.00 704,904.00
B. SUPER-STRUCTURE
B1 Concrete works 163,600.00 0.00 5,520.00
SUPER-STRUCTURE Subtotal 163,600.00 0.00 39,996.00
C. SITE WORKS
C1 Landscaping 0.00 0.00 0.00
C2 Site Sanitary 816.00 0.00 0.00
C3 Pavment Work 624.00 0.00 0.00
SITE WORKS Subtotal 1,440.00 0.00 0.00
Total 174,354.00 9,826,918.00 744,900.00
Current Page No.: 1
Total Page No.: 1
Zoom Factor: 100%
Comment
Preview
Exit


Payment Certificate/ Reports
Rate Table
Priced Bill Of Quantity
Current Detailed Measurement
Current Bill of Quantity
Summary
Payment Certificate
Comment
Main Report
PaymentsCrystalReport.rpt
PAYMENT CERTIFICATE No. 8
For Measurement No. 7
Date: 06/29/10
Project Name: MY PROJECT
Location: ADDIS ABABA
Employer: tes
Consultant: JACK
Contractor: SEIF
Contract Amount: 100,000,000.00
Supplementary Works:
Variation 1:
Variation 2:
Total: 100,000,000.00
Executed Amount 0.00
5.6% Rebate 0.00 0.00
Previous Payments 1,130,224,381.80
4.6% Retention 0.00
Penalty
Advance Repayment 15,000,000.00
Total 1,145,224,381.80 -1,145,224,381.80
Net Sum To Contractor -1,145,224,381.80
Net VAT -171,783,657.27
Net Sum Payable To Contractor -1,317,008,039.07
Previous Payment VAT Amount
Advance Payment 100,000,000.00 15,000,000.00
Payment 1 1,200.00 180.00
Payment 2 6,750.00 1,012.50
Payment 3 1,440.00 216.00
Payment 4 1,627.00 244.05
Payment 5 40,440.00 6,066.00
Payment 6 1,120,346,006.80 168,051,901.02
Payment 7 9,826,918.00 1,474,037.70
1,130,224,381.80 184,533,657.27
We certify that the Contractor is now entitled to the sum of Birr -1,432,008,039.07
Prepared By
Certified By
Approved By
Current Page No.: 1
Total Page No.: 1
Zoom Factor: 65%
Comment
Preview
Exit

What is new in the reports?

The reports are aimed to serve the same purpose the documents produced in the traditional do. However due to the fact that the way data are processed through the model software has some difference from the traditional way, some minor differences are made to ease the computerizing process. The changes are shown below.

- ✓ The format of Take off Sheet used in traditional way is changed in the software application because the software does not allow vertical calculation of entries like the usual way. However the end result remains the same.
- ✓ Itemizing tasks has a bit modification here. For example: - four levels of numbering are assigned to differentiate the level and type of work.
  - ➢ First level: - alphabets like A, B, C are assigned to Sub-Structure, Super-Structure and Site Works respectively for building work items.
  - ➢ Second level: - A1, B1 or C1 are for trade of works like excavation and earth work, concrete work, block work, finishing etc.
  - ➢ Third level: - A1.10, B1.10, C1.10 refers to activities like site clearance, bulk excavation, concrete work, form work, HCB/Brick wall plastering etc.
  - ➢ Fourth level: - A1.11, B1.11, C1.11 refers to same activities with some differences /Dittos. For example, ditto but to a depth not exceeding …., ditto but with a thickness of …., ditto but two coats of plastering etc are assigned with the fourth level of numbering.

Critical Activities

- ✓ Critical activities are activities that can neither avoided not ignored. From the study of the payment certificate preparation trend analysis the only activity that cannot be ignored is recording the measurement of work done once the project details are saved. The rest of the tasks can be ignored/ skipped while using the model software. This is not possible in the case of traditional method as the process is sequential.

Part Three:

Chapter VI- *Conclusion and Recommendation*

6.1Conclusions

From the responses of the focus group discussion and the trend analysis, the writers of this paper have come to conclude the following points:

- ✓ The manual payment processing takes much time and is prone to arithmetic error.
- ✓ Ms Excel reduces the time it takes in manual processing but there is a probability that calculation error will happen due to cell miss referencing.
- ✓ Ms Excel does not have a built in database system so it lacks systematic data processing and handling.
- ✓ The development of particular software for construction projects is important.
- ✓ Arithmetic error is never expected when using particularly developed software.
- ✓ Speed is enhanced as writing formulas or calculating is not necessary.
- ✓ Data processing and handling is digitally managed.
- ✓ Security is not an issue when applying particular software.
- ✓ Payment issuance through electronic media can be incorporated with the software as the end results are automatically and digitally produced.
- ✓ In Ethiopia automating tasks by specific software especially in construction is not common.
- ✓ Affordability issues with the available softwares are one of the challenges keeping the industry from computerizing works.
- ✓ There is a demand to make awareness about the advantages of using software to automate routine tasks in the construction industry.

