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Cash Flow Forecasting Using Monte Carlo Simulation Method for Building Construction Projects

A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in partial Fulfillment of the Requirements for the Degree of Master of Science in Civil and Environmental Engineering

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Author's Declaration

I hereby declare that the work which is being presented in this thesis entitle "***Cash Flow Forecasting Using Monte Carlo Simulation for Building Construction Projects***" is an original work of my own, which has not been presented for a degree of any other university and all the resources of materials used for the thesis have been duly acknowledged.

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Abstract

Construction industry has the biggest role in the nurturing of country's development and prosperity. It gives tremendous basic benefits with the interrelationship with other industries to the citizens of a country with vast undertakings. Having continual and intensive transactions, Construction industry also needs plenty amount of finance for the desired designs of buildings, roads, dams and irrigation projects and the like to transform them into their physical state and to begin their operations then after. In relation to these huge financial transactions though, the construction industry suffers the largest rate of insolvency of any sector of the economy. Many construction companies fail because of poor financial management, especially inadequate attention to cash flow forecasting. Accordingly, many have also been trying to forecast cash flows with the help of models through which they can easily forecast with relative accuracy.

This research has worked on cash flow forecast of a case study building construction project using Monte Carlo simulation method. The thesis identified and ranked the Systemic cash flow Risk variables through the intensive Literature Review and structured questionnaires. Accordingly, the Top ten Systemic Cash flow Risks are found to be Receiving Advance Payment, Materials and Equipment Shortage, Delay in Receiving Certified Interim Payment Documents from Consultant, Poor Design & Inaccurate Bid Items, Consultant's Instructions/Change Orders, Buying Equipment and Machineries, Retention, Price Fluctuation, Delays in Payment Issuance from Client, and Inflation in Resources used.

Upon selection of Seven Systemic cash flow risks and Project Specific risks selected only based on applicability to the case study project, analysis of the project was done to determine and forecast the probabilistic cash flows using Monte Carlo Simulation Method Tool i.e. @Risk 7.5. As a result, the thesis revealed that the probabilistic cash flow results have resembled to the actual cash flow of the case study building. Thus, confirming Monte Carlo Simulation as a powerful and applicable method for similar and related cases by incorporating systemic and project specific risks.

Key Words: Cash Flow, Cash Flow Risks, Construction Finance, Deficit, Forecasting, Monte Carlo Simulation.

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Acronyms

MCS:	Monte Carlo Simulation
MCM:	Monte Carlo Method
UN:	United Nations
GDP:	Gross Domestic Product

Chapter One: Introduction

1.1 General Introduction

All activities and transactions are alive because of the expenditure of finance that are used as an engine for the transactions continuously on going and made the things that human beings are privileged from. This as part of the real needed resources, finance has the greater asset proportion since the things such as materials and human power can be fulfilled through the expense of finance alone. Construction Industry is also one of the due main industries that is engaged in the construction executions of Residential Buildings up to huge processing factories which eases and suits the lives of human beings. However, this big industry also need plenty amount of finance for the desired designs to put on the ground for buildings, roads, dams and irrigations projects and the like. Thus needs significant finance management techniques since the industry resides on explicit funding.

As the simplest form of finance, cash is one form of liquidated finance that is used as pay for expenses and related costs in the construction industry. To the greater portion, the main stakeholders of the construction industry are always in the process of cash transforming since one has to fund so that others could construct. Handling of cash includes covering things to whatever the stakeholders want as in the employer settles payment in return for the contractor's required performance and the consultant's supervision and project administration jobs. Nonetheless, the intensity of using and converting things for the well progress of the construction project becomes challenging for the contractor due to the responsibility of involving more resources by procuring different and large amount of materials, employing a considerable amount of human power and deploying Equipment and Machineries.

In order to perform well, Contractors have to manage the cash in hand for the expenditures of the project. Well-managed cash will not get the contractors into shortfall at some dangerous times, which may become unbearable that the companies could no longer be in business due to the great deficit. One of the tools to prevent these unwanted cash deficits, Contractors sometimes forecast the cash flow of the project and try to know the results in advance as if they happen at the point of future time so that they could take specific and appropriate measures for the cash demands of their construction projects.

1.2 Research Background and Purpose

Financial Management has long been recognized as an important tool in construction management which manages financial systems in proper and modernized manner. Conversely, the construction industry usually suffers the largest rate of insolvency of any sector of the economy. Many construction companies fail because of poor financial management, especially inadequate attention to cash flow forecasting. The major problem that construction managers encounter in making financial decisions involves both the uncertainty and ambiguity surrounding expected cash flows (Ahmed, 2014).

Cash flows are essential to solvency. They can be presented as a record of something that has happened in the past, such as the sale of a particular product (building infrastructures), or forecasted into the future, representing what a business or a person expects to take in and to spend. Cash flow is crucial to an entity's survival. Having ample cash on hand will ensure that creditors, employees and others can be paid on time (Ahmed, 2014). In the case of many and complex projects, the problem of uncertainty and ambiguity are assumed to be greater proportion because of the difficulty in predicting the impact of unexpected changes on construction progress and consequently, on cash flows.

Systems for accurately predicting trends in a project's cash flow prior to the construction phase have been created. However, advance knowledge of the factors affecting cash flow and understanding their impact is essential to the contractors. Many methods have been applied to the forecasting analysis of cash flows. The non-mathematical approaches, mostly referred to as project-oriented forecasting models, were greatly used in traditional research. These forecasting models, which were established based on historical project data, were used to monitor and modify project process. Since construction projects are usually uncertain, complex and unique, mathematical models have provided much simpler and cheaper approaches (Yaqiong, et al, 2009).

Apart from the former methods, this research uses the Monte Carlo Simulation method, which analyses construction-engineering works by testing the required responses through incorporating known risks that help plan and solve in advance the cash deficit through an accurate cash flow projection that improves the capacity of contractor's cash management.

1.3 Research Problem Statement and Rationale

Construction industry is the riskiest business that is usually vulnerable to failures of companies through the uncertainties incorporated due to poor technical capacity and management approaches (Khosrowshahi & Kaka, 2007). Accordingly, cash management, as one of the failure reasons, needs considerable attention for the construction business to continue on. Construction companies are always involved in cash management issues specially related to the working capital of their projects, which lets the project costs to be handled for a specific period of time until the interim payment is retrieved. Thus, it creates an issue of cash deficit within the construction period.

In consequence, cash forecasting to a desired degree of accuracy makes financial decisions easy based on the probable results. It helps to know the anticipated cash flow deficits, which affect the progress of project undertakings and make a room to consider the financial alternatives that the contractor shall make in order to reduce the loss of finance and its performance. Without having a better cash flow management on a basis of an accurate cash flow forecasting estimate, every contractor blindly will go into depression due to cash shortage at some periods of project executions in which it can no longer fund the working capital requirement of its projects. Finally, the accumulation of unpaid bills hence leads to the financial failures of the contractor (Henry and John, 2000).

A well-prepared and managed financial system of a company may not go into severe cash shortage called shortfall that leads to insolvency. However, most of the domestic construction contractors are not well capable and advanced in managing the cash flow of their construction projects and their cumulative/collective impact on head office. Even if they try to forecast project’s cash flow, the projection method is not accurate due to the use of Deterministic method without incorporating uncertainties and risks.

As a result, they cannot be able to complete their projects with a needed consistent performance without any delay and related consequences. Therefore, in order to minimize and if possible to avoid the risks associated to the very existence of the construction companies, this research strives for the contextualized application of a functioning cash flow forecasting system based on Monte Carlo Simulation Method for the contractor’s use.

1.4 Research Objective

These aims are divided into two major categories in which the specific one is the extended concept within the general aims.

General Objectives

The main objective of this research is to simulate and forecast the cash flow of case study Building Project using Monte Carlo Simulation. It also tries to appraise the significance of Monte Carlo simulation method. Additionally, the following are the specific objectives of that the thesis has worked on.

Specific Objectives

- To identify and rank the major influencing Systemic Cash flow Risks for Domestic Contractors,
- To simulate Project specific cash flow risk impacts on project cost and delay,
- To examine and evaluate the probabilistic cash flow forecasts with Actual and Deterministic project cash flow.

1.5 Significance of the Research

As indicated earlier, the significance of this research is more connected with the creations of workable financial systems of the contractors and improving it to a better degree of financial management. Since the main problems of contractor's insolvency and then to final bankruptcy leads the companies to be out of business, It could be avoided and well mitigated through appropriate financial management method hence having a working cash flow management system by incorporating the cash flow risks.

Well-managed cash surely reduce the impacts on financial systems of a company at dangerous deficits that levies a significant effect on the continual of the construction business. The research therefore assists the construction companies to know in advance the cash needs and revenues of a project through simulations, which in turn help enjoy the privilege of maximizing its wealth and future company development. Thus, the importance of using such methods and dealing with these critical financial issues would give an ultimate benefit to the contractors.

1.6 Research Questions

These questions are interrelated with the aim and are thought to answer the very crucial point of the thesis.

- What kinds of Major Systemic Risks are there which affect the Cash Flow of Building Construction projects in Ethiopia?

- Could the Monte Carlo Simulation be useful and accurate in the forecasting of project cash flow?

1.7 Research Scope and Limitation

The scope of the research is limited only to Building Construction Projects. The questionnaire were sent to major industry stakeholders which include Domestic Contractors who are BC or GC 1 and consultants of Category 1 considering these companies have better company organization with a lot of constructing and consulting experience. Some Employers with a significant construction were also part of the questionnaire analysis. Additionally, it uses case study building project that matches the execution capacity of Grade One Contractors, for the application of Monte Carlo Simulation.

The accuracy of questionnaire data analysis results is based on the respondent's answers which somehow fairly limits the outputs for the application of the Monte Carlo Simulation. The thesis is also limited to the evaluation of the simulated cash flow forecast with the Actual cash flow, which needed appropriate editing due to luck of data only on cash outflow part of the case study project data. Lastly, some assumptions on probability distribution function and values of systemic and project specific risks applicability on the case study project were made for the ease application of Monte Carlo Method to insure the retrieval of desired cash flow projection results.

Chapter Two: Literature Review

2.1 Introduction

Construction industry has the biggest role in the nurturing of country's development and prosperity. It gives tremendous basic benefits with the interrelationship with other industries to the citizens of a country with vast undertakings. This industry supports the initiation of different industries to lean on for further industrial developments. In order to have such developments, construction industry depends on the deployment of significant finance, which lets construction projects to be initiated and finally completed to their intended purposes.

The transaction of financial commodities triggered by the inputs, processes and output values of the construction industry makes it the back bone of once country economic development. The economic index which describes the involvement of a nationwide construction activity can surely have a significant impact on the GDP of a nation. The report published by UN (1985) showed that most developed countries have direct relationship of construction which encompasses about 5-10% of their GDP. Besides those developed countries, the developing ones also share the same analogy. The Ethiopian Economic Association has depicted on its report (2006) Ethiopian construction industry has an average GDP share of 5.2%. The UN report also confirms that those developing countries that have increasing construction activities are of being in the road to development with a considerable portion of GDP shares, Contribution to employment Government Revenue and a Multiplier effect in relation to other sectors of one's economy. On the contrary, those who have not induced construction to the desired level are not, with the expectation of unstable economy.

The industry to economic value relationship is put into wider dimension in terms of research and development that strives for the industry to advance itself to the higher degree of implementation. This in turn will increase the output quality of construction, the timely completion of projects, with minimal budget fluctuations and with the accepted health and safety precautions. The changing world, which capacitates itself to the modernized techniques, results in the allocation of a huge amount of finance to accommodate the modernization of techniques and its final project output.

The Literature Review tries to give comprehensive information about Construction Project Financing, Construction Cash Flow management, Cash Flow Forecasting and Cash flow risks including major points on Monte Carlo Simulation Method. It finally summarizes and the literature and identifies the gap within.

2.2 Construction Project Financing

When it comes to the concepts of projects, any project that is put into the benefits of the developers is unique on its own, by having temporary period to develop and to execute through project life cycle. As a result, it needs some significant finance for that particular project to go through different stages of maturity. David and James (2010) in their Book defined what in their opinion Project Finance is.

"The raising of finance on a Limited Recourse basis, for the purposes of developing a large capital- intensive infrastructure project, where the borrower is a special purpose vehicle and repayment of the financing by the borrower will be dependent on the internally generated cash flows of the project"

Extension to the project idea, Construction Project with in the construction industry is the most basic initiator in which all other projects relay on due to the necessity of having buildings and other infrastructures to build upon so that other non – construction projects can reside in the results of Construction project output to process their specific work targets. As in to all projects, construction project also needs a significant amount of finance stretching from small scale to massive infrastructure projects.

The project finance, which is poured into the whole construction industry, has been rising from time to time due to the need of accommodating technologically advanced buildings and infrastructures with a positive impact on nationwide economic development. In 2010, a report on project finance had been revealed by the Thomas Reuters Project Finance International which described the Global finance allotment of construction industry by classifying the finance zones of EMA (Europe, Middle East and Africa), North America and Asia Pacific with country basis and Construction Project finance utilization. Here is the tabulated data regarding the aforementioned information (Table 1).

Table 1: Project Finance transactions by region (2010) (Source Thomson Reuters project finance international)

	2010		2007	
	US $m	**%**	**US $m**	**%**
Asia Pacific	98,708.30	47.42%	44,842.30	20.38%
EMEA	83,931.20	40.32%	130.667.30	59.40%
Americans	25,534.50	12.26%	44,476.30	20.22%
Global Total	**208,174.00**	**100.00%**	**89,318.60**	**100.00%**

Acknowledging the huge amounts of finance allocated for different sectors, the method and management of financing those construction projects has to be one of the core thing that the concerned major parties (such as clients, contractors and consultants) has to care for. Especially All contractors – whether small, medium or large – need to know and understand the financial situation of their projects in order to recognize when things are going wrong and be able to take remedial action before it is too late. However, many contractors and subcontractors in the construction industry, especially the smaller ones, are simply not 'in the loop' when it comes to the financial aspects of their business. They see a healthy order book, they see cash coming in, they see a healthy bank balance and they assume that all is well. This may be far from the case, however, and disaster may be waiting just around the corner (Andrew & Peter, 2013).

One of the great problems in understanding what goes on financially in contracting is that construction contracts of any significant size are complex. The way that contracts are priced, the design changes and unexpected events that take place during construction, the natural human tendency to argue over money and the endemic financial instability of many of the firms that operate in the construction industry all contribute to the complex nature of the financial aspects of construction projects.

2.3 Construction Project Financing Problems and Effects

Investment in a construction project represents a cost in the short term that returns benefits only over the long-term use of the facility. Thus, costs occur earlier than the benefits, and owners of facilities must obtain the capital resources to finance the costs of construction. A project cannot proceed without adequate financing, and the cost of providing adequate

financing can be quite large (Asfaw, 2009). For these reasons, attention to project finance is an important aspect of project management. Finance is also a concern to the other organizations involved in a project such as the general contractor and material suppliers.
At a more general level, project finance is only one aspect of the general problem of corporate finance. If numerous projects are considered and financed together, then the net cash flow requirements constitute the corporate financing problem for capital investment. Whether project finance is performed at the project or at the corporate level does not alter the basic financing problem. In essence, the project finance problem is to obtain funds to bridge the time between making expenditures and obtaining revenues.

Based on the conceptual plan, the cost estimate and the construction plan, the cash flow of costs and receipts for a project can be estimated. Normally, this cash flow will involve expenditures in early periods. Covering this negative cash balance in the most beneficial or cost effective fashion is the project finance problem.

For repetitive problems caused by different financial cases, a company severely could suffer from in a consequence. Construction Companies failure mostly appears in a critical situation because of a complex process and is rarely dependent on a single factor. Out of these, Arditi et al, (2000) found that budgetary and macroeconomic issues as the main reasons for construction company failure in the US. Over 80% of the failures were caused by five factors, namely insufficient profits (27%), industry weakness (23%), heavy operating expenses (18%), insufficient capital (8%) and burdensome institutional debt (6%). All these factors, except for industry weakness, are budgetary issues and should therefore be handled by companies that are cognizant of the effects of these factors on their survivability.

Kivrak and Arslan (2008) also examined the critical factors causing the failure of construction companies through a survey conducted among 40 small to medium-sized construction companies. A lack of business experience and country’s economic conditions were found to be the most influential factors to company failure. A scrutiny of the sub-factors related to the lack of business experience confirms that difficulties with cash flow and poor relationship with the client drove the contractor’s failure. In addition, preparing an accurate and realistic bid proposal with the profit margin being carefully determined is highly critical. However, due to high competition, companies are usually forced to reduce their profit in order to win the bid and this would increase the default risk substantially. Kangari (1988) found that more than half of business failures in construction were due to unrealistic profit margin.

Davidson and Maguire (2003) based on their accountancy experience, identified ten most common causes for contractor failures. These are (i) growing too fast; (ii) obtaining work in a new geographic region; (iii) dramatic increase in single job size; (iv) obtaining new types of work; (v) high employee turnover; (vi) inadequate capitalization; (vii) poor estimating and job costing; (viii) poor accounting system; (ix) poor cash flow; and (x) buying useless stuff. Osama (1997), on the other hand, presented a study of the factors that contribute to the failure of construction contractors in Saudi Arabia and found that the most important factors were difficulty in acquiring work, bad judgment, lack of experience in the firm’s line of work, difficulty with cash flow, lack of managerial experience, and low profit margins.

Furthermore, Ibrahim Mahamid (2011) in his research on the potential to cause contractor's business failure in the West Bank in Palestine, found out that the financial factors as the top ranked group that affects business failure, followed by managerial factors and external factors. It is no surprise that the working capital and inadequate capitalization of construction contractors are continuously cited as leading reasons for failure (James and Thomas, 2010). This summarizes that most of the researchers agree that construction business failures are caused by financial factors in general and poor cash management in particular. Hence tackling these critical cases would be the appropriate start for the construction company to continue on business.

2.4 Construction Project Cash Flow Management

Construction industry is an industry, which through woeful financial management strategies, has created loss, heartache, failed projects, and cascading insolvency which has gone far beyond the direct influence of one contractor’s projects suffering the largest rate of insolvency of any sector of the economy. The major problem that construction managers encounter in making financial decisions involves both the uncertainty and ambiguity surrounding expected cash flows. In the case of complex projects, the problem of uncertainty and ambiguity assumed even greater proportion because of the difficulty in predicting the impact of unexpected changes on construction progress and consequently, on cash flows. The uncertainty and ambiguity are caused not only by project-related problems but also by the economic and technological factors that are indulged within the transactions of the construction industry (James and Thomas, 2010).

Cash flow management, as described above, is the major management process which deals with the cash in and out flow of a project in particular and a construction company in general. The following sections are composed of the cash flow management processes and its sub processes. These sub divisions are cash flow planning divisions; discusses about cash analysis and cash flow farming cycle along the detailing on working capital. It will also focus in a separate section on cash flow forecasting; focusing on its importance, cash flow forecasting analysis, cash flow monitoring and evaluation processes, forecasting challenges and so on.

2.4.1 Construction Project Cash Farming Cycle

Cash Flow is the bloodline of construction companies. The construction lifecycle could take as long as 60 days or more for full cash-to-cash conversion (Ihab, 2014). Initially construction operations start with cash provided from one of two sources equity or debt and oftentimes it is provided through a mixture of the two.

The construction contractor uses its cash to purchase fixed assets, purchase raw materials, pay for its labor, pay for its overheads, pay for its subcontractor suppliers and vendors, pay for its lenders, or pay taxes. The combination of the raw material, labor, overheads, and subcontractors' work is transformed into a finished product. This finished product is typically in the form of a completed or partially completed (progress) construction of some sort. Based on a certain agreed upon valuation method (fixed price, cost plus, etc.), the completed or partially completed construction (the finished good) is valued by the client, and the client pays a certain amount of cash to compensate the contractor for the finished goods (Ihab, 2014).

There are some inherent challenges in the cash-to-cash conversion cycle for construction companies. The valuation of "finished goods" is a complex process. The finished good is generally valued based on the partial completion of construction, which implicitly assumes some subjectivity in the assessment of the progress completion and corresponding cash payment due. The owner's review of the pay application and payment can take anywhere between 7 – 30 days in addition to s 30 days' work execution depending on contract terms (Ihab, 2014). After the contractor receives its payment, it will generally pay the subcontractor in 7–14 days. In total, the contractor is funding its costs for 14–65 days, with the average closer to the higher end than the lower end.

Two factors make this long cash-to-cash conversion cycle even worse. First, construction projects are plagued with changes. The timely assessment and approval of the cash value for these changes often lag behind the physical construction, further extending the cash-to- cash conversion cycle for these changes. Contractors often find themselves in a position where they have to pay for the labor, material, and suppliers for a change in the scope of work; this happens month(s) before it can be included in the pay application. Second, the payment amount is reduced by retentions (5% or more) that has the effect of keeping a contractor in a negative cash flow for a longer duration, and in many cases for the total duration of the project.

A construction contractor may very well be profitable and show a positive income on its financial statement, yet suddenly go bankrupt due to a lack of cash. A company may survive for some time with low profitability or even with a loss, but often fails rapidly if it lacks cash to operate. The following figure (Asfaw, 2009) enlightens the concepts related to the operating and cash cycle of a construction project and summarizes the discussions above.

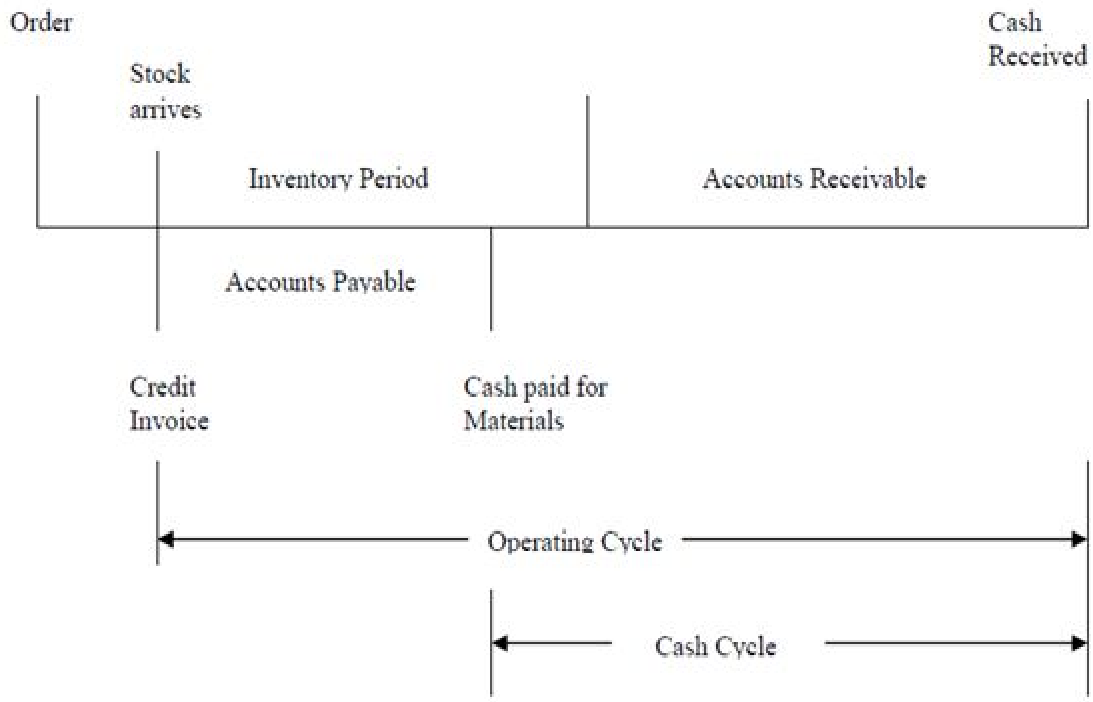

Figure 1: Cash Cycle (Asfaw, 2009)

2.5 Cash Flow Forecasting

Projecting cash flow is an important aspect of Contractors' financial management. A cash flow forecast is a projection of the cash receipts and cash payments for a future period of time. A company's cash supply is determined by its profitability and efficiency. Failure to have an adequate cash flow has resulted in the bankruptcy of many otherwise profitable companies. Without this projection a company can easily get behind in paying their subcontractors and suppliers due to late payment from the owner or the improper allocation of payment monies received by the contractor. Christopher (1994) has confirmed that Lack of adequate capital or operating reserves can also contribute to the contractor's inability to pay subcontractors and suppliers.

Good construction financial management should result in a positive Cash Flow, which allows the contractor to avoid or minimize borrowing. A positive Cash Flow also allows the contractor to take advantage of supplier discounts for early payment. In order to have a complete cash flow project, Emad Elbeltagi (2012), has identified the three main ingredients in determination of cash flow. These are:

- **Expenses (cash out):** which represents the aggregate of the payments, which the contractor will make over a period of time for all resources used in the project such as labor, equipment, material, and subcontractors.
- **Income (cash in**): that represents the receipts a contractor will receive over a period of time for the work he/she has completed.
- **Timing of payments**: The timing of payments is essential in knowing what the payments are due, related to the work done by the contractor in cash flow analysis of projects.

2.5.1 Importance of Cash Flow Planning and Forecasting

Cash is often seen as the most important element of construction companies and their projects. Adequate sources of capital, and a reasonable debt to income ratio, are critical for a business's profitability (Chen, et al, 2005). Conversely, lacking this capital can lead to default or bankruptcy (Lucko & Cooper, 2010).

Similarly, Cash flow in particular is the bloodline of construction companies. A lack of cash can mean no payments to subcontractors, laborers, and crews, and no purchases of needed materials. It can lead to a limited ability to complete tasks on site, a need to cut corners in the work, or a slower pace to match the amount of cash available. Negative outcomes can include delayed or incomplete work, increased financing costs and project risks, or the reduction of payments from owners and project funders **(**Ihab, 2014).

Cash flow is particularly important during the project implementation period for a construction contractors. This period is most often the highest risk compared to planning and operation periods (Martinez, et al). During this time, if revenues are not available, supporting expenses through loans can lead to an accumulation of interest that becomes a significant part of the project's overall costs (Martinez, Halpin, & Rodriguez). Because the overall balance of profits and losses only appears at the finish of a project, a scarcity of physical cash during the project's implementation can lead to disruptions, and even bankruptcy (Lucko & Cooper, 2010).

Cash is distinguished from profitability in that a company can survive for a transitional period without demonstrating a profit, or even while holding a loss. Nevertheless, a lack of cash can cause a company to collapse, even if it has a positive balance. Indeed, globally most construction companies that failed did so because of lack of working capital, and in spite of profitability (Navon, 1996).

The management of cash flow is claimed to be key for a construction business's financial viability and survival (Navon, 1996) (Kenley, 2003). Because liquidity problems for a construction company can often arise without prior warning (Navon, 1996), effective planning and the use of available resources plays an important role in the success of project management (Hegazy & Kassab, 2003). The prediction of cash flow in particular can anticipate the resources a company needs during current and upcoming projects and periods (Touran, 1991).

In consequence, forecasting cash flow is necessary for a construction company for the following reasons (Emad (2012), Christopher & Lynda, 2014).

- It ensures that sufficient cash is available to meet the demands and determines a company's future borrowing needs.
- It shows the contractor the maximum amount of cash required and when it will be required. Thus, the contractor can made arrangements to secure the required cash.
- It serves as an early warning system that alerts treasurers to potential cash shortfalls.
- It provides a reliable indicator to lending institutions that loans made can be repaid according to an agreed program.
- It ensures that cash resources are fully utilized to the benefit of the owner and investors in the company.

2.5.2 Cash Flow Forecasting Analysis

In forecasting the project's cash flow, three main components give rise to a full cash flow projection. Construction project cost creates the S-curve and the Project Interim Payment and Timing of payments. These components will be dealt below to have a better understanding of the cash flow forecasting ordinary calculations.

A. Construction Project Costs

In preparing the cash flow for a project, it is necessary to compute the costs that must be expended in executing the works using activities durations and their direct and indirect costs. The principal components of a contractor's costs and expenses result from the use of labors, materials, equipment, and subcontractors. Additional general overhead cost components include taxes, premiums on bonds and insurance, and interest on loans. The sum of a project's direct costs and its allocated indirect costs is termed as the project cost. Emad (2012) has classified the costs that spent on a specific activity or project as;

- **Fixed cost:** costs that spent once at specific point of time (e.g., the cost of purchasing equipment, etc.)
- **Time-related cost:** costs spent along the activity duration (e.g., labor wages, equipment rental costs, etc.)
- **Quantity-proportional cost:** costs changes with the quantities (e.g., material cost)

a. Project Direct Costs

The costs and expenses that are incurred for a specific activity are termed direct costs. These costs are estimates based on detailed analysis of contract activities, the site conditions, resources productivity data, and the method of construction being used for each activity. A breakdown of direct costs includes labor costs, material costs, equipment costs, and subcontractor costs.

b. Project Indirect Costs

Other costs such as the overhead costs are termed indirect costs. Part of the company’s indirect costs is allocated to each of the company's projects. The indirect costs always classified to: project (site) overhead; and General (head-office) overhead.

Project/Site Overhead

Project overhead are site-related costs and includes the cost of items that cannot be directly charged to a specific work element and it can be a fixed or time-related costs. These include the costs of site utilities, supervisors, housing and feeding of project staff, parking facilities, offices, workshops, stores, and first aid facility. It also includes plants required to support working crews in different activities. A detailed analysis of the particular elements of site-related costs is required to arrive at an accurate estimate of these costs. However, companies used to develop their own forms and checklists for estimating these costs. Site overhead costs are estimated to be between 5% - 15% of project total direct cost.

General overhead

The costs that cannot be directly attributed a specific project called general overhead. These are the costs that used to support the overall company activities. They represent the cost of the head-office expenses, managers, directors, design engineers, schedulers, etc. Continuous observations of the company expenses will give a good idea of estimating reasonable values for the general overhead expenses. Generally, the general overhead for a specific contract can be estimated to be between 2% - 5% of the contract direct cost.

B. The S-Curve

The curve represents the cumulative expenditures of a project direct and indirect costs over time is called the S-curve, also called **Contractor's Expenditure Curve** as it take the S-shape as shown in Figure 2. In many contracts, the owner requires the contractor to provide an S-curve of his estimated progress and costs across the life of the project. During the production process, the contractor expends on various activities and expects to be reimbursed on the expenses made. This forms what is called 'the cyclic income and expenditure curve' of the contractor (Joseph & Theophilus, 2012). Throughout the active stage of a project, expenditure is an ongoing process which occurs at irregular intervals during the project duration. A plotted expenditure pattern for a typical project that includes the entire direct and indirect cost and head office expenses normally rises or peaks, and then begins to fall, along the trajectory or duration of the project.

This S-shaped of the curve results because early in the project, activities are mobilizing and the expenditure curve is relatively flat. As many other activities come on-line, the level of expenditures increases and the curve has a steeper middle section. Toward the end of a project, activities are winding down and expenditures flatten again as it can be seen in the Figure below. The S-Curve is one of the most commonly techniques to control the project costs (Emad, 2012).

Furthermore, Research has shown that, for most building construction projects, a chunk of the cash out flow is expended directly or indirectly on materials procured, except for capital-intensive civil works. (Joseph & Theophilus, 2012) Contractors can thus negotiate the billing period with nominated suppliers for the payment of the cost of materials purchased to be deferred until a later date after the client has honored certificates.

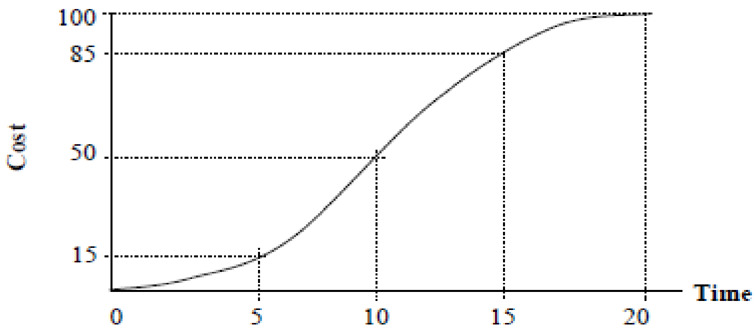

Figure 2: A sample S-Curve (Emad, 2012)

C. Project Income (Cash-in)

Project Income/Contractor's Income Curve is the flow of money from the owner to the contractor in the form of progress payments/Interim Payments or Valuations. Estimates of work completed are made by the contractors periodically (usually monthly), and are verified by the owner's representative, usually the Engineer/Consultant. Depending on the type of contract (e.g., lump sum, unit price, etc.), these estimates are based on evaluations of the percentage of total contract completion or actual field measurements of quantities placed. Owners usually retain 5-10% of all validated progress payment submitted by contractors. The accumulated retainage payments are usually paid to the contractor half with the Final payment and the other half at the end of Defect Liability Period (Usually a year after take over by the client). They also deduct the Advance Repayment form each interim payment if advance payment is issued for mobilization and to begin major construction works which tends to ease the working capital needed from the pocket of the contractor.

Engineer’s valuation takes account of any application for payment made by the contractor. The valuation also considers the current forecast of actual construction (which represents the direct cost of materials, labour and plant to execute the project) for the works submitted by the contractor. These interim payments are of critical importance to the contractor's cash flow. Thus, contractors are faced with undertaking interim valuations, usually at monthly intervals or stage evaluation, although this can vary. Joseph & Theophilus (2012) have depicted the importance of these valuations stems from the fact that they:

- Control the contractor's cash in flow
- Provide financial information for the contractor
- Serve as information on the general progress of the works

As opposed to the expenses presented above with smooth profile, the revenue will be a stepped curve. In addition, when the contractor collects his/her money it is named project income (cash in) as shown in Figure 3 below. The recognition of revenue is done before income is issued from the clients with some days lag.

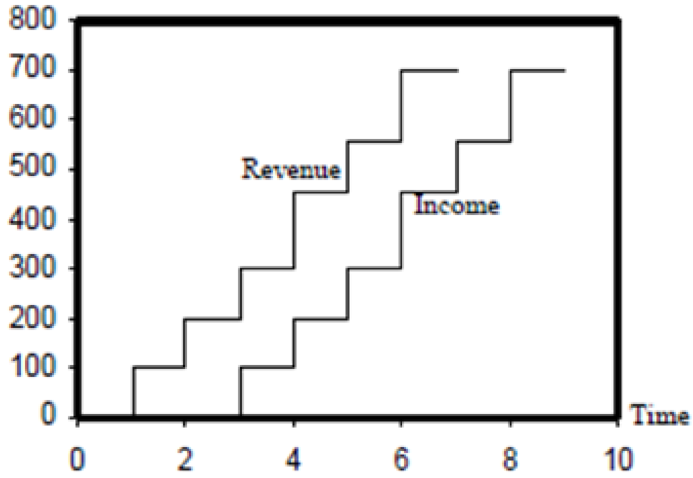

Figure 3: Project Revenue and Income graph (Emad, 2012)

D. Calculating Contract Cash Flow

Having determined the contract expenses and income as presented in the previous section, it is possible to calculate the contract cash flow. If we plotted the contract expense and income curves against each other, then the cash flow is the difference between the points of both curves. Figure below shows the cash flow of a specific contract. The hatched area (overdraft) represents the difference between the contractor’s expense and income curves, i.e., the amount that the contractor needs to finance the working capital. The larger the overdraft area, the more money to be financed and the more interest charges are expected to cost the contractor (Emad, 2012). In addition, the cash flow can also be determined by calculating the net cash of a project and taking out the figures, which show the most negative edge points on the net cash flow graph with a projected time of finance needs.

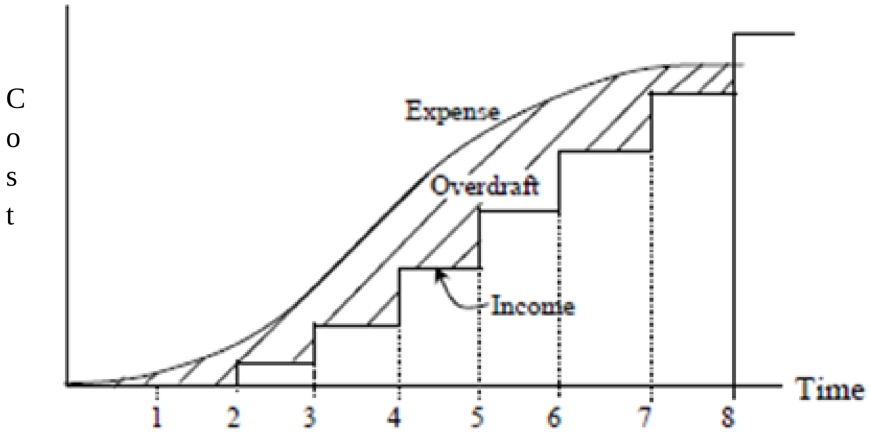

Figure 4: Expense and Income graphs combined (Emad, 2012)

2.5.3 Cash Flow Forecasting Models Review

The traditional approach to cash flow prediction usually involves the breakdown of the bill of quantities in line with the contract program to produce an estimated expenditure profile. This could be expected to be reasonably precise provided that the bill of quantities is accurate and the contract program is complied with. This however is likely to be slow and costly to produce; as such, several attempts have been made to devise a 'short cut' method of estimation, which will be both quicker and cheaper to utilize. Attempts have been made at the mathematical formulae and statistical based modeling of construction cash flow in both the contractor and client's organizations. This was demonstrated by the development of a series of typical S-curves by many. The models obtained by these researchers rest on the assumption that reasonably accurate prediction is possible by means of a single formula utilizing two or more parameters which may vary according to the type, nature, location, value and duration of the contract (Ahmed, 2014).

Several attempts have also been made at computer modeling of cash flow forecast. Some of the models were based on computer simulations while others were based on value curves. Berny and Howes (1982) and Kenly and Wilson (1986) took the ideographic approach to cash flow forecasting by maintaining that value curves are generally unique and should be modeled separately. They insisted that a curve should be fitted for each project as opposed to the nomothetic models, which aggregate groups of projects in order to develop a single standard curve to produce typical value curves. Boussabaine and Kaka (1998) however maintained that ideographic models are only useful for analytical purposes. As such, they argued that forecasting requires the use of standard curves developed out of a group of projects similar to the one to be executed (nomothetic models). They therefore have developed cash flow models based on standard cost / value flow curves using logit transformation to fit the data.

Some of the previously used methods are Artificial Network Method by Boussabaine (1999), Case-Based Reasoning systems by Rosina Weber Lee, Ricardo Miranda Barcia and Suresh K. Khator (1995), Mathematical Models/Expressions by Khosrowshahi1 (2001) and Khosrowshahi & Kaka (2007), Novel Multiple Linear Regression model by Karl Blyth and Ammar Kaka (2006). In addition, Adaptive Time dependent Least Squares Support Vector Machine Prediction models was used by Min-Yuan Cheng, Nhat-Duc Hoang, Yu-Wei Wu (2012), Value at risk by Mohammad Reza Feylizadeh and Morteza Bagherpour (2013), Fuzzy Set theory by Serhat Melik (2010), Cash flow with SSA by Gediminas Zylius (2016).

The above studies gave rise to the development of a series of models which can be grouped into a number of categories. The main categorization relates to whether the model is based on the use of a mathematical expression or alternative methods such as heuristic, activity-based and the use of cost centers. All these models are yet to make an impact on the industry which often tends to make use of activity-based forecasting (often derived from project management systems), elemental approach (with the use of an estimating package) or a simplified decomposition method of separating areas of cost into labour, material, equipment and overhead, as suggested by Harris and McCaffer (1995). This is probably due to lack of confidence about the accuracy of the forecasting models (Flanagan and Norman, 1983, and Kaka and Evans, 1998). While some of these expert system models focused on the construction contractors, others focused on the clients. Most of the models however have not taken risk and uncertainty into consideration (Ahmed, 2014).

2.6 Construction Financial Risks

As construction projects become larger and more complex, the risks associated with them are also more complex and harsher. The utter scope, size, and timing of today's projects pose significant challenges in risk management, including risk identification, determining the allocation of risks among the involved parties, developing mitigation and risk treatment plans and opportunities for cost savings in single project applications or across an entire portfolio of projects.

Project risks are usually bifurcated between the construction and operational periods of the project. Lenders are most ‘at risk’ during the construction period (and this is typically the period when most defaults occur) (David and James, 2010). These risk factors involve issues or concerns associated with the financing of the project, including the execution period and operations or equity financing. Jayasudha and Vidivelli (2016) Confirmed in their research that the financial risks are among the most critical risks ranking third, which influence the implementation of the construction works. This dignifies that construction projects usually have difficulties on financing their needs of funds to execute the works according to the contracts signed. Hence, particular due diligence shall be undertaken on the strength and contingent support associated with the construction contract.