6.2 Recommendations

6.2.1 General

As discussed earlier in the introduction part, this study is grouped under applied research category. Apparently the discoveries of this thesis work have several implications that demand the attention of the concerned parties. Under the next topic the implications of the study are discussed.

6.2.2 Implications

The writers of this study have come up with the recommendation by showing the implications of the paper work. These implications may not be the only but the major ones. If the concerned parties can respond to these implications and take action, the writers are convinced change will come.

*** Industrial implication;**

The writers of this thesis work have come up with the conclusion that there is a need for some of the routine construction works to be automated. Payment certification is one of the routine tasks that need automation. Accordingly the

model software that is developed to demonstrate the automation, even if supposed to be used for demonstration purpose only, can be used for real projects too. The construction industry in Ethiopia is usually known by delayed, extended time and the corresponding cost.

But applications of modern technologies like the information communication systems can contribute to the effort to minimize the time wasted unnecessarily. Therefore companies in the industry are strongly advised to be familiar and get advantage of it.

* **Stakeholder's role;**

As the need for automating routine tasks is inevitable, every necessary step shall be taken to boost the effort of computerizing the tasks. It is unquestionable that the minimized time has advantages for all parties involved in a given project. Therefore the contractual stakeholders can play significant role to support the effort. The client/ consultant can include clauses in the specific conditions that enforce the application of particularly developed software. The contractor can initiate the consultant by showing the advantages of using software in daily tasks.

* **Theoretical implication;**

There are tasks that need human act, but for routine tasks specially the ones that involve calculations no one can do better and faster than a computer. A Computer can make it faster because it does not follow the sequential way of processing.

* **Institutional implication;**

By principle Institutions are where professions born and flourish on research basis. Institutions ought to lead the corresponding industry. In this context the newly formed EiABC in cooperation with AAU, professional associations and other related institutes, can make a difference.

For example: - including programming courses in the curriculum or in association with Computer Science Department in Science Faculty/ Informatics or whichever is convenient, facilitate programming courses trainings for interested students. This is a common practice in other faculties like Linguistics at sidist kilo.

* **Research implication;**

The writers of this study with the limitations indicated earlier have come up with the conclusion that, it's possible to make changes on the traditional way of doing things. The changes can be utilized to speed up processes and increase quality. But further can be done specific to the construction industry. Concerning payment certification, additional features that the writers of this thesis work did not included due to limited time bound can be studied further. The features include: -

- → Inclusion of a separate form that enables the quantification of reinforcement bar.
- → Integration of VB with graphic software like AutoCAD, to take measurements directly from the softcopy of the drawing is also possible.
- → Enabling the software manage several projects at the same time.
- → Inclusion of change orders; claims, escalations, variations etc to be processed.
- → Inclusion of Help menu to make the software more user friendly so that a user can operate even for the first time by referring to help menu.
- → Commenting possibilities for the supervisor after checking the current executed work so that the contractor can see the changes the supervisor made by comparing with his application.

6.3 References

1. FIDIC, 1987; Conditions of Contract for Works of Civil Engineering Construction
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4. Edwards H.griffith, March, 1953, Specification
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6. Taylor & Francis e-Library 2005, Taking Off Quantities: Civil Engineering- First edition1995 by Bryan span, (peg 11-18)
7. Michael Halvorson, 2008, Microsoft- Visual Basic_ 2008 step by step.
8. Jeff Kent, 2006, Visual Basic 2005_DeMistified
9. www.constructionmanagmentguide.org

6.4 Annex

A. Focus Group Discussion Guide

→ Professional requirement

Respondents shall be from professions that are believed to practice the payment certificate preparation. Building Engineering, Civil Engineering, Construction Technology and Management etc

→ Experience

The respondents need to be from positions that can practice payment certificate preparation. At least one year of experience.

→ Position of Practice

The position the respondents were working on shall be the type of position that performs payment certification. Office Engineer, Site Engineer, Project Manager, Project Engineer or any other

B. Printed Reports of the model software

→ To be attached

C. Payment Related Clauses from FIDIC and MoWUD and the Thesis proposal

→ To be attached