2.6.1 Cash Flow Risk Factors

There are many cash flow risks which in their way of impact have their own effect mechanisms. Many researchers tried to incorporate the cash flow risk factors by including within the analysis of project’s cash flow models. Those models have been developed to assist contractors and clients in their cash flow forecasting. The majority of these have been based on standard cash flow S-curves, developed using the traditional manual approach, mathematical and statistical models. Many of these models failed to consider and analyses the factors responsible for the considerable variations in the modeled cash flow profiles (Henry and John, 2000).

2.6.2 Systemic and Project Specific Risks

Conceptually thinking, the most important aspect of project risk management is risk identification, which commences contemporaneously with risk management planning. The process of risk identification brings to fore the need for risk categorization and the eventual development of a risk breakdown structure. During the process of risk identification, risk can be categorized as endogenous and exogenous risk, i.e. internal or external, enterprise environmental factors or organizational process asset. Considering the predictability of the risk in relation to the project, a further sub-categorization is systemic and project specific groupings (Buertey, et al, 2012).

Hervert (2011) also postulated that risk identification has revealed two categories of risk: systemic and project specific risk. Systemic risk are those risks which can be identified at the onset of project and can be predicted to have an impact on a project which would likely result in a cost overruns if good planning is not made towards it. Systemic risk are said to be an artifact of the project system, culture, process, technology or complexity. Systemic risks are thus measurable and predictable, even at the very earliest stage of the project definition, with cost impact stochastic in nature, thus making it very difficult for individual team members to determine impact at the earliest project stage (AACE, 2009).

Hervert (2011) agrees with the AACE (2009) that systemic risk affects the artifact of the system; with systemic risk affected by the estimation approach, understanding of scope, and alignment of stakeholders, project team experience and completeness of engineering drawings. Thus systemic risks are more inclined to design factors, scope definition and factors within the direct control of the project team.

Project specific risks, on the other hand, are factors which may affect the artifact of the project, these includes delivery delays, constructability, site conditions, terms and conditions and can be termed as factors beyond the domain of the design team (Hervert, 2011). These risk factors are associated with the construction which can neither be determined now nor be predicted in the future. These are project related uncertainties which may occur on a project which an estimator at the point of estimation neither has an idea about the type of risk nor the magnitude of the risk nor the impact of the risk nor the cost to be associated with it. AACE (2009) has defined Project specific risk are risks that are specific to projects, with the impact of these highly unpredictable between projects of within a system or industry as a whole. The impact of project specific cannot be thoroughly measured but can identified using risk riggers and early warning signs of probable impact to enhance mitigation.

Systemic risk drives having possible effect on cost growth includes basic design, level of technology, process complexity, material quality, soil requirement, engineering design, schedule development, team experience, cost information, bidding and labor climate, and cost information available (Hollmann, 2007). Unpredicted project specific risk results in additional cost growth shifting the total cost curve outwards. The implication of the above is that systemic risk can be predicted empirically using historical data whereas project specific risk can only be predicted by simulation. As the case for Cash flow risk factors, systemic risks are identified from different literatures as tabulated hereunder. Unfortunately, project specific risks have to be simulated further from data of case study project.

2.6.3 Reviewed Systemic Cash Flow Risks

Systemic Cash flow risks are categorized, for the methodological use of this thesis, into two major classifications: Cash in and Cash out flow Risk factors. These factors are generally classified based on the impacts they could have on the streams of the cash flow projection. Accordingly, their classification eases the applications of the risks in the cash flow forecasting of building construction projects.

Cash inflow impacting risks are the uncertainties that most probably have a significant impact on the inward movement of cash from the client to the contractor. These risks are associated with the interim and advance payments and any other informal payments from the client upon a substantial work progress reported in a monthly or other basis. Whereas, the risks that impact the cash out flows have a considerable effect on the outward movement of cash from the contractor's pocket to run the construction project. These risks are related to the expenses and costs of the contractor, which are incurred during the actual execution of the project works. Both of these classes of cash flow have their own risks that have a significant effect on one's project cash flow forecasting model.

The models usually make use of these risk factors to maximize the accuracy of the cash flow forecast and advance the techniques into updated one, simplifying the use of the models in the real construction world. As an input to the Monte Carlo stimulation, the following risks are identified which are thought to affect the cash flow of Building construction projects. These cash flow risk factors are first selected to the applicability of Ethiopian construction projects, summarized from the previous studies of Emad (2012), Ahmed (2014), and Nuruddeen, et al (2016). The reviewed risk factors are then categorized into cash flow impact divisions: cash in and out flows designated as (I) & (O) respectively and are tabulated here under.

Table 2- Cash Flow Risk Factors

No.	Cash Flow Risk Factors
1	Delay in Agreeing interim valuations on site/Temporary Evaluations (O)
2	Delay of making/preparing payments(O)
3	Estimating error in Constr. Execution planning(O)
4	Consultant's instructions/change orders(I / O)
5	Retention(I)
6	Delays in payment issuance from client(I)
7	Delay in settling claims (O)
8	Labour Strikes(O)
9	Harsh Weather Condition(O)
10	Problems with the Foundations(O)
11	Delay in agreeing Variation/ Day Work(O)
12	Changes in Currency Exchange rates(I / O)
13	Inflation in Resources used (O)
14	Delay in Receiving Certified Interim Payment Documents from consultants (I)
15	Extent of Activity float in contract schedule (I)
16	Tender Unbalancing (Front and Back Loading) (I)
17	Provision for Fluctuating payments due to any sudden additional payments (I)
18	Changes in Interest Rates (I / O)
19	Receiving Advance Payment (I)
20	Materials and Equipment shortage (O)
21	Change in Interim payment duration other than monthly issuance (I)
22	Accident and Theft (O)
23	Advance Loan repayment (I)
24	Worker attitude and lack of Skilled Labour (O)
25	Buying equipment (O)
26	Price Fluctuation (Price Irregularity) (I/O)
27	Rework due to error in execution (O)
28	Equipment Breakdown (O)
29	Bankruptcy of Subcontractor (O)
30	Unstable Company Financial Position(I / O)
31	Over/Under Measurement(I / O)
32	Poor design & Inaccurate bid items (O)

2.7 Monte Carlo Simulation Method

Research Analysts use multivariate models to forecast investment outcomes to understand the possibilities surrounding their investment exposures and to better mitigate risks. Monte Carlo Simulation is one specific multivariate modeling technique that allows researchers to run multiple trials and define all potential outcomes of an event or investment. It was named after Monte Carlo, Monaco, where the primary attractions were casinos containing games of chance in which application of this method had begun in the early 1940s. Games of chance such as roulette wheels, dice, and slot machines exhibit random behavior. The random behavior in games of chance is similar to how Monte Carlo simulation selects variable values at random to simulate a model. When you roll a die, you know that a 1, 2, 3, 4, 5, or 6 will come up, but you don't know which for any particular roll. It is the same with variables that have known range of values but an uncertain value for any particular time or event.

Running a Monte Carlo model creates a probability distribution or risk assessment for a given investment or event under review (Robert, 2015). Tzveta (2015) also defined MCS as “a technique that converts uncertainties in input variables of a model into probability distributions. By combining the distributions and randomly selecting values from them, it recalculates the simulated model many times and brings out the probability of the output.”

In finance, there is a fair amount of uncertainty and risk involved with estimating the future value of figures or amounts due to the wide variety of potential outcomes. Monte Carlo simulation (MCS) is a technique that helps to reduce the uncertainty involved in estimating future outcomes. It is also a method used to understand the impact of risk and uncertainty in financial, project management, cost, and other forecasting models. MCS can be applied to complex, non-linear models or used to evaluate the accuracy and performance of other models. It can also be implemented in risk management, portfolio management, pricing derivatives, strategic planning, project planning, cost modeling and other fields.

2.7.1 MCM Basic Characteristics

These are the main characters that MSC has which helps reach into the desired outcomes (Tzveta, 2015).

- MCS allows several inputs to be used at the same time to create the probability distribution of one or more outputs.
- Different types of probability distributions can be assigned to the inputs of the model. Some of the Probability Distribution functions are Normal, Lognormal, Triangular, Uniform Exponential distributions and etc. When the distribution is unknown, the one that represents the best fit could be chosen.
- The use of random numbers characterizes MCS as a stochastic method. The random numbers have to be independent; no correlation should exist between them.
- MCS generates the output as a range instead of a fixed value and shows how likely the output value is to occur in the range.

2.7.2 MCM Modeling Tools and Techniques

Once designed, executing a Monte Carlo model requires a tool that will randomly select factor values that are bounded by certain predetermined conditions. By running a number of trials with variables constrained by their own independent probability of occurrence, an analyst creates a distribution that includes all the possible outcomes and the probability that they will occur.

There are many random number generators in the marketplace. In the Monte Carlo analysis, a random-number generator picks a random value for each variable (within the constraints set by the model) and produces a probability distribution for all possible outcomes (Robert, 2015). The standard deviation of that probability is a statistic that denotes the likelihood that the actual outcome being estimated will be something other than the mean or most probable event. The most common tools for designing and executing Monte Carlo models are @Risk, Risk Solver, and Crystal Ball. All of these can be used as add-ins for spreadsheets and allow random sampling to be incorporated into established spreadsheet models (Robert, 2015).

Crystal Ball is the easiest to use and has the best set of resources – an excellent user guide, reference manuals, an abundance of illustrative models and many texts. Crystal Ball is the most complete package for simulation and optimization, integrating the functionality to perform Monte Carlo simulation, optimization, and even time-series forecasting as risk sub-models. On the other hand, @RISK has the best procedure for identifying the key variables affecting the range and shape of the results. This is its *regression sensitivity option*. In addition, the recent new version contains many upgrades, including a significantly improved interface that makes Monte Carlo modeling a simple drag-and-drop exercise. Each function is just an icon-click away on the @RISK ribbon bar. @RISK is a close second to Crystal Ball in terms of resources. Its demos and tutorials are straightforward and nicely packaged (Sam, 2008).

In addition, all three packages have the simulation optimization capability. It is built into Crystal Ball and is called Opt Quest. For @RISK, there is the companion Risk Optimizer, and Risk Solver has the companion Premium Solver Platform Stochastic (PSPS), which is an upgraded version of the Excel add-in. The analyst specifies the objectives and constraints for optimization in the optimization software and the Monte Carlo software performs the simulations (Sam, 2008).

2.8 Literature Summary and Gap Identification

The literature review is a composition of main topic titles, which are thought to be useful for the wide prospective ideas related to cash flow management especially to the cash flow forecasting of construction projects. It is collected from a secondary information sources such as journals, books (published and unpublished), brochures, websites and other similar sources.

2.8.1 Literature Summary

It begins with general concepts of Construction project finance and goes deep into Cash flow management and then into the cash flow forecasting literatures of a construction project. Later, Construction project cash flow risk factors are addressed to have a full in depth concepts/ perspectives of the whole literature review. Finally, it flows with a comprehensive review of the literatures related to Monte Carlo Simulation method and its applications in the construction sector. So far, the literature review is categorized into four major groups that are briefly described in the Table 3 below.

Table 3: Literature Summary

No.	Main categories	Description
1	Construction Project Financing	It is composed of the basic financing scenarios of a construction project. It also tries to include general financing problems associated with company's business failure.
2	Construction Project Cash Flow Management	This category is all about the cash flow basic terms, how the cash is cycled/ received and paid/, how is project cash flow forecasted, forecasting models review and its challenges towards having an accurate projection.
3	Construction Project Financial Risks	It begins with introducing the general aspects of Construction financial Risks and tries to review systemic and project specific cash flow risk factors which have impacts on the cash in/out flows. It finally identified and selected systemic risks to be processed according to the compatibility purposes of Ethiopian Conditions.
4	Monte Carlo Simulation Method (MCSM)	This topic introduces the Monte Carlo Method in which it defines terminologies and its characteristics. It also includes modeling tools and their comparisons with their applications.

2.8.2 Gap Identification

After the compilation of the literature reviews, there were some gaps recognized for processing and addressing issues through methodology of the research. This identification further clarifies how the Monte Carlo Method can be applied to the concepts of project cash flows with multiple cash flow risks and its case study applications. The following are the main topics which needs prior explanation.

Table 4: Identified Gaps and Proposed Solutions

No.	Identified Challenges / problems	Description	Proposed Solutions
1	**Cash flow Risks**	These risks are uncertainties which affect the cash flow projection of a given construction project. The risks are classified into cash in and out flow risks, and generally classified into Systemic and Project Specific Risks.	Customized selection process is done using brief questionnaire on the identified Systemic risks from literatures. Appropriate to the case study project from the ranked systemic risks are then selected for further processing. Project specific risks however are analyzed from the data of the case study project.
2	**Risk Ranges for MCSM**	Monte Carlo Method needs ranges of impact occurrence for the cash flow risk factors i.e. minimum and maximum.	The selected systemic risk's Range can be specified from general industry experience. Project specific risks range could also be found from the data of distribution fits using analysis results work items cost variations of case study project including itemized delay risks close to the actual project scenario.

Chapter Three: Research Methodology

3.1 Research Approach

The research adopts the most suitable researching techniques that go along with the main topic in focus. Since the study involves identifying and analyzing the cash flow risk factors from the questionnaires data and modeling the cash flow with Monte Carlo Simulation system in which cash transactions within construction companies have been dealing throughout their active business lives, the appropriate approach towards this target would be the Quantitative Approach. The cash flow forecasting also involves mathematical expressions to magnify and explain the cash in and outflows and their correlation with each other that correctly incorporate the impacts on project cash flows risks.

3.2 Research Subjects

Since the research investigates the main stakeholders of the construction industry, it selects direct stakeholders involved in medium and large-scale construction projects. These bodies are known to be Contractors, Consultants and Clients. The subjects are limited to companies whose head offices are located in Addis Ababa, capital of Ethiopia. The questionnaire selected Grade one contractors and consultants whom the researcher thought are more organized and well performing ones, and the clients which run and fund private or public Building Construction Projects.

Accordingly, the study selects more amounts of Contractors that have explicit experiences in undertaking different projects in a sense of having difficulty of fulfilling the financial demands for each project they are contracting and with fair number of consultants and a few employers. A case study project is also selected conveniently for the evaluation of the Deterministic cash flow and the projection experimented through the help of Monte Carlo Simulation, with actual cash flow of case study project.

3.3 Subject Sampling

In Ethiopia, there were about 133 registered Grade one; General contractors and 82 consultants which are engaged in Governmental and non-governmental large scale Building projects in 2009 EC. As Kish (1965) formulated this sampling formula, out of these distinctive subjects the research identified a specified portion of samples using a 95% Confidence-based sampling formula as follows:

n= (n')/[1+(n'/N)], ………………………………………………. *[Equation 3.1]*

where:

N= total number of population

n= sample size from finite population

n'= sample size from infinite population which is S^2/E^2; where S is the variance of the population elements and E is a standard error of sampling population. (Taking the highest variability of S=0.5 and standard error of E=0.07)

Therefore, for a total of 215 Major Stakeholders:

- $n'=S^2/E^2= 51.02$
- N=215
- n=51.02/[1+(51.02/215)]=41

To account for the non-responsive questionnaires, a 20-30% increment on the total sample size is made. Therefore the total samples would be:

= 41*(1+0.2) = 41*1.2= 49 target samples

Out of the calculated samples, the contractors do have a higher percentage of participation since the main task of managing project cash flows falls on their hands. Thus, contractors account about 62% (133/215) of the total samples i.e. 49*0.62= 30. The remaining 19 (82*49/215) questionnaires are distributed to the consultants. However, Five Employers are chosen based on the convenience of the researcher who have a strong basic knowledge (upon employing professional or so) about construction. The study also uses a convenience & availability selection method to choose the directly participating stakeholders in the industry to whom the questionnaires are sent to, based on the calculated portions.

3.4 Data Sources and Collection Methods

In order to synthesize the goal of the study topic, the research has a confirmed and reliable data source and collection methods. The study uses a data, which is available in books, journals, persons, web sites, magazines and any other related sources. There are different types of techniques that are deployed to gather trusted and relevant information to analyze and synthesize the cash flow management systems, best practices and elaborative analysis of a case study project using MCS. These explicit methods are close-ended Questionnaires distributed for each conveniently selected stakeholder for the identification and selection and ranking of Systemic cash flow risk factors, after selecting the questionnaire responses through careful acceptance and rejection, and E- surveys other than personal contact when questionnaires delivery is more appropriate**.** Additionally, case study project based data is also put into the analysis of project cash flow forecasting.

3.5 Data Analysis

The research uses the so-called statistical analysis that proceeds to interpret, manipulate and evaluate the core idea and findings of the data. This analysis can be of *descriptive* one that is done by describing the shape, central tendency and variability of the cash flow risk factors and looking at those variables one at a time with probabilistic notion: mean, median, range, proportion and its impacts on the project cash flow amount. The research also uses *inferential analysis*, which looks at associations/correlations among the major identified cash flow risks and cash flow results through generation of a Formula. The analysis then implements Monte Carlo simulation software application on case study project by applying the statistical analysis principles.

In order to prioritize or rank the impacts of domestic cash flow risks which are identified through the intensive literature and to select the major ones; the mean score for the frequency of occurrence, the impact effect and the integration of both is used for comparison purposes Frequency mean score is then computed as:

$$\textbf{Mean Score} = \Sigma\,(1f_1+2f_2+3f_3+4f_4+5f_5)/N \quad \text{[Equation 3.2]}$$

Where: N = Total number of respondents

f_1: rarely occurrence, f_2: sometimes, f_3 : Usually, f_4 : Often and f_5 : Always

The same formula is also used for impact mean score (a detailed formulation of mean scores is described in the analysis part). The analysis also implements Monte Carlo Tool /software/, through @Risk 7.5 excel add in developed by Palisade Corporation based in USA, to apply on the case study project.

Furthermore, to find the cash flow of the case study project, project's cost loaded schedule is executed by using work break down structures and cost of work items. In consequence, the deterministic or a static cash flow based on the static schedule and cost of the project can be traced without any anticipated risks. Integrating with deterministic cash flow, a simulated or probabilistic cash flow is also calculated using @Risk: a Monte Carlo Simulation Excel add in. Finally, probabilistic and deterministic cash flows are evaluated against the actual project cash flows collected from the case study project.

For purposes of higher degree of expressions and further explanations: Textual, Graphical and Numeric explanations on the analyzed topics are incorporated based on the analysis findings and are finalized by drawing a concrete package of reliable information, which helps the conclusions and recommendations to be clearly and precisely described.

3.6 Research Design

The research design is drawn according to the proposed procedures to be followed so that a desired data can be collected for the internalization and customization of the research problems and its forwarded questions. The procedural design lets the research to be full on its own based on reliable sources and cross checking of the research objective with the findings from the analysis of the data. The methodological chart is well described as figured in Figure 5 below.

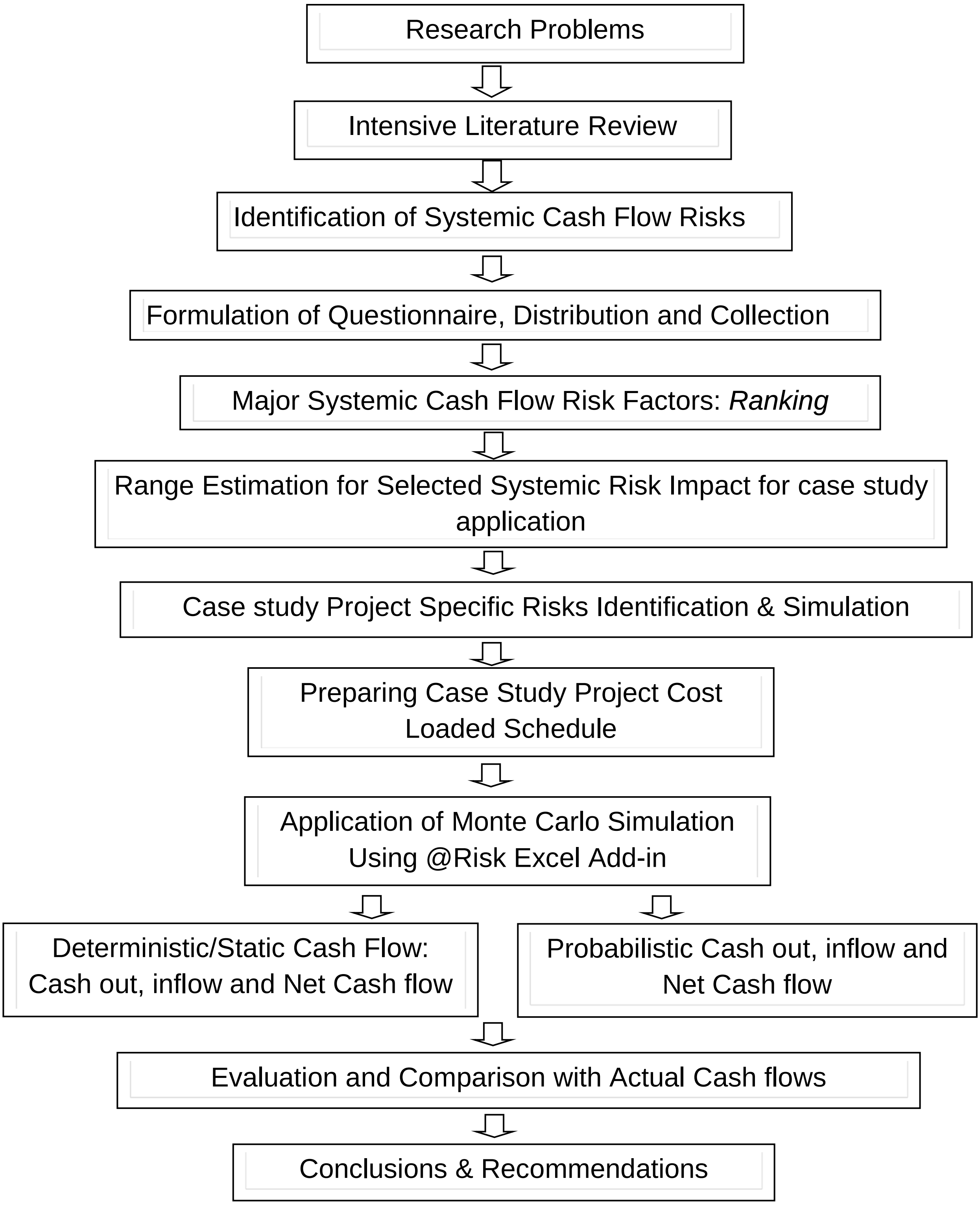

Figure 5- Research approach design

Chapter Four: Questionnaire Data Analysis and Interpretation

4.1 Introduction

This section entails about the questionnaires and their interpretation and discussions along with comparisons with the literatures. The primary data collection methods is a Close ended Structured Questionnaires with risks frequency and impact assessments. The questionnaire assesses about the major systemic cash flow risk factors, which respondents depict as such, and tries to discuss the finding by using elaborative explanations. The chapter finally summarizes the very results of the analysis for further simulations.

4.2 Questionnaire Lay out

As introduced before, a structured questionnaire is used to find out the most influential cash flow risks. This questionnaire is composed of three main columns from 1 – 5 for the frequency of occurrences and impacts on project cash flow and one with lists of cash flow risks. The questionnaire has also three categories of risks; Cash Inflow, Cash Outflow and risks that fall into both cash in or outflows designated as I/O. The analysis is done through a separate calculation based on frequency and impact alone and an integrated composite, incorporating both the frequency and impact results.

4.3 Response Rate

A total of 49 questionnaires were distributed, as described in the research methodology section, for selected Grade one contractors, consultants and 5 clients were also selected which in the researchers' opinion are knowledgeable on project cash flow in specific and on total building construction area in general. After having collected back the filled out questionnaires, the following response rate is summarized here under.

Table 5: Response rate

No.	Stakeholders/Respondents	Questionnaires Distributed	Questionnaires Collected	Response rate
1	Contractors	30	30	100%
2	Consultants	19	15	78.9%
3	Clients	5	4	80%

Table 5 shows that all questionnaires are collected from the contractors but with some deviations on consultant and client Reponses. When we compare with the numbers depicted on the methodology, the response that we have on the table is almost compatible with the targets planned before.

Table 6: Deviation from the Planned Target

No.	Respondents	Planned Responses	Usable Responses	Deviation
1	Contractors	25	30	+20%
2	Consultants	16	13	-19%
3	Clients	5	4	-20%

The general result shows that a total deviation of 13 % with a total 87% response rate which is acceptable as a summarized result with 2 rejected questionnaires. However, number of respondent needed is 41 excluding the client responses and the contrast on these figures shows that the responses are somehow met the target with an extra of 2 responses i.e. (30+13)- (25+16) = 2. Therefore, the response rate is above the target number within the range of acceptable standard.

4.4 Respondent Classification

The respondents of the questionnaire are classified based on how much projects the companies are executing, company experience and the professional duties with their year of experience. Figure 6 shows that most of the contractors and consultants are handling projects from 5 to 10 projects with 61%, 10-15 projects with 21% and only 9% of them are handling 15-20 projects and more than 20 projects at once. It therefore indicates that most of the companies are undertaking smaller number of projects.

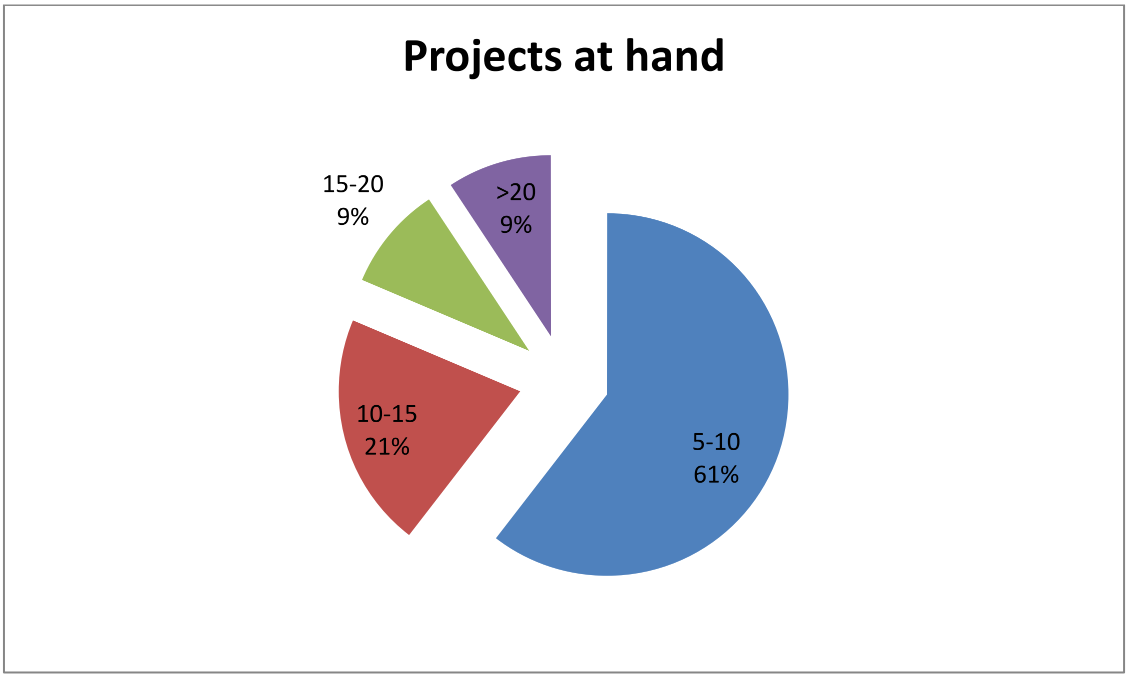

Figure 6: Classification based on Projects at hand

Figure 7 classifies all stakeholders (Contractors, Consultants and Clients) according to their year of experience in executing construction projects. Most of the companies have been in business from 5 to 10 years accounting 53% and some companies have experiences of 10-15 years with 19% coverage. However, only 9% have more than 20 years of experience.

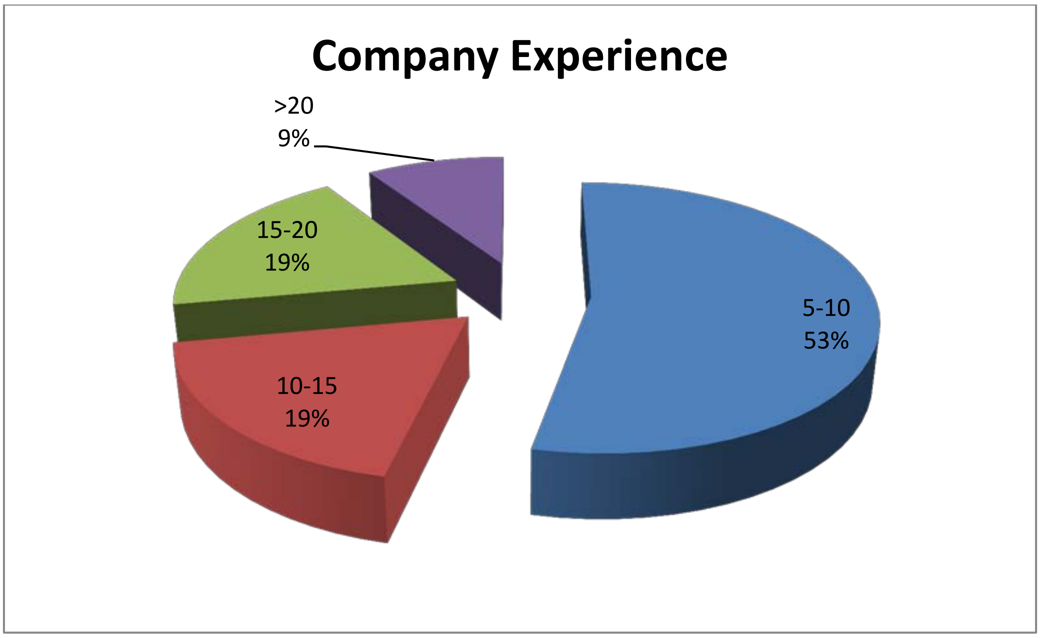

Figure 7: Classification based on Company Construction Experience

4.5 Data Analysis

This analysis is done based on three distinctive fragments to make better selection for the major influential systemic cash flow risks on project cash flow forecasts. There are three things to be considered here: Frequency, Impact and Integration of both. The frequency-based analysis is based on the occurrence repetition of the risks and impact based analysis is based on the effect the cash flow risk has on cash flow forecasts when it occurs. The integration uses the comprehensive influence of the frequency and impact all together.

The frequency analysis bases its calculation by multiplying the numbers of frequencies the respondents marked for each risks with the number ranges of frequencies from 1 with a rarely to 5 with the highest occurrence. The impact effect on the other hand differs in a way that the impact ranges for each numbers from 1-5 are 0.2-1 with 0.2 intervals (0.2 for 1 and 0.4 for 2 and so on). Finally, the integration is calculated by multiplying the frequency and impact score of the risks and dividing by the whole number of questionnaires collected. Here is the summary of formulas used for the analysis and selection of the risks.

Table 7: Analysis Formula

Analysis Description	**Formula**
Frequency of Occurrence	FMS = $(\sum f*r)/n$
Impact Effect	IMS = $(\sum i*r')/n$
Integrated	INS = FMS*IMS = $(\sum f*r*i*r')/n^2$
Where: FMS: Frequency Mean Score IMS: Impact Mean Score INMS: Integrated Mean Score f: number of frequency for each frequency ranges r: Frequency Ranges from 1-5 i: number of impact for each impact ranges r’: Impact Effect Ranges n: Total Number of Responses	

1. **Frequency Based Analysis**

According to the formula based analysis given above, the following result has been tabulated for the frequency analysis of the risks. From Table 8 results, it can be shown that the most frequent risk factor is Retention (FMS=5) and the 2nd and 3rd ranked risk factors are Receiving Advance Payment (FMS=4.3) and Repaying advance payment (FMS=4.23) respectively. The least frequent one becomes Change in Interim Payment duration other than Monthly Installments succeeding Delays in Payment issuance from Client.

2. **Impact Based Analysis**

Similarly, the impact mean score for all risk categories is calculated and presented in Table 9 below. Accordingly, The table shows that the risk factor with the highest impact mean score of Poor Design & Inaccurate Bid Items is in a tie with Material & Equipment Shortage (IMS=0.78), and Delays in making payment Issuance from the client (IMS=0.77) becoming the 3rd having the most impact effect on cash flow forecasting. The last ones are Labour Strikes and Retention (IMS=0.52 and 0.50).

3. **Integrated Based Analysis**

Table 10 shows the list of risk factors with their integrated mean scores. It also shows, in their order of precedence, that Receiving Advance Payment ranked 1st with the highest integrated mean of 2.8, Materials and Equipment Shortage with a mean score of 2.7, Delay in Receiving Certified Interim Payment Documents from consultants with mean score of 2.66 and with the last mean score becomes ranking Changes in Interest Rates having 1.02.

Table 8: Frequency Mean Score

No.	Cash Flow Risk Factors	Frequency Mean Score
1	Delay in Agreeing interim valuations on site/Temporary Evaluations (O)	3.15
2	Delay of making/preparing payments(I)	2.89
3	Estimating error in Constr. Execution planning(O)	3.17
4	Consultant's instructions/change orders(I & O)	3.51
5	Retention(I)	5
6	Delays in payment issuance from client(I)	3.11
7	Delay in settling claims (O)	3.23
8	Labour Strikes(O)	2.06
9	Harsh Weather Condition(O)	2
10	Problems with the Foundations(O)	2.38
11	Delay in agreeing Variation/ Day Work(O)	2.83
12	Changes in Currency Exchange rates(I & O)	2.55
13	Inflation in Resources used (O)	3.23
14	Delay in Receiving Certified Interim Payment Documents from consultants (I)	3.68
15	Extent of Activity float in contract schedule (I)	2.83
16	Tender Unbalancing (Front and Back Loading) (I)	2.91
17	Provision for Fluctuating payments due to any sudden additional payments (I)	2.34
18	Changes in Interest Rates (I or O)	2.06
19	Receiving Advance Payment (I)	4.3
20	Materials and Equipment shortage (O)	3.47
21	Change in Interim payment duration other than monthly issuance (I)	3.09
22	Accident and Theft (O)	2.17
23	Advance Loan repayment (I)	4.23
24	Worker attitude and lack of Skilled Labour (O)	3.19
25	Buying equipment (O)	3.6
26	Price Fluctuation (Price Irregularity) (I/O)	3.21
27	Rework due to error in execution (O)	2.53
28	Equipment Breakdown (O)	2.62
29	Bankruptcy of Subcontractor (O)	1.98
30	Unstable Company Financial Position(I or O)	2.57
31	Over/Under Measurement (I / O)	2.87
32	Poor design & Inaccurate bid items (O)	3.32

Table 9: Risks Impact Mean Score

No.	Cash Flow Risk Factors	Impact Mean Score
1	Delay in Agreeing interim valuations on site/Temporary Evaluations (O)	0.63
2	Delay of making/preparing payments(O)	0.70
3	Estimating error in Constr. Execution planning(O)	0.68
4	Consultant’s instructions/change orders(I & O)	0.73
5	Retention(I)	0.50
6	Delays in payment issuance from client(I)	0.77
7	Delay in settling claims (O)	0.69
8	Labour Strikes(O)	0.52
9	Harsh Weather Condition(O)	0.61
10	Problems with the Foundations(O)	0.71
11	Delay in agreeing Variation/ Day Work(O)	0.63
12	Changes in Currency Exchange rates(I & O)	0.66
13	Inflation in Resources used (O)	0.74
14	Delay in Receiving Certified Interim Payment Documents from consultants (I)	0.72
15	Extent of Activity float in contract schedule (I)	0.55
16	Tender Unbalancing (Front and Back Loading) (I)	0.70
17	Provision for Fluctuating payments due to any sudden additional payments (I)	0.56
18	Changes in Interest Rates (I or O)	0.49
19	Receiving Advance Payment (I)	0.65
20	Materials and Equipment shortage (O)	0.78
21	Change in Interim payment duration other than monthly issuance (I)	0.70
22	Accident and Theft (O)	0.57
23	Advance Loan repayment (I)	0.56
24	Worker attitude and lack of Skilled Labour (O)	0.69
25	Buying equipment (O)	0.71
26	Price Fluctuation (Price Irregularity) (I/O)	0.76
27	Rework due to error in execution (O)	0.62
28	Equipment Breakdown (O)	0.64
29	Bankruptcy of Subcontractor (O)	0.54
30	Unstable Company Financial Position(I or O)	0.72
31	Over/Under Measurement(I / O)	0.68
32	Poor design & Inaccurate bid items (O)	0.78

Table 10: Risks Integrated Mean Score

No.	Cash Flow Risk Factors	Integrated Mean Score
1	Delay in Agreeing interim valuations on site/Temporary Evaluations (O)	1.98
2	Delay of making/preparing payments(I)	2.03
3	Estimating error in Constr. Execution planning(O)	2.14
4	Consultant’s instructions/change orders(I & O)	2.57
5	Retention(I)	2.51
6	Delays in payment issuance from client(I)	2.41
7	Delay in settling claims (O)	2.22
8	Labour Strikes(O)	1.07
9	Harsh Weather Condition(O)	1.22
10	Problems with the Foundations(O)	1.68
11	Delay in agreeing Variation/ Day Work(O)	1.78
12	Changes in Currency Exchange rates(I & O)	1.68
13	Inflation in Resources used (O)	2.38
14	Delay in Receiving Certified Interim Payment Documents from consultants (I)	2.66
15	Extent of Activity float in contract schedule (I)	1.55
16	Tender Unbalancing (Front and Back Loading) (I)	2.05
17	Provision for Fluctuating payments due to any sudden additional payments (I)	1.30
18	Changes in Interest Rates (I or O)	1.02
19	Receiving Advance Payment (I)	2.80
20	Materials and Equipment shortage (O)	2.70
21	Change in Interim payment duration other than monthly issuance (I)	2.17
22	Accident and Theft (O)	1.24
23	Advance Loan repayment (I)	2.38
24	Worker attitude and lack of Skilled Labour (O)	2.20
25	Buying equipment (O)	2.54
26	Price Fluctuation (Price Irregularity) (I/O)	2.43
27	Rework due to error in execution (O)	1.57
28	Equipment Breakdown (O)	1.68
29	Bankruptcy of Subcontractor (O)	1.06
30	Unstable Company Financial Position(I or O)	1.85
31	Over/Under Measurement(I / O)	1.96
32	Poor design & Inaccurate bid items (O)	2.58

4.6 Summary of Risks

As summarized from Table 11 below, the average integrated mean score of risk factors becomes 1.98. Every risk factor more than or equal to the average number are assumed to be the critical which have to be taken into consideration. Accordingly, some of the cash flow risks that fall above the average mean score (1.98) in the integrated scenarios are selected and made ready for further processing i.e. as an input for the Monte Carlo Simulation.

The integrated analysis (Table 11) shows that the influential risk factors are ranked as Receiving advance payment- 1st with INMS of 2.8, Material and equipment shortage – 2nd with INMS of 2.7, Delay in receiving Interim Payment Certificate from consultants- 3rd with INMS of 2.66. It goes on with the last ranked factor of Delay in agreeing interim valuations on site with 1.98 mean score. In order to have a realistic and optimum risk Impact on cash flow forecasting, both cash inflow and outflow risks shall also be incorporated from the ranked integrated mean scores through the suitability assessment on the case study project.

Table 11: Ranked Cash Flow Risks

No.	Cash Flow Risk Factors	IxF	Rank
1	Delay in Agreeing interim valuations on site/Temporary Evaluations (O)	1.98	18th
2	Delay of making/preparing payments(I)	2.03	17th
3	Estimating error in Constr. Execution planning(O)	2.14	15th
4	Consultant’s instructions/change orders(I & O)	2.57	5th
5	Retention(I)	2.51	7th
6	Delays in payment issuance from client(I)	2.41	9th
7	Delay in settling claims (O)	2.22	12th
8	Inflation in Resources used (O)	2.38	10th
9	Delay in Receiving Certified Interim Payment Documents from consultants (I)	2.66	3rd
10	Tender Unbalancing (Front and Back Loading) (I)	2.05	16th
11	Receiving Advance Payment (I)	2.8	1st
12	Materials and Equipment shortage (O)	2.7	2nd
13	Change in Interim payment duration other than monthly issuance (I)	2.17	14th
14	Advance Loan repayment (I)	2.38	11th
15	Worker attitude and lack of Skilled Labour (O)	2.2	13th
16	Buying equipment and Machineries (O)	2.54	6th
17	Price Fluctuation (Price Irregularity) (I/O)	2.43	8th
18	Poor design & Inaccurate bid items (O)	2.58	4th

Chapter Five: Case Study Simulation

5.1 Introduction

This chapter is composed of main issues regarding the case study project information, formulation of mathematical expressions and risk analysis inputs with simulations to the probabilistic cash in and out flows. It also steps on to the procedures of Monte Carlo method in order to simplify the application of the case study building project as per the discussion in chapter 3. The chapter at last, presents, discusses and eventually summarizes the simulation results.

5.2 Project Overview

Addis Ababa City Administration has begun building typical administration buildings for its Ten sub cities based on National Bidding of Contractors. Kirkos Sub City, as one of the Sub cities, has been constructing its own administration Typical Office building, which is taken as a case study project. This building project was designed by MGM Consult, a category one Consultant, which also supervises and administers the construction project. Asmelash and Sons General Contractor have also been hired to construct the whole project. The project is mainly 2B+G+11 Office Building which is located around Meskel Square on the road from Estifanos to Bambis, Addis Ababa Ethiopia. The building is intended to be used for the office facilities given by Kirkos sub city in different sectors within its sub city territory.

The building is composed of Two main building parts (Block A and B), and another smaller building (Block C) including Three Guard Houses and Generator and Transformer House including Fencing and Road Works. The building is intended to be completed within 730 calendar days with a total initial Contract Price of around ETB 258 million after 6% rebate. The construction project was scheduled to be completed on September 26, 2017 with an official starting date of September 28, 2015. Unfortunately, the project has not been finished yet, elapsing more than 7 months to this day with a physical work of 92% and financial performance of about 87% (240million) as of April 30, 2018.

5.3 Project Program

Basic procedures were followed before the analysis of project cash flows in which is preparing the schedule of the case study project is done first. Consequently, the case study project static schedule (without schedule risks) is completed using MS Project 2007 with the following procedural steps.

First general work items are recognized and transferred from the Bills of Quantities to internalize the construction work methodology of the case study project. Construction methods are techniques of executing project activities, which help to organize project's Work Break Down structure. Second, Construction Crew is defined. It is a combination of human power and equipment to complete a given activity within a specific period. It also determines the duration in which an activity is completed based on item productivity of Resources (Human and Equipment). Third, loading all the information into MS Project 2007 and specifying the activity relationship (FS: Finish to Start, SF, FF, and SS) is the next step. Lastly, the schedule is loaded with costs of each work item to finalize the construction program and to have a deterministic cash flow of the construction project.

5.4 Project Cash Flows

In order to come up with the projects' cash flow, there must be a method that helps the cash in and out flows of a project to be forecasted for the future, besides the use of cash in and outflow integrated formula. Such methods implemented here are cost loaded scheduling system with the use of Software tracings, mathematical formula or graphs. Since cash inflow bases on the cash outflow within a controlled project, this research begins by processing the cash outflows of case study project results adopting from the cost-loaded schedule. Additionally, software based cash flow data tracing is used for both Deterministic and Simulated results based on @Risk MC Simulation Software integrating with the construction program prepared.

Accordingly, some useful information of the case study project, which helps for the analysis of cash flows, has been retrieved from the site office engineer testimonial and the Contract Document. The following inputs for the analysis are summarized as listed under:

- Markup (Overhead+ Profit): 25%, (17% Overhead and 8% profit)
- Advance Payment: 30% of Contract Price
- Retention: 5% of Each Executed Value
- Initial Contract Price: 258,244,485.26 after 6% Rebate**.**

5.4.1 Cash In and Outflow Integrated Formula

In order to calculate the payments that are going into the pockets of the contractor, it is mandatory that an integrating formula has to be formulated. The integrated formula is based on the fact that the cost incurred during construction (cash outflow) is determined from the simulation of the project. However, the Revenue (cash inflow) of the contractor is a function of the expenditure cost of the construction project. Therefore, the unknown revenue of the project is mathematically formulated in the procedures described below.

Accordingly, things to consider when preparing interim payments are: Construction Cost of Expenditure (C), Revenue (R), Retention (Rn), Project Markup (Overhead + Profit) (M) and Advance payment (AD) and repayment (AR). The payment release at the beginning of the project includes advance repayment percentage (equal or unequal installment). So the formula at this time is computed as:

R' = C*(1+M), since revenue is a function of cost incurred………[*Equation 5.1]*

Where, R' is Revenue before any deductions

C is the cost incurred

M is the mark up

But retention and advance repayment (if issued) have to be deducted from the revenue. With those two parameters, we get:

R = C*(1+M) – Rn*R' – AR* R'………[*Equation 5.2]*

Substituting *Equation 5.1* into *Equation 5.2*,

R = C*(1+M) – Rn*C*(1+M) – AR* C*(1+M)

Rearranging the parameters considering a cumulative sum,

R = (1-Rn-AP)* C*(1+M),

R = ∑(1-Rn-AP)* (C+CM) –Previous Pays ……….[*Equation 5.3]*

Accordingly, for the period after the advance payment is fully refunded, the formula stipulated in equation 5.3 above becomes:

R =∑ (1-Rn)* (C+CM) – AP – Previous Pays ………………….. [*Equation 5.4]*

5.4.2 Analysis Inputs

The deterministic cash flow consists of a cash outflow and inflow data, which under any controlled condition, the cash flow of a project becomes. Such cash flow is thought to be determined from the static or non-changing schedule and total project cost where the effect of uncertain risks is ignored. Accordingly, the cash out and inflows of this case study project will be presented as per the data traced from @Risk Excel Add in and formula formulated in section 5.1.

Whereas, the probabilistic cash flow is found when the risks of the cash flow are applied with help of Monte Carlo Simulation by simulating different scenarios at 1000 iterations. Since the cash flow is calculated based on the project work schedule and the expense/cost of a project, the percentage deviation from the contract value and completion time is required.

To fulfill these project deviation data on cost and schedule, two Cash out flow risks and Five Cash inflow systemic Risks were selected from the ranked and summarized cash flow risks. Accordingly, Change Orders and Poor Design and Inaccurate bid Items, were assumed to have a confirmed effect on the cash outflow of a contractor. The main reason behind these cash flows is that most of the time a variation is most likely to occur which changes the item scope of the project. Poor design that usually results in the inaccuracy of BOQ items could lead to more changes and hence cost fluctuation.

Additionally, Systemic cash inflow risks are also selected for further processing. They are Delay in preparing Interim Payments designated as Payment Preparation Interval, Delay in certifying payments by the consultant, payment collection period by the contractor, Retention and Advance Repayment. The first three cash inflow risks directly affect the timing of payments in which the delay in collecting certain cash after executing portions of works. The remaining two (Retention and Advance Repayment) are usually part of the calculations in payment analysis which affect the amount of cash going into the pocket of the contractor. Furthermore, Project Specific risks are also part of the analysis based on the itemized deviation of the selected works of the case study project both for cost and time effects.

5.4.3 Systemic Cash Flow Risks Simulation

In order to have a simulated result for the case study project, the influencing risks are simulated based on the cash out and in flow divisions separately.

A. Cash Out flow Risks

The cash outflow selected risks are synthesized based on the risk impact they have on the outgoing cash or expenses of the project. A Triangular Distribution function is used based on the assumed Minimum, most likely and maximum values the risks have.

The anticipation for Change Orders is usually alive in every construction project. The need of changing or varying some part of the works could change the cost of expenditure in both negative and positive ways. It is observed that this project issued a total cost reduction thus it is assumed of having -5%, 5% and 10% for minimum, most likely and maximum respectively. Moreover, Poor Design, which is related to inaccurate bid items, could lead to increment or decrement of contract price. Thus, by assuming the impact it has for this specific project, a minimum, most likely and maximum deviation value of -10%, -5% and 5% respectively has been fixed.

B. Cash Inflow Risks

The selected cash inflows risks impact on the cash by itself is not significant rather on the timing of cash collection except for Retention and Advance payment & Repayment. The three selected cash inflow risks have their own impact on the income collection of the project and the delays are simulated from the data gathered from the case study project. Here for such simulation, payment request letter, payment approval letter form Addis Ababa Construction Bureau and Payment collection dates/ period information was collected. The data was fitted to find what type of distribution function in every risk falls through @Risk Distribution fit tool. Payment collection data however could not be gathered from the contractor.

The case study project has a different set for the approval of payments from the usual construction cases. Instead of the constructor submitting a payment to the consultant and the consultant commenting, certifying and then the client approving for the payment collection, the consultant and the contractor mutually agreed to both engage in preparing the payments and submit for approval to the client. This definitely shortens the time elapsed due to the redundancy of reviewing and commenting the payments by the consultant back and forth. Hence, the payment is collected after payment approval by the client immediately after as the construction engineer confirmed not later than 7 days.

After a payment is issued, it will be certified by the consultant within some specific days. The delay in payment certification would result in the delay in the settlement of the payment. The payment issuance duration is usually prepared on monthly basis. This date may increase and become more than a monthly installment. It is the payment interval period in which the contractor prepares and requests for payment (the payment maturation period other than monthly basis).

Table 12 shown below summarizes a result of the simulation for payment maturity and approval periods for 12 certified and paid payments. As per the data collected from the trends of this case study project, a Triangular Probability Distribution and Uniform Distribution function was fitted for the consultant's certification period and payment preparation period respectively. Additionally, a Time Scale tool was used for both cases in which a final remaining payment could mature and be processed thus risks can be simulated for the 13 certificate closing to the reality. As a result, a mean value of 32.51 days and 64.87 days were simulated for payment approval and payment preparation period. Unfortunately, Retention and Advance Payment and its repayment could not be simulated rather used as specified as 5%, 30%, 37.5% respectively as stipulated in the contract document.

Table 20: Cash Inflow Risks Simulation

SN	Payment No	Contractor Payment Request date (1)	Construction Bureau Approval Date (2)	Payment Processing Period (2-1)	Payment Preparation Interval Period
1	IPC-1	09-Dec-15	01-Jan-16	23	
2	IPC-2	23-Feb-16	09-Mar-16	15	76
3	IPC-3	04-Apr-16	27-Apr-16	23	41
4	IPC-4	01-May-16	25-May-16	24	27
5	IPC-5	02-Aug-16	02-Sep-16	31	93
6	IPC-6	25-Oct-16	24-Nov-16	30	84
7	IPC-7	27-Jan-17	03-Mar-17	35	94
8	IPC-8	24-Apr-17	24-May-17	30	87
9	IPC-9	03-Jul-17	25-Jul-17	22	70
10	IPC-10	09-Oct-17	22-Nov-17	44	98
11	IPC-11	28-Dec-17	01-Mar-18	63	80
12	IPC-12	06-Mar-18	09-Apr-18	34	68
13				25.69	72.55
Simulated Mean Periods				**32.51**	**64.87**

The graph in Figure 9 clearly shows that total delay from the payment preparation interval becomes a minimum of 27.06 and a maximum of 102.68 days and the certification of contractor's payment request has a range of minimum and maximum values from 15.02 and 66.66 as per the fitted distribution functions.

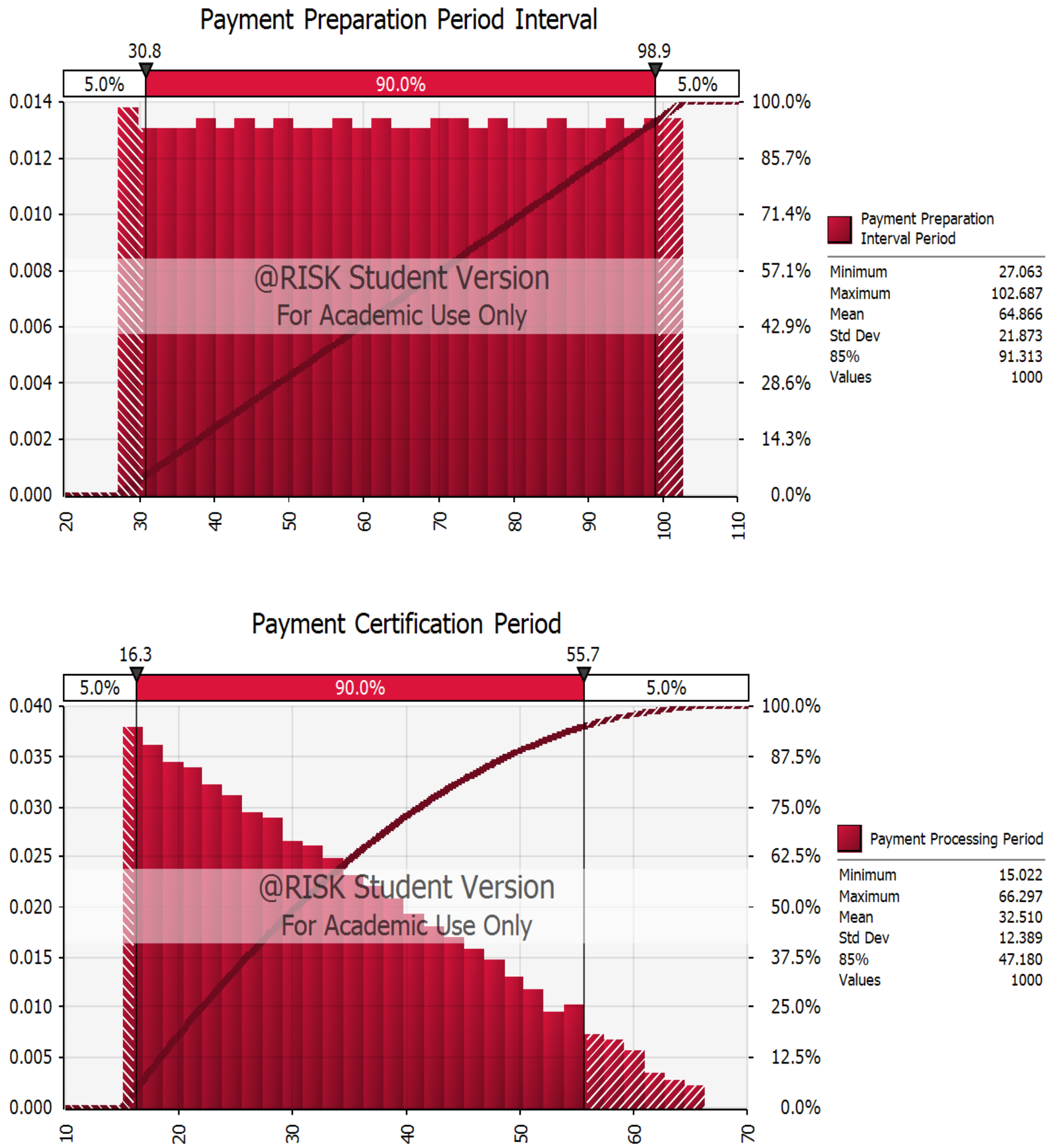

Figure 8: Payment preparation Interval (a) Payment Certification Period (b)

5.4.4 Project Specific Risks Simulation

These risks are separately analyzed since they are somehow difficult to deal with them due to insufficient information at the time of planning. In order to reduce the difficulty and ease the application of these risks into the case study building, data on the execution quantities were taken from the documents of interim payments and then the variation in quantities revealed the variation in cost due to increment a or decrement of itemized quantities.

To account these project based risks, some of the work items were analyzed. Substructure works of Excavation & Earth work, Concreting, Formwork and Rebar’s for the three blocks (Block A, B & C) and Total works of Fence, were selected and the differences in cost percentage from the original quantities were calculated in excel. With the help of @Risk Add in, distribution fits were executed for three distributions namely: Normal, Uniform and Triangular. In consequence, results of distribution functions were retrieved based on Alkaline Information Criterion (AIC) prioritizing method for the distribution functions. Table 13 below shows the summary result of distributions fits for the selected work items with mean percentage values and distribution functions and all output and input data is compiled in the appendix.

Table 13: Project Based Risks Distribution Fit Simulation

Item No	Description	Cost Variation Distribution Output
1	**BLOCK TYPE A**	
	A. SUB-STRUCTURE	
	Excavation & Earth Works	-47.94%
	Concrete Works	
	Concreting	-1.59%
	Formwork	-14.00%
	Rebars	-0.42%
	Masonry Works	-36.35%
	B. SUPER-STRUCTURE	
	Concrete Work	
	Concreting	-8.15%
	Formwork	-45.46%
	Rebars	-27.35%
2	**BLOCK TYPE B**	
	A. SUB-STRUCTURE	
	Excavation & Earth Works	-42.25%
	Concrete Works	
	Concreting	-20.75%
	Formwork	-49.68%
	Rebars	-4.22%
	Masonry Works	-39.53%
	B. SUPER-STRUCTURE	
	Concrete Work	
	Concreting	-50.35%
	Formwork	-14.41%
	Rebars	-19.79%
	Other Works	-8.49%
3	**BLOCK TYPE C**	
	A. SUB-STRUCTURE	
	Excavation & Earth Works	-56.78%
	Concrete Works	
	Concreting	-0.03%
	Formwork	-17.14%
	Rebars	-21.04%
	Masonry Works	-28.79%
	B. SUPER-STRUCTURE	
	Concrete Work	-4.60%
4	**FENCE**	
	All Works	-80.08%

Additionally, project specific risks regarding Completion time were also assumed so that project's delay can be simulated close to the reality. The case study project has officially been started since September 28, 2015 and almost 92 % physical work has been executed with a time elapse of about 121% as of April 2018. Its completion time is extended to up to the August 12, 2018. The research then selected some of the items, which is thought to delay the overall project completion date.

After some trials, a common assumed minimum of -1% and a maximum of about 100% of deviation with Triangular Distribution function is used to incorporate the delay and make a close simulation to the reality. Accordingly, all of the Substructure works, Super structure concrete works, block works, plastering, finishing and painting from Blocks A, B and C were simulated. Since Fencing, Guardhouse, road and generator house works are smaller to that of the other bigger blocks, the whole work items are put into simulation.

5.4.4 Actual, Deterministic and Probabilistic Cash Flows

I. Cash Outflows

Based on data simulation inputs discussed and as attached in the appendix, the cash outflow of the case study project is determined. Additionally for the purposes of comparisons, the actual and deterministic cash out flows are also retrieved. The actual cash flow as a basis determines how much the simulation matches for the real scenario and the deterministic one tells how much deviations are there when cash flow risks are ignored.

Accordingly, the actual cash out flow is calculated based on the data gathered from the contactor. Unfortunately, there was no data collected for the monthly cash flow in progress reports since the issuance of the detail cash flow reports for the processing of interim payments, was not mandatory. In consequence, the researcher has used the data on Project schedule updated on April 2016 in which the forecasted completion period was October 2017 by combining the current work performed and using Engineer's estimation on the final executed value to be around 260 million less 6% rebate i.e. ETB 244,814,000. Having confirmed the actual date of the project to be on August 12 2018, some editions on the cumulative cash outflow percentages were made to resemble the realistic cash outflows of the project, accounting the project completion delay and current project status, which then can be evaluated with the deterministic and probabilistic ones.

The deterministic cash flow is traced from @Risk simulation time scaled data as the probabilistic is retrieved. Unlike the deterministic cash outflows, the probabilistic cash out flow is simulated with 1000 iterations and is traced from the simulation analysis as per the input simulation data as attached in the appendix. This probabilistic cash flow result is a combination of Eight Systemic risks and Project specific risks as discussed earlier including the time delays on the critical and compressed schedule work items.

The cash out flow of this case study project incorporates direct cost of the project and the overhead. From the 25% Markup of the project about 8% is assumed as profit for the project and the remaining 17% as general and site overhead cost. All cash out flows are then processed by deducting the profit from the bid price so that the cash outflows can be traced from the simulations.

Based on the simulation procedures described above, @Risk Excel Add in simulated cash outflow graph is presented along with the Actual, Deterministic and simulated cash outflow results as tabulated in Table 14.

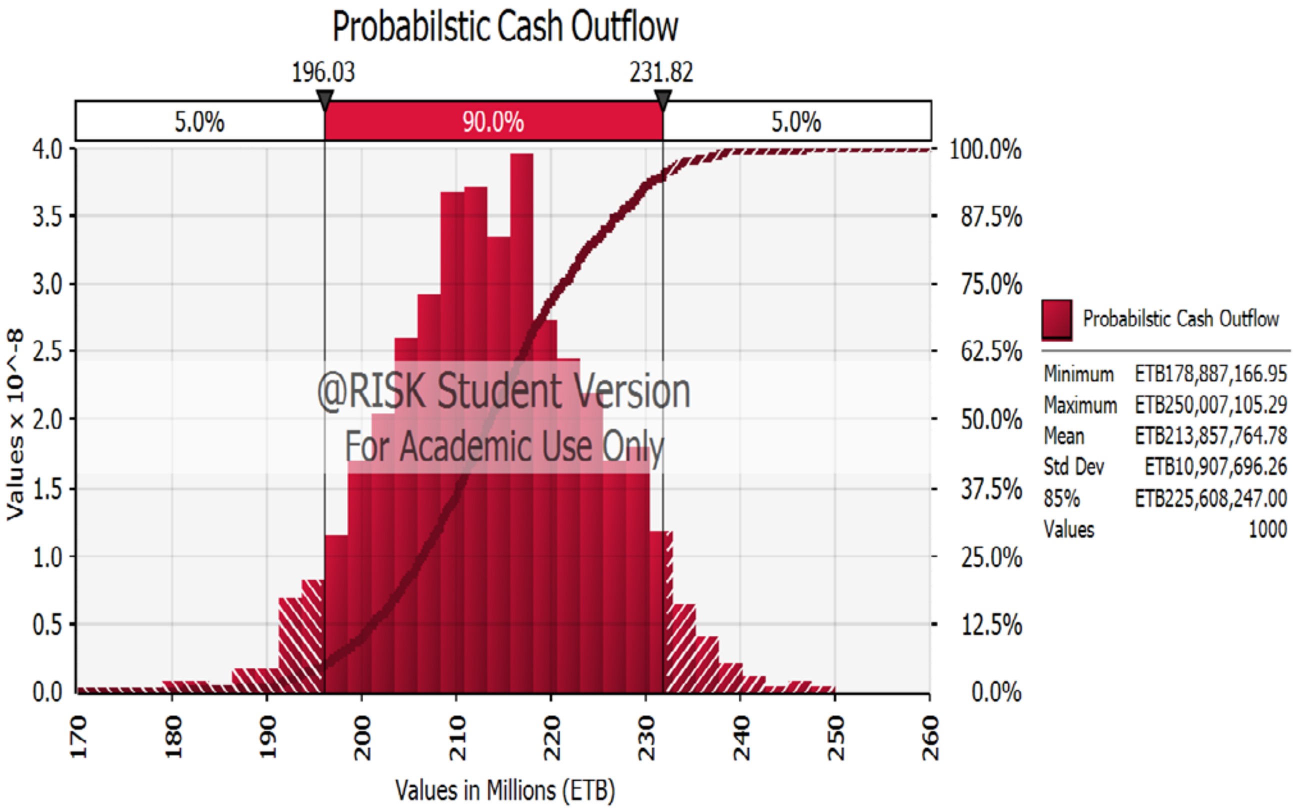

Figure 9: Simulated Cash Outflow

Table 14: Actual, Deterministic and Probabilistic Cash Outflow Data

Months	P 85	Deterministic	Actual **
Sep-15	-	-	-
Oct-15	13,932,886.10	5,961,210.78	1,520,199.20
Nov-15	18,276,647.27	15,793,539.82	5,576,887.80
Dec-15	26,615,841.95	26,598,655.95	9,983,757.33
Jan-16	33,994,680.20	36,355,401.91	22,952,445.41
Feb-16	40,823,606.93	44,417,445.45	27,465,319.01
Mar-16	46,785,943.86	55,509,604.97	32,701,635.66
Apr-16	54,269,843.24	69,467,033.94	37,485,955.51
May-16	61,881,514.60	79,491,622.61	42,057,161.23
Jun-16	67,262,551.30	90,043,891.02	47,342,021.03
Jul-16	72,694,109.32	101,051,074.97	52,952,749.50
Aug-16	79,926,607.14	105,078,735.17	60,379,898.43
Sep-16	86,602,609.00	111,235,311.33	72,726,112.43
Oct-16	92,059,431.80	116,445,994.70	81,433,316.14
Nov-16	97,908,771.59	122,913,581.77	87,624,115.47
Dec-16	102,753,443.73	131,586,797.18	94,911,732.21
Jan-17	107,558,419.55	140,011,774.49	109,365,715.09
Feb-17	111,679,533.72	149,348,039.84	116,446,391.38
Mar-17	117,182,856.28	170,089,308.98	121,275,184.15
Apr-17	123,578,234.18	187,298,841.68	129,592,559.11
May-17	132,238,034.49	201,090,558.42	139,269,039.87
Jun-17	145,018,848.00	211,951,675.65	151,615,253.88
Jul-17	160,663,816.28	218,862,716.17	160,322,457.59
Aug-17	175,093,484.35	225,709,577.88	166,513,256.91
Sep-17	186,696,576.13	236,358,410.31	173,800,873.65
Oct-17	195,875,685.32	-	186,006,376.53
Nov-17	201,809,421.57	-	191,558,086.42
Dec-17	206,111,977.04	-	194,857,912.80
Jan-18	210,903,089.36	-	201,646,321.35
Feb-18	215,917,449.30	-	209,793,835.72
Mar-18	220,913,888.84	-	216,415,054.02
Apr-18	222,846,158.12	-	219,882,526.28
May-18	224,560,453.02	-	221,993,970.29
Jun-18	225,418,899.28	-	223,734,021.95
Jul-18	225,544,537.86	-	224,815,048.31
Aug-18	225,608,247.00	-	224,841,537.55

** Actual cash outflow is edited as per the work plan of April 2016 Schedule.

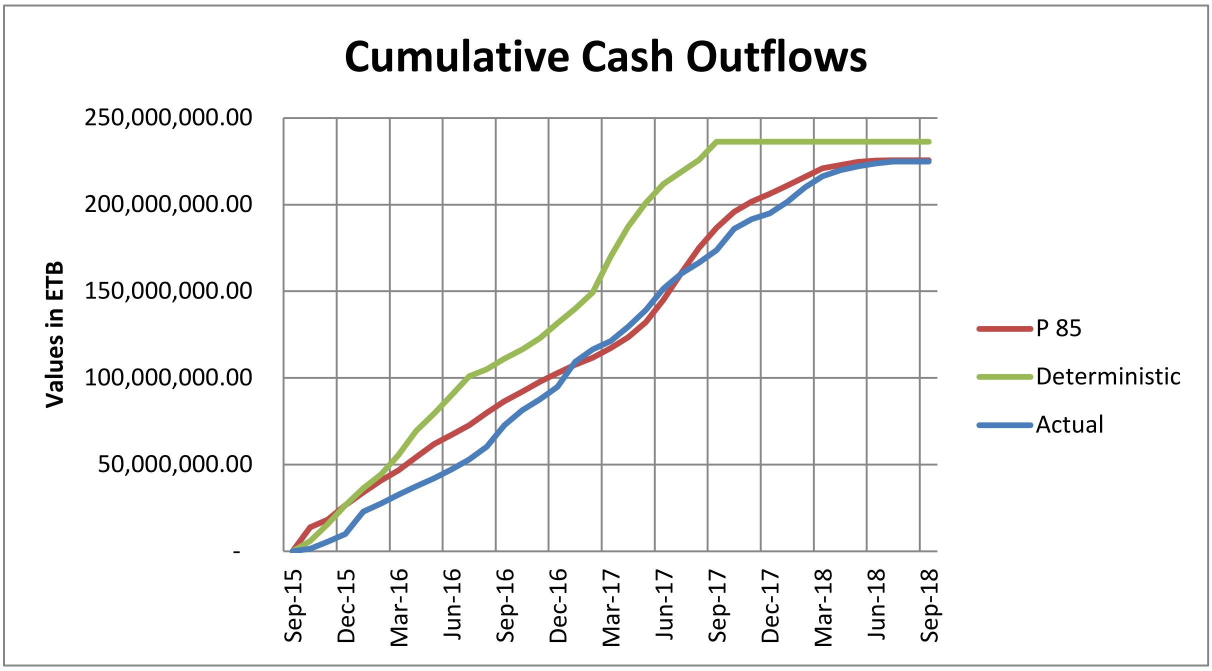

Figure 10: Actual, Deterministic and Probabilistic Cumulative Cash Outflow

II. Cash Inflows

The cash inflow or the income of the contractor is determined on the basis of the direct cost and Overhead cost of the project i.e. the cash outflow results. Here the cash inflow affecting risks have their own impact especially on the timing of the cash collection scheme. These are Delay in Interim Payment Certification by the Consultants, Delay in settling payment by the client/Cash collection period and Change in Interim Payment Duration other than Monthly Payment/ Payment preparation Interval.

These three risks are simulated on a different basis since their impact is on the cash in/ income timing for the contractor to gather with a probabilistic cash inflow result. First the cash inflow is calculated by the integrated formula through the incorporation of the simulation data. For the account of this project and the real cases confirmed, the simulated interim payment certification period at P85 confidence of 47.18 days were found. Upon on rounding up to two months to a confidence level of 99%, this period is found to be somehow extended out of the realistic case and rounding down to a month (30 days) is thought to be logical which lowers the confidence level to almost 50%. The payment preparation interval simulated result at P85 with 91.13 days rounding to 3 months is taken. Finally, payment collection would also take at most 7 days as the Construction Engineer confirmed it. Retention, Advance Payment and repayment values are used as stipulated in the contract.

Deterministic cash flows are also calculated by considering a payment request not less than 5% of project execution as depicted in the contract. In this case, a 10 % minimum execution is considered to request an interim payment and a certification and cash collection period of one month is taken into a calculation in Excel Sheet, for deterministic cash flows. The Actual cash inflow of the project is collected from the actual cash collection days that is clearly shown in the recent payment certificate (12^{th}) approved by the construction bureau with a maximum cash collection period of 7 days after approval. After all the considerations and manually calculated in excel sheet, the following results are finally tabulated and graphed.

Table 15: Actual, Deterministic and Probabilistic Cumulative Cash Inflow

Months	Actual**	P85	Deterministic
Sep-15	34,000,000.00	77,534,464.85	77,534,464.85
Oct-15	77,534,464.85	77,534,464.85	77,534,464.85
Nov-15	77,534,464.85	77,534,464.85	77,534,464.85
Dec-15	77,534,464.85	77,534,464.85	77,534,464.85
Jan-16	91,250,579.52	77,534,464.85	77,534,464.85
Feb-16	91,250,579.52	94,062,902.70	100,339,216.96
Mar-16	101,361,974.87	94,062,902.70	100,339,216.96
Apr-16	101,361,974.87	94,062,902.70	100,339,216.96
May-16	110,488,095.90	106,588,535.99	121,109,240.69
Jun-16	120,348,602.05	106,588,535.99	121,109,240.69
Jul-16	120,348,602.05	106,588,535.99	121,109,240.69
Aug-16	120,348,602.05	119,304,509.20	140,921,048.24
Sep-16	125,083,812.89	119,304,509.20	140,921,048.24
Oct-16	125,083,812.89	119,304,509.20	140,921,048.24
Nov-16	125,083,812.89	131,314,685.04	140,921,048.24
Dec-16	133,614,835.93	131,314,685.04	140,921,048.24
Jan-17	133,614,835.93	131,314,685.04	160,075,273.99
Feb-17	133,614,835.93	141,344,353.41	160,075,273.99
Mar-17	144,267,362.27	141,344,353.41	160,075,273.99
Apr-17	144,267,362.27	141,344,353.41	184,226,849.58
May-17	144,267,362.27	150,305,018.60	184,226,849.58
Jun-17	156,512,782.52	150,305,018.60	208,402,942.36
Jul-17	156,512,782.52	150,305,018.60	208,402,942.36
Aug-17	164,146,014.21	167,591,169.46	208,402,942.36
Sep-17	164,146,014.21	167,591,169.46	208,402,942.36
Oct-17	164,146,014.21	167,591,169.46	251,399,400.06
Nov-17	164,146,014.21	191,550,687.11	-
Dec-17	172,230,094.20	191,550,687.11	-
Jan-18	172,230,094.20	191,550,687.11	-
Feb-18	179,715,136.61	211,470,888.45	-
Mar-18	194,130,110.50	211,470,888.45	-
Apr-18	205,551,722.97	211,470,888.45	-
May-18		226,657,649.95	-
Jun-18		226,657,649.95	-
Jul-18		226,657,649.95	-
Aug-18		226,657,649.95	-
Sep-18		237,565,484.09	-

** Actual Final Payment only up to 12th payment certificate is used.

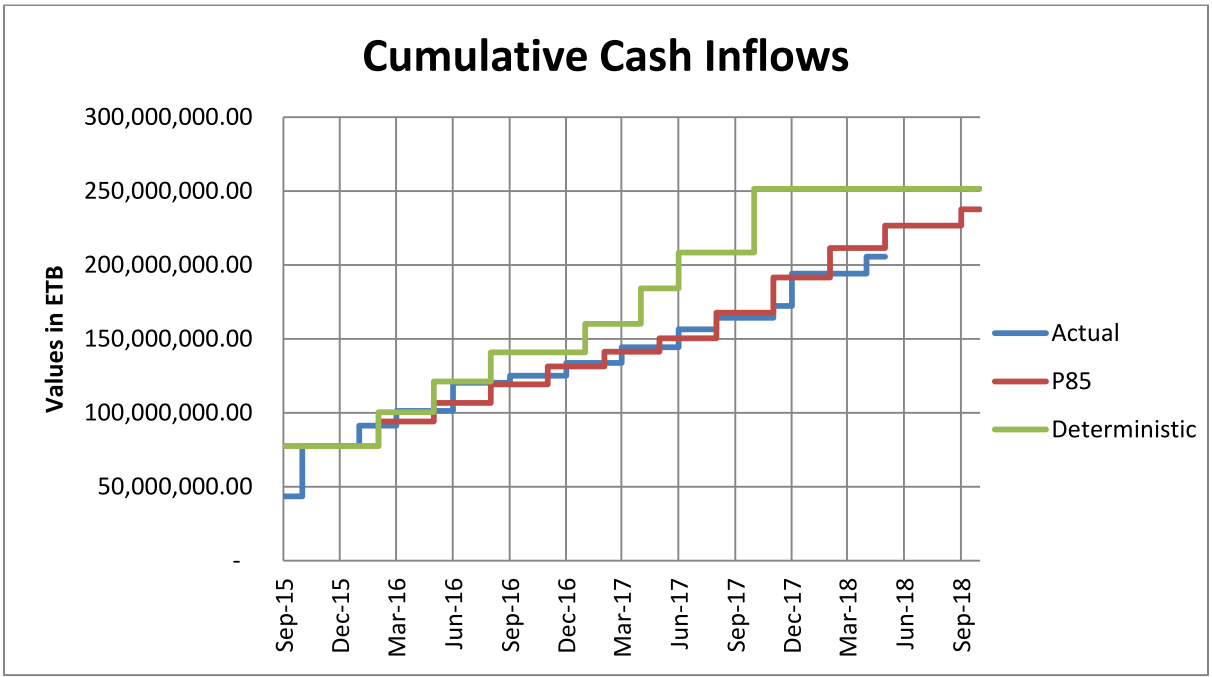

Figure 11: Deterministic and Probabilistic Cumulative Cash Inflows

III. Net Cash Flows

Net cash flows are calculated by deducting Total Cost (direct + overhead cost) from the interim payment taking into account the timing of payments and associated risk costs. The results are presented in Table 16 and graphed in Figure 12 here under.

Table 16: Actual, Deterministic and Probabilistic Net Cash flow

Months	Actual**	P85	Deterministic
Sep-15	34,000,000.00	77,534,464.85	77,534,464.85
Oct-15	76,014,265.65	63,601,578.75	71,573,254.07
Nov-15	71,957,577.05	59,257,817.58	61,740,925.03
Dec-15	67,550,707.52	50,918,622.90	50,935,808.90
Jan-16	68,298,134.11	43,539,784.65	41,179,062.94
Feb-16	63,785,260.51	53,239,295.77	55,921,771.51
Mar-16	68,660,339.21	47,276,958.84	44,829,611.99
Apr-16	63,876,019.36	39,793,059.46	30,872,183.02
May-16	68,430,934.67	44,707,021.39	41,617,618.07
Jun-16	73,006,581.02	39,325,984.69	31,065,349.67
Jul-16	67,395,852.55	33,894,426.67	20,058,165.72
Aug-16	59,968,703.62	39,377,902.07	35,842,313.07
Sep-16	52,357,700.46	32,701,900.21	29,685,736.91
Oct-16	43,650,496.75	27,245,077.41	24,475,053.54
Nov-16	37,459,697.42	33,405,913.44	18,007,466.47
Dec-16	38,703,103.72	28,561,241.31	9,334,251.06
Jan-17	24,249,120.84	23,756,265.48	20,063,499.50
Feb-17	17,168,444.55	29,664,819.69	10,727,234.15
Mar-17	22,992,178.12	24,161,497.13	(10,014,034.99)
Apr-17	14,674,803.16	17,766,119.23	(3,071,992.11)
May-17	4,998,322.40	18,066,984.11	(16,863,708.84)
Jun-17	4,897,528.64	5,286,170.60	(3,548,733.28)
Jul-17	(3,809,675.07)	(10,358,797.69)	(10,459,773.81)
Aug-17	(2,367,242.70)	(7,502,314.89)	(17,306,635.52)
Sep-17	(9,654,859.44)	(19,105,406.67)	(27,955,467.95)
Oct-17	(21,860,362.32)	(28,284,515.86)	15,040,989.75
Nov-17	(27,412,072.21)	(10,258,734.47)	
Dec-17	(22,627,818.60)	(14,561,289.93)	
Jan-18	(29,416,227.15)	(19,352,402.25)	
Feb-18	(30,078,699.11)	(4,446,560.85)	
Mar-18	(22,284,943.52)	(9,443,000.39)	
Apr-18	(14,330,803.31)	(11,375,269.68)	
May-18	(16,442,247.32)	2,097,196.93	
Jun-18		1,238,750.67	
Jul-18		1,113,112.09	
Aug-18		1,049,402.95	
Sep-18		11,957,237.09	

** Actual Final Payment only up to 12th payment certificate is used.

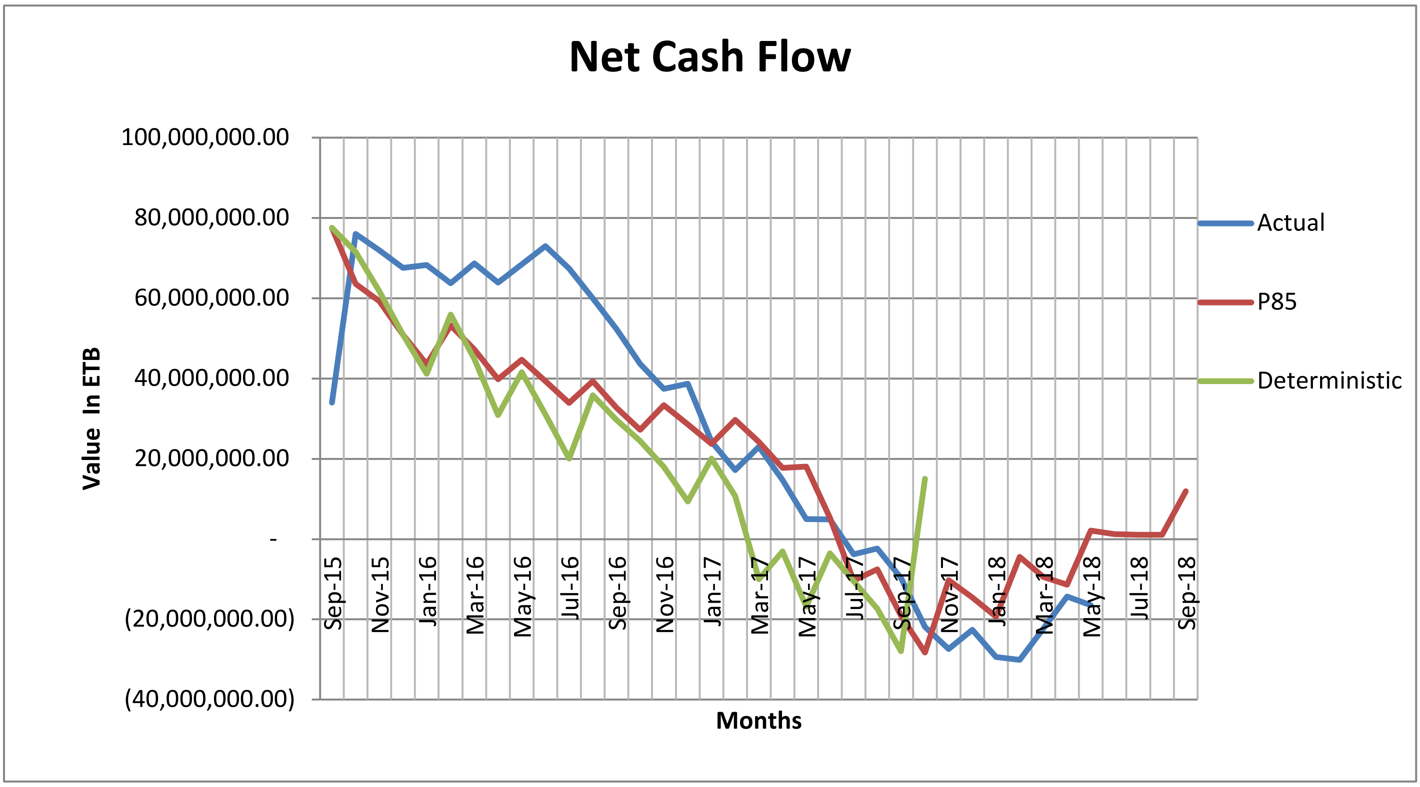

Figure 12: Deterministic and Probabilistic Net Cash flow

5.5 Analysis Summary

The simulated risks in cost and completion time results in the associated cash flows for the case study project. Thus, the newly simulated costs and schedule have made a significant change in the cash flow results.

The analysis shows that the total cash outflow (the incurred cost) of deterministic values are higher with a cost of around ETB 11 and 10 million than the probabilistic and actual cash outflows. The probabilistic result starts with much higher expenditure in the beginning of the project. After 15 months however, the expenditures intersect with the actual values and gets below the actual and then becomes exceeds to have similar total cash expenditure ending. Unfortunately, the deterministic cash outflow detached from the beginning to the end and gets much higher since no consideration of risks was made. The expenditure in a deterministic one ends with the planned 236.38 Million and the probabilistic expenditure at P85 is ETB 225.61 Million, in this case, has an amount closer to the reality (Actual expenditure ETB 224.84 million), which in turn helps the contractor to determine cost of expenditure to be budgeted for a specific period of project execution.

The cash inflows on the other hand have distinctive differences between the deterministic cash inflow result, which ends with a total revenue of ETB 251.4 Million, is higher with ETB 13 Million from the actual case. Furthermore, the deterministic payment certificates and their timing are not realistic since the time execution is compressed to finish within the original completion date, which in turn diverges from the reality that compromises extension of completion time. The probabilistic however somehow converges to the actual value ending with ETB 237.56 Million at P85 confidence level. Unfortunately, the actual revenue is still at the 12^{th} certificate (ETB 205.55 Million) and no other assumption on remaining payments was made.

The difference between the payment collections made a critical deepening into the negative cash flow that requires a considerable amount of cash to fill up the working capital need of the project. The deterministic net cash flow tends to become positive for almost 18 months. The probabilistic and actual net cash flows however have positive cash for 20 months, which makes the probabilistic estimate more reliable than the deterministic.

The analysis shows that the deterministic net cash flow goes negative for almost 7 months with a maximum cash deficit of ETB 27.95 Million. The probabilistic net cash flow becomes negative for 10 months with cash deficit of ETB 28.24 Million at most and the actual negative net cash flow prolongs for 11 months with maximum of ETB 29.42 Million. Hence, the resemblance between the actual and the probabilistic cash deficits makes the Probabilistic forecast a more reliable forecast than the deterministic one by tracing the cash deficits close to the reality so that contractors could prepare themselves by making ready different financing alternatives.

Chapter Six: Conclusions and Recommendations

6.1 Conclusions

Anticipating every known risk to the far end will make the forecasting, and planning integration work smoothly and to reduce the uncertainties and to manage them as much as possible. Construction cash flow forecasting also relies based on this concept. This research has met the main objectives of the thesis backing with analysis results on cash flow forecasts of a case study building construction project as follows:

1. The research has found 18 Systemic cash flow risks that have the most influential effect in determining the cash flow of building construction. These, in their order of precedence, are Receiving Advance Payment, Materials and Equipment shortage, Delay in Receiving Certified Interim Payment Documents from consultants, Poor design & Inaccurate bid items, Consultant's instructions/change orders, Buying equipment and machineries, Retention, Price Fluctuation, Delays in payment issuance from client, and Inflation in Resources used. Tender Unbalancing, Delay of making/preparing payments and Delay in agreeing interim valuations on site/Temporary Evaluations are the least cash flow forecast influencing risks with ranking of 16^{th}, 17^{th}, and 18^{th} respectively.

2. The cash flow results also have distinctive differences in expenditure, income and working capital needs. Unlike the deterministic value, the expenditure and income of the probabilistic and actual results are both lesser. The cash deficit of the project lasts 3-4 more months than the deterministic one that in turn alerts contractors in a realistic way to be ready for such financial demands at simulated point of times.

3. The thesis revealed that Project Cash flow forecasting, through the incorporation of cash flow specifically project specific risks and project time risks, is useful in resembling to the actual cash flow scenario, which helps the contractor to be ready for any incoming cash deficits ahead of time. It also helps to budget expenditure cost of a project and its revenue due to the contractor.

4. The research finally confirms that Monte Carlo Simulation is a useful, applicable and powerful method for construction cash flow forecasting, which brings the most probable cash flow forecasting for future applications.

6.2 Recommendations

The thesis finally recommends that Monte Carlo Simulation method is highly proposed for the use not only to the cash flow forecasts rather extends to similar application of risk anticipation cases in construction industry if an accurate and plenty of data is available to have reliable results.

6.3 Future Research Recommendation

The research tried to apply the realistic and tangible information to forecast project cash flow using Monte Carlo Simulation method. This however could be a base for other researches but needs some updated and full information to have a more accurate and reliable analysis results.

Even if the cash flow risks have been selected and prioritized, a clear and distinctive impact each systemic risk could have on project's cash flow is not quantitatively and explicitly known on range limits. Such detailed cash flow impacts for these identified and other risks that are directly related to the cash flow of the project shall be determined through intensive research by taking vast amount of data from the industry.

The thesis compared the actual with deterministic and probabilistic cash flow forecasts. However, the actual cost of expenditure could not be gathered, instead edited version was used. This could make the actual to be 'not exactly actual' but with variance in costing which somehow have some effect on the comparisons with the others two.

Finally, Acknowledging all the difficulties and obstructions, researches could be significantly updated and made available for the application of Monte Carlo Method using Simulation Tools. Out of which, Simple Methodologies of applying the simulation into the construction industry would be the most appreciated achievement that resides on the efforts of the future and ongoing researches.

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Appendices:

Questionnaire Survey

Cash flow management is important for the survival of the construction Business. It manages the cash flow of construction projects by analyzing the cash in and out within the transaction circle of the company. It also helps the company to have a steady flow of cash, which prevents the business from becoming bankrupt. As a tool indicator to this phenomenon, cash flow forecasting is one of the main categories in which a construction company projects it's to be cash transaction for a particular project.

Having forecasted the cash in and out flows of the project helps to know about when and what amount of cash is needed to finance a given project, based on the projection accuracy considering the **critical cash flow risk factors**. It therefore is one of the objectives of this research to analyze and select the Major cash flow risks, which significantly affect the cash flow forecast of a construction project, and the result will be put into further Stochastic Mathematical framework to serve as an input to run Monte Carlo simulation afterwards.

This thesis is prepared to be submitted to Addis Ababa Institute of Technology- AAU in partial fulfillment of the requirement for the Degree of Master of Science for the Construction Technology and Management Stream for the year of 2017.

I kindly request your honest professional response which plays a great role on the output of the research. Please be reminded that all information is kept strictly confidential. At last, if you have any query on this survey, don't hesitate to contact me.

Thank you for your time and cooperation!

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MSc Thesis on Cash Flow Forecasting using Monte Carlo Method for Building Construction Projects

Company Name (optional): ___________________________

Construction Business Category: ___________________________________

Respondent Duty Position: ____________________________

Respondent Professional Experience in years: _______________

1. Company's Years in Business (circle one): a) 5-10 b) 10-15 c) 15-20 d)>20
2. Projects at hand (circle one): a) 5-10 b) 10-15 c) 15-20 d) >20
3. Please Mark ( ) in the table which corresponds to the scales from 1 – 5 as described below.

Whereas, **Frequency: 1-***rarely*; **2-***sometimes*; **3-** *fair*; **4-***often*; **5-***always*.
Impact: 1-*least*; **2-***low*; **3-** *medium*; **4-***high*; **5-***extremely high*.
I: effect on cash inflow **and O:** effect on cash outflow

No.	Cash Flow Risk Factors	Frequency of Occurrence					Impact Effect				
		1	2	3	4	5	1	2	3	4	5
1	Delay in Agreeing interim valuations on site/Temporary Evaluations (O)										
2	Delay of making/preparing payments(I)										
3	Estimating error in Constr. Execution planning(O)										
4	Consultant's instructions/change orders(I / O)										
5	Retention(I)										
6	Delays in payment issuance from client(I)										
7	Delay in settling claims (O)										
8	Labour Strikes(O)										
9	Harsh Weather Condition(O)										
10	Problems with the Foundations(O)										
11	Delay in agreeing Variation/ Day Work(O)										
12	Changes in Currency Exchange rates(I & O)										
13	Inflation in Resources used (O)										
14	Delay in Receiving Certified Interim Payment Documents from consultants (I)										

No.	Cash Flow Risk Factors	Frequency of Occurrence					Impact Severity				
		1	2	3	4	5	1	2	3	4	5
15	Extent of Activity float in contract schedule (I)										
16	Tender Unbalancing (Front and Back Loading) (I)										
17	Provision for Fluctuating payments due to any sudden additional payments (I)										
18	Changes in Interest Rates (I/O)										
19	Receiving Advance Payment (I)										
20	Materials and Equipment shortage (O)										
21	Change in Interim payment duration other than monthly issuance (I)										
22	Accident and Theft (O)										
23	Advance Loan repayment (I)										
24	Worker attitude and lack of Skilled Labour (O)										
25	Buying Equipment (O)										
26	Price Fluctuation (Price Irregularity) (I/O)										
27	Rework due to error in execution (O)										
28	Equipment Breakdown (O)										
29	Bankruptcy of Subcontractor (O)										
30	Unstable Company Financial Position(I /O)										
31	Over/Under Measurement(I / O)										
32	Poor design & Inaccurate bid items (O)										

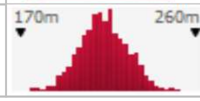
ፕሮጀክት፡-
PROJECT: Kirkos Sub-city Administration Office Building
ቦታው
LOCATION : ADDIS ABABA
አሰሪው መ/ቤት
EMPLOYER : Addis Ababa City Government Kirkos Sub City Administration Chief Executive Office
አማካሪው መ/ቤት:-
CONSULTANT -MGM Consult Plc.
የሥራ ተቋራጭ፡-
CONTRACTOR : ASEMELASH ND SONS CONSTRUCTION PLC

ALL BLOCKS

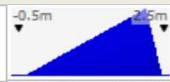
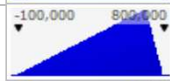
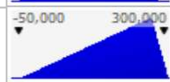
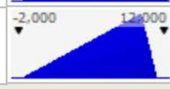
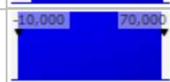
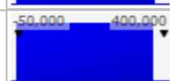
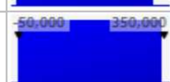
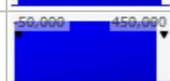
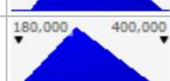
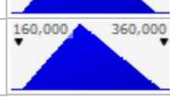
SUMMARY OF BOQs

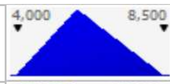
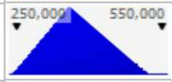
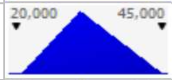
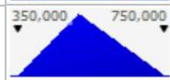
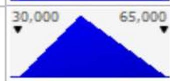
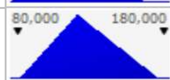
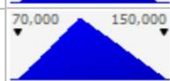
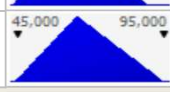
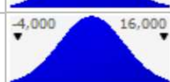
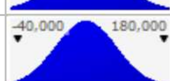
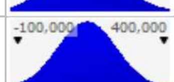
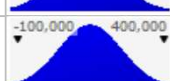
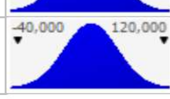
Item No	Description	Contract Amount	Total
1	General Provision	3,302,347.83	
2	BLOCK TYPE A	161,740,895.00	
3	BLOCK TYPE B	67,404,485.00	
4	BLOCK TYPE C	25,278,342.00	
5	GUARD HOUSE	906,678.00	
6	ROAD	8,457,985.00	
7	FENCE	6,685,620.00	
8	Generator and Transformer House	1,168,558.00	
	Total		274,944,910.83
	6% Rebate		16,496,694.65
	Total After Rebate		258,448,216.18
	15% VAT		38,767,232.43
	Total with VAT		297,215,448.61

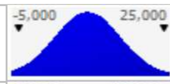
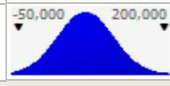
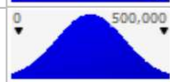
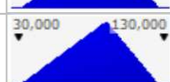
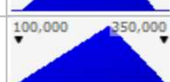
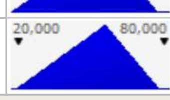
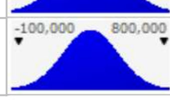
@RISK Output Results

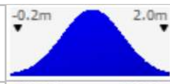
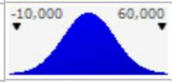
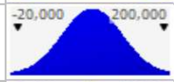
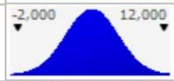
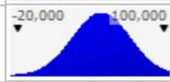
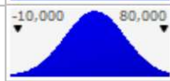
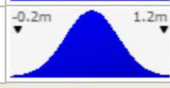
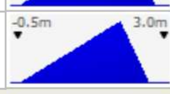
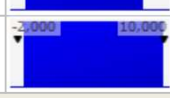
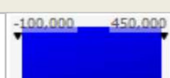
Name	Worksheet	Cell	Graph	Min	Mean	Max	5%	95%	Errors
Project Duration	Tasks	C2		669.5 days	788.4578 days	901.64 days	727.97 days	853.18 days	0
Probabilstic Cash Outflow	Tasks	G2		ETB178,887,200.00	ETB213,857,800.00	ETB250,007,100.00	ETB196,029,800.00	ETB231,822,900.00	0

@RISK Model Inputs

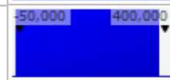
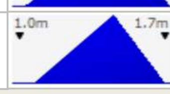
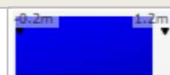
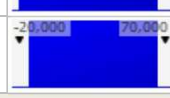
Category: Block A excavation and earth work					
Bulk excavations and Cartaway / Cost		RiskVary(ProjectFieldVal,-110.4,14.44,0,5,"Triang",RiskCategory("A exca"))	-ETB213,547.80	ETB1,396,548.00	2349848
Fill between hard core & mat foundation with borrowed selected granular material / Cost		RiskVary(ProjectFieldVal,-110.4,14.44,0,5,"Triang",RiskCategory("A exca"))	-ETB69,011.91	ETB451,320.20	ETB759,396.40
Fill between hard core & mat foundation with excavaed material / Cost		RiskVary(ProjectFieldVal,-110.4,14.44,0,5,"Triang",RiskCategory("A exca"))	-ETB183,978.10	ETB1,203,170.00	2024467
Cart away surplus excavated materials / Cost		RiskVary(ProjectFieldVal,-110.4,14.44,0,5,"Triang",RiskCategory("A exca"))	-ETB134,025.80	ETB876,494.60	1474800
Hard basaltic hard core / Cost		RiskVary(ProjectFieldVal,-110.4,14.44,0,5,"Triang",RiskCategory("A exca"))	-ETB27,010.88	ETB176,644.20	297223.6
Fill on top of mat beam with 10mm thick gravel pack . / Cost		RiskVary(ProjectFieldVal,-110.4,14.44,0,5,"Triang",RiskCategory("A exca"))	-ETB987.42	ETB6,457.46	10865.39
Category: Block A masonary					
3.1 50cm thick masonry foundation wall below GL / Cost		RiskVary(ProjectFieldVal,-114.06,41.34,0,5,"Uniform",RiskCategory("A mason"))	-ETB18,790.35	ETB85,051.04	188892.4
3.2 50cm thick stone masonry foundation wall above GL / Cost		RiskVary(ProjectFieldVal,-114.06,41.34,0,5,"Uniform",RiskCategory("A mason"))	-ETB6,529.46	ETB29,554.42	65638.3
under basement floor slabs / Cost		RiskVary(ProjectFieldVal,-114.06,41.34,0,5,"Uniform",RiskCategory("A mason"))	-ETB71,156.65	ETB322,077.50	715311.6
to retaining walls / Cost		RiskVary(ProjectFieldVal,-114.06,41.34,0,5,"Uniform",RiskCategory("A mason"))	-ETB35,172.05	ETB159,199.80	353571.6
to mat foundations... / Cost		RiskVary(ProjectFieldVal,-114.06,41.34,0,5,"Uniform",RiskCategory("A mason"))	-ETB32,857.71	ETB148,724.40	330306.5
3.3 60cm thick Brick wall / Cost		RiskVary(ProjectFieldVal,-114.06,41.34,0,5,"Uniform",RiskCategory("A mason"))	-ETB40,301.30	ETB182,416.40	405134.2
3.3 Two coats of plastering / Cost		RiskVary(ProjectFieldVal,-114.06,41.34,0,5,"Uniform",RiskCategory("A mason"))	-ETB41,766.80	ETB189,049.80	419866.3
3.3 Supply and fix 30x20mm rubber expedite / Cost		RiskVary(ProjectFieldVal,-114.06,41.34,0,5,"Uniform",RiskCategory("A mason"))	-ETB27,954.57	ETB126,531.20	281017
Supply & fix 200-250mm width water bar / Cost		RiskVary(ProjectFieldVal,-114.06,41.34,0,5,"Uniform",RiskCategory("A mason"))	-ETB6,874.08	ETB31,114.23	69102.54
3.3 Supply & apply poly sulphide joint sealant / Cost		RiskVary(ProjectFieldVal,-114.06,41.34,0,5,"Uniform",RiskCategory("A mason"))	-ETB17,174.91	ETB77,739.06	172653
Category: Block A sub concreting					
a) Under footing / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB2,409.12	ETB3,541.48	4809.729
b) Under Mat foundation / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB116,942.80	ETB171,909.50	233472.3
c) Under basement and ground floor slabs / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB191,075.00	ETB280,886.20	381474.7
In foundation column / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB23,117.83	ETB33,983.93	46153.96
In 2nd basement floor elevation column / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB152,577.70	ETB224,294.00	304616.2
In 1st basement floor elevation column / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB152,577.70	ETB224,294.00	304616.2
In 200mm thick lift cores & RC partition wall / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB174,308.50	ETB256,238.80	348000.9

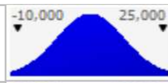
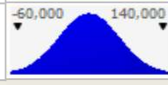
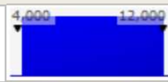
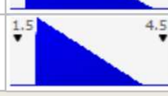
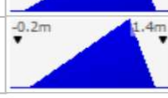
	In 300mm thick shear wall / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB4,161.21	ETB6,117.11	8307.714
	In retaining walls / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB256,607.90	ETB377,221.70	512309
	In footing Pad / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB22,083.61	ETB32,463.60	44089.18
	In mat foundation / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB1,160,394.00	ETB1,705,815.00	2316686
	In mat beam / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB700,652.80	ETB1,029,981.00	1398830
	In 150mm thick 2nd basement & ground floor slabs / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB369,197.90	ETB542,732.30	737090.9
	In staircase / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB32,121.62	ETB47,219.78	64129.72
	In 100mm thick Steps / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB1,003.80	ETB1,475.62	2004.054
	In 1st basement & ground floor beams / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB86,326.85	ETB126,903.20	172348.6
	In ground floor beams / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB74,281.24	ETB109,195.70	148300
	In 150mm thick suspended 1st basement floor slab / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB252,656.60	ETB371,413.10	504420.3
	In 200mm thick suspended 1st basement floor slab / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB46,576.35	ETB68,468.68	92988.09
	In 150mm thick suspended ground floor slab / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB254,764.60	ETB374,511.90	508628.8
	In 200mm thick suspended ground floor slab / Cost		RiskVary(ProjectFieldVal,-29.26,41.23,0,5,"Triang",RiskCategory("A sub con"))	ETB46,576.35	ETB68,468.68	92988.09
Category: Block A sub formwork						
	to footing pad / Cost		RiskVary(ProjectFieldVal,-176.19,135.85,0,5,"Normal",RiskCategory("A sub form"))	-∞	ETB3,096.00	+∞
	to mat foundation / Cost		RiskVary(ProjectFieldVal,-176.19,135.85,0,5,"Normal",RiskCategory("A sub form"))	-∞	ETB7,740.00	+∞
	to foundation column / Cost		RiskVary(ProjectFieldVal,-176.19,135.85,0,5,"Normal",RiskCategory("A sub form"))	-∞	ETB10,784.40	+∞
	to 1st & 2nd basement floor elevation columns / Cost		RiskVary(ProjectFieldVal,-176.19,135.85,0,5,"Normal",RiskCategory("A sub form"))	-∞	ETB153,441.20	+∞
	to suspended Basement & Ground floor slabs / Cost		RiskVary(ProjectFieldVal,-176.19,135.85,0,5,"Normal",RiskCategory("A sub form"))	-∞	ETB362,696.40	+∞
	to basement floor beams / Cost		RiskVary(ProjectFieldVal,-176.19,135.85,0,5,"Normal",RiskCategory("A sub form"))	-∞	ETB80,410.00	+∞
	to mat beam / Cost		RiskVary(ProjectFieldVal,-176.19,135.85,0,5,"Normal",RiskCategory("A sub form"))	-∞	ETB175,956.00	+∞
	to retaining wall / Cost		RiskVary(ProjectFieldVal,-176.19,135.85,0,5,"Normal",RiskCategory("A sub form"))	-∞	ETB188,340.00	+∞
	to lift house core, RC wall & shear wall / Cost		RiskVary(ProjectFieldVal,-176.19,135.85,0,5,"Normal",RiskCategory("A sub form"))	-∞	ETB149,640.00	+∞
	to staircase / Cost		RiskVary(ProjectFieldVal,-176.19,135.85,0,5,"Normal",RiskCategory("A sub form"))	-∞	ETB51,170.00	+∞

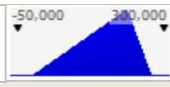
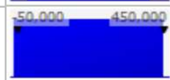
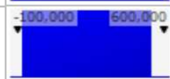
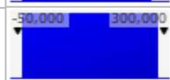
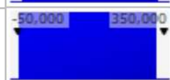
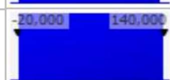
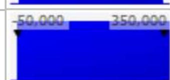
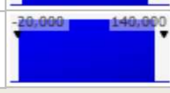
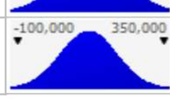
	to side of ramp / Cost		RiskVary(ProjectFieldVal,-176.19,135.85,0,5,"Normal",RiskCategory("A sub form"))	-∞	ETB11,825.00	+∞
	to Ground floor beams / Cost		RiskVary(ProjectFieldVal,-176.19,135.85,0,5,"Normal",RiskCategory("A sub form"))	-∞	ETB83,850.00	+∞
Category: Block A sub rebar						
	a) Ø 6mm plain bar / Cost		RiskVary(ProjectFieldVal,-127.56,128.3,0,5,"Normal",RiskCategory("A sub rebar"))	-∞	ETB1,108,299.00	+∞
	b) Ø 8mm deformed bar / Cost		RiskVary(ProjectFieldVal,-127.56,128.3,0,5,"Normal",RiskCategory("A sub rebar"))	-∞	ETB1,269,773.00	+∞
	c) Ø 10mm deformed bar / Cost		RiskVary(ProjectFieldVal,-127.56,128.3,0,5,"Normal",RiskCategory("A sub rebar"))	-∞	ETB556,970.40	+∞
	d) Ø 12mm deformed bar / Cost		RiskVary(ProjectFieldVal,-127.56,128.3,0,5,"Normal",RiskCategory("A sub rebar"))	-∞	ETB248,677.60	+∞
	e) Ø 14mm deformed bar / Cost		RiskVary(ProjectFieldVal,-127.56,128.3,0,5,"Normal",RiskCategory("A sub rebar"))	-∞	ETB1,516,352.00	+∞
	f) Ø 16mm deformed bar a / Cost		RiskVary(ProjectFieldVal,-127.56,128.3,0,5,"Normal",RiskCategory("A sub rebar"))	-∞	ETB1,919,692.00	+∞
	g) Ø 20mm deformed bar / Cost		RiskVary(ProjectFieldVal,-127.56,128.3,0,5,"Normal",RiskCategory("A sub rebar"))	-∞	ETB2,707,968.00	+∞
	g) Ø 24mm deformed bar / Cost		RiskVary(ProjectFieldVal,-127.56,128.3,0,5,"Normal",RiskCategory("A sub rebar"))	ETB0.00	ETB0.00	0
Category: Block A sup con						
	In Elevation column / Cost		RiskVary(ProjectFieldVal,-60.12,36.37,0,5,"Triang",RiskCategory("A sup con"))	ETB668,581.80	ETB1,543,762.00	2286221
	In lift shaft cores, CB, RC wall & Shear wall. / Cost		RiskVary(ProjectFieldVal,-60.12,36.37,0,5,"Triang",RiskCategory("A sup con"))	ETB458,754.00	ETB1,059,268.00	1568713
	In Floor & top tie Beams / Cost		RiskVary(ProjectFieldVal,-60.12,36.37,0,5,"Triang",RiskCategory("A sup con"))	ETB553,447.40	ETB1,277,916.00	1892518
	In 150mm thick suspended floor slab / Cost		RiskVary(ProjectFieldVal,-60.12,36.37,0,5,"Triang",RiskCategory("A sup con"))	ETB1,243,899.00	ETB2,872,175.00	4253522
	In 190mm thick suspended floor slab / Cost		RiskVary(ProjectFieldVal,-60.12,36.37,0,5,"Triang",RiskCategory("A sup con"))	ETB35,911.84	ETB82,920.80	122800.8
	In 200mm thick suspended floor slab / Cost		RiskVary(ProjectFieldVal,-60.12,36.37,0,5,"Triang",RiskCategory("A sup con"))	ETB304,226.30	ETB702,461.80	1040305
	In 150mm thick roof slab / Cost		RiskVary(ProjectFieldVal,-60.12,36.37,0,5,"Triang",RiskCategory("A sup con"))	ETB62,135.51	ETB143,471.50	212472.9
	In 200mm thick roof slab / Cost		RiskVary(ProjectFieldVal,-60.12,36.37,0,5,"Triang",RiskCategory("A sup con"))	ETB12,223.38	ETB28,223.91	41797.95
	In stair case & landing / Cost		RiskVary(ProjectFieldVal,-60.12,36.37,0,5,"Triang",RiskCategory("A sup con"))	ETB101,861.50	ETB235,199.30	348316.3
	In RC gutter / Cost		RiskVary(ProjectFieldVal,-60.12,36.37,0,5,"Triang",RiskCategory("A sup con"))	ETB15,159.19	ETB35,002.71	51836.96
	In Vertical mullions / Cost		RiskVary(ProjectFieldVal,-60.12,36.37,0,5,"Triang",RiskCategory("A sup con"))	ETB22,155.73	ETB51,157.82	75761.72
Category: Block A sup form						
	To Floor & Top tie Beams / Cost		RiskVary(ProjectFieldVal,-118.05,27.18,0,5,"Normal",RiskCategory("A sup form"))	-∞	ETB835,318.00	+∞
	To Elevation Column / Cost		RiskVary(ProjectFieldVal,-118.05,27.18,0,5,"Normal",RiskCategory("A sup form"))	-∞	ETB640,820.40	+∞

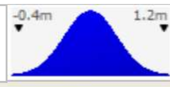
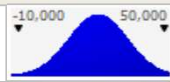
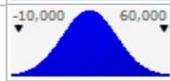
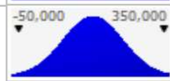
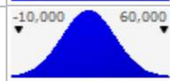
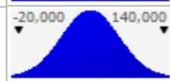
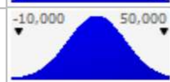
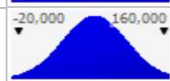
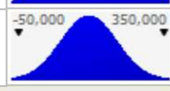
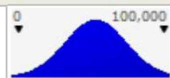
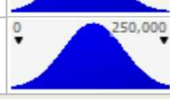
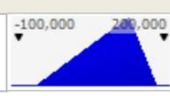
To suspended floor slab / Cost		RiskVary(ProjectFieldVal,-118.05,27.18,0,5,"Normal",RiskCategory("A sup form"))	-∞	ETB1,708,854.00	+∞
To roof slab / Cost		RiskVary(ProjectFieldVal,-118.05,27.18,0,5,"Normal",RiskCategory("A sup form"))	-∞	ETB46,164.80	+∞
To stair case & landing / Cost		RiskVary(ProjectFieldVal,-118.05,27.18,0,5,"Normal",RiskCategory("A sup form"))	-∞	ETB170,495.00	+∞
To steps / Cost		RiskVary(ProjectFieldVal,-118.05,27.18,0,5,"Normal",RiskCategory("A sup form"))	-∞	ETB9,460.00	+∞
To RC gutter / Cost		RiskVary(ProjectFieldVal,-118.05,27.18,0,5,"Normal",RiskCategory("A sup form"))	-∞	ETB89,096.00	+∞
To Vertical mullions / Cost		RiskVary(ProjectFieldVal,-118.05,27.18,0,5,"Normal",RiskCategory("A sup form"))	-∞	ETB69,350.40	+∞
To lift shaft & shear wall / Cost		RiskVary(ProjectFieldVal,-118.05,27.18,0,5,"Normal",RiskCategory("A sup form"))	-∞	ETB944,538.00	+∞
Category: Block A sup rebar					
a) Ø 6mm plain bar / Cost		RiskVary(ProjectFieldVal,-113.99,32.89,0,5,"Triang",RiskCategory("A sup rebar"))	-ETB2,675.78	ETB13,955.90	25417.07
b) Ø 8mm deformed bar / Cost		RiskVary(ProjectFieldVal,-113.99,32.89,0,5,"Triang",RiskCategory("A sup rebar"))	-ETB407,445.80	ETB2,125,087.00	3870298
c) Ø 10mm deformed bar / Cost		RiskVary(ProjectFieldVal,-113.99,32.89,0,5,"Triang",RiskCategory("A sup rebar"))	-ETB449,189.90	ETB2,342,809.00	4266823
d) Ø 12mm deformed bar / Cost		RiskVary(ProjectFieldVal,-113.99,32.89,0,5,"Triang",RiskCategory("A sup rebar"))	-ETB119,014.60	ETB620,736.20	1130511
e) Ø 14mm deformed bar / Cost		RiskVary(ProjectFieldVal,-113.99,32.89,0,5,"Triang",RiskCategory("A sup rebar"))	-ETB134,164.50	ETB699,752.70	1274419
f) Ø 16mm deformed bar / Cost		RiskVary(ProjectFieldVal,-113.99,32.89,0,5,"Triang",RiskCategory("A sup rebar"))	-ETB275,085.90	ETB1,434,747.00	2613022
g) Ø 20mm deformed bar / Cost		RiskVary(ProjectFieldVal,-113.99,32.89,0,5,"Triang",RiskCategory("A sup rebar"))	-ETB281,987.20	ETB1,470,741.00	2678576
g) Ø 24mm deformed bar / Cost		RiskVary(ProjectFieldVal,-113.99,32.89,0,5,"Triang",RiskCategory("A sup rebar"))	-ETB267,828.60	ETB1,396,895.00	2544085
Category: Block B excavation and earth work					
Bulk excavations and Cartaway B. / Cost		RiskVary(ProjectFieldVal,-112.81,28.3,0,5,"Uniform",RiskCategory("B exca"))	-ETB223,012.30	ETB1,005,296.00	2233605
Fill between hard core & mat foundation with borrowed selected granular material / Cost		RiskVary(ProjectFieldVal,-112.81,28.3,0,5,"Uniform",RiskCategory("B exca"))	-ETB16,293.55	ETB73,448.17	163189.9
Fill between hard core & mat foundation with excavaed material / Cost		RiskVary(ProjectFieldVal,-112.81,28.3,0,5,"Uniform",RiskCategory("B exca"))	-ETB2,732.12	ETB12,315.85	27363.82
Cart away surplus excavated materials / Cost		RiskVary(ProjectFieldVal,-112.81,28.3,0,5,"Uniform",RiskCategory("B exca"))	-ETB139,965.90	ETB630,939.20	1401844
Hard basaltic hard core / Cost		RiskVary(ProjectFieldVal,-112.81,28.3,0,5,"Uniform",RiskCategory("B exca"))	-ETB19,967.59	ETB90,010.02	199987.6
Fill on top of mat beam with 10mm thick gravel pack . / Cost		RiskVary(ProjectFieldVal,-112.81,28.3,0,5,"Uniform",RiskCategory("B exca"))	-ETB951.83	ETB4,290.69	9533.203
Category: Block B mason					
under basement floor slabs / Cost		RiskVary(ProjectFieldVal,-120.15,40.99,0,5,"Uniform",RiskCategory("B mason"))	-ETB60,304.92	ETB180,825.00	421954.9
to retaining walls / Cost		RiskVary(ProjectFieldVal,-120.15,40.99,0,5,"Uniform",RiskCategory("B mason"))	-ETB114,454.60	ETB343,193.30	800841.3

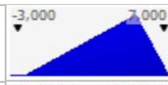
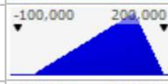
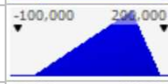
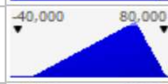
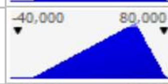
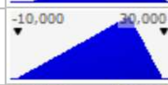
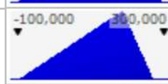
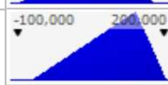
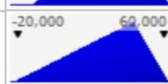
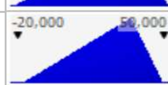
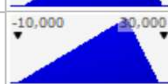
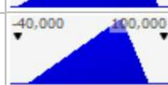
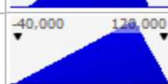
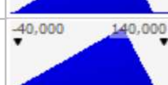
	3.3 60cm thick Brick wall / Cost	-0.2m 1.0m	RiskVary(ProjectFieldVal,-120.15,40.99,0,5,"Uniform",RiskCategory("B mason"))	-ETB131,145.90	ETB393,242.40	917630.6
	3.3 Two coats of plastering / Cost	-0.2m 1.0m	RiskVary(ProjectFieldVal,-120.15,40.99,0,5,"Uniform",RiskCategory("B mason"))	-ETB135,914.80	ETB407,542.10	950999
	3.3 Supply and fix 30x20mm rubber expedite / Cost	-100,000 600,000	RiskVary(ProjectFieldVal,-120.15,40.99,0,5,"Uniform",RiskCategory("B mason"))	-ETB80,865.78	ETB242,476.90	565819.7
	Supply & fix 200-250mm width water bar / Cost	-40,000 140,000	RiskVary(ProjectFieldVal,-120.15,40.99,0,5,"Uniform",RiskCategory("B mason"))	-ETB19,885.03	ETB59,625.48	139136
	3.3 Supply & apply poly sulphide joint sealant / Cost	-50,000 200,000	RiskVary(ProjectFieldVal,-120.15,40.99,0,5,"Uniform",RiskCategory("B mason"))	-ETB27,553.11	ETB82,618.30	192789.7
Category: Block B Sub con						
	b) Under Mat foundation B. / Cost	-50,000 200,000	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB17,525.39	ETB111,102.60	195878.4
	c) Under basement and ground floor slabs / Cost	-50,000 250,000	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB18,334.64	ETB116,232.90	204923.3
	In foundation column / Cost	-5,000 35,000	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB2,956.89	ETB18,745.25	33048.63
	In 2nd basement floor elevation column / Cost	-50,000 450,000	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB35,852.25	ETB227,286.10	400714.7
	In 1st basement floor elevation column / Cost	-50,000 400,000	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB34,743.41	ETB220,256.70	388321.4
	In retaining walls / Cost	-100,000 900,000	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB72,074.11	ETB456,915.40	805560.4
	In mat foundation B. / Cost	-0.5m 2.0m	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB172,044.10	ETB1,090,678.00	1922909
	In mat beam / Cost	-100,000 900,000	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB76,713.70	ETB486,328.20	857416.3
	In 150mm thick 2nd basement & ground floor slabs / Cost	-50,000 400,000	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB34,906.34	ETB221,289.50	390142.3
	In 100mm thick Steps / Cost	-100 800	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB64.20	ETB406.97	717.5032
	In 1st basement & ground floor beams / Cost	-20,000 160,000	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB13,481.07	ETB85,463.53	150675.7
	In ground floor beams / Cost	-50,000 250,000	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB20,542.58	ETB130,230.10	229601
	In 150mm thick suspended 1st basement floor slab / Cost	-50,000 450,000	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB37,217.38	ETB235,940.40	415972.5
	In 200mm thick suspended 1st basement floor slab / Cost	-10,000 60,000	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB4,686.28	ETB29,708.75	52377.73
	In 150mm thick suspended ground floor slab / Cost	-50,000 450,000	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB37,746.99	ETB239,297.90	421891.8
	In 200mm thick suspended ground floor slab / Cost	-10,000 60,000	RiskVary(ProjectFieldVal,-111.31,26.41,0,5,"Triang",RiskCategory("B Sub con"))	-ETB4,686.28	ETB29,708.75	52377.73
Category: Block B Sub form						
	to mat foundation / Cost	-2,000 14,000	RiskVary(ProjectFieldVal,-112.48,13.11,0,5,"Uniform",RiskCategory("B Sub form"))	-ETB1,390.97	ETB5,607.91	12606.79
	to foundation column B / Cost	-2,000 10,000	RiskVary(ProjectFieldVal,-112.48,13.11,0,5,"Uniform",RiskCategory("B Sub form"))	-ETB1,060.40	ETB4,275.17	9610.73
	to 1st & 2nd basement floor elevation columns / Cost	-50,000 350,000	RiskVary(ProjectFieldVal,-112.48,13.11,0,5,"Uniform",RiskCategory("B Sub form"))	-ETB33,080.64	ETB133,369.60	299819.8

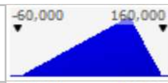
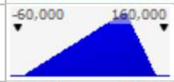
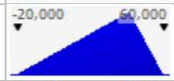
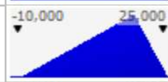
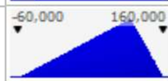
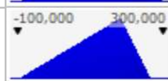
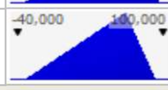
	to suspended Basement & Ground floor slabs / Cost		RiskVary(ProjectFieldVal,-112.48,13.11,0,5,"Uniform",RiskCategory("B Sub form"))	-ETB40,211.51	ETB162,118.80	364449
	to basement floor beams / Cost		RiskVary(ProjectFieldVal,-112.48,13.11,0,5,"Uniform",RiskCategory("B Sub form"))	-ETB9,114.29	ETB36,745.65	82605.59
	to mat beam / Cost		RiskVary(ProjectFieldVal,-112.48,13.11,0,5,"Uniform",RiskCategory("B Sub form"))	-ETB22,502.39	ETB90,721.77	203945.9
	to retaining wall / Cost		RiskVary(ProjectFieldVal,-112.48,13.11,0,5,"Uniform",RiskCategory("B Sub form"))	-ETB40,650.48	ETB163,888.50	368427.6
	to side of steps / Cost		RiskVary(ProjectFieldVal,-112.48,13.11,0,5,"Uniform",RiskCategory("B Sub form"))	-ETB295.15	ETB1,189.95	2675.052
	to Ground floor beams / Cost		RiskVary(ProjectFieldVal,-112.48,13.11,0,5,"Uniform",RiskCategory("B Sub form"))	-ETB11,924.14	ETB48,073.97	108072.1
Category: Block B Sub rebar						
	a) Ø 6mm plain bar / Cost		RiskVary(ProjectFieldVal,-24.02,15.59,0,5,"Triang",RiskCategory("B Sub rebar"))	ETB0.00	ETB0.00	0
	b) Ø 8mm deformed bar / Cost		RiskVary(ProjectFieldVal,-24.02,15.59,0,5,"Triang",RiskCategory("B Sub rebar"))	ETB643,600.40	ETB823,263.10	979123.1
	c) Ø 10mm deformed bar / Cost		RiskVary(ProjectFieldVal,-24.02,15.59,0,5,"Triang",RiskCategory("B Sub rebar"))	ETB752,539.90	ETB962,613.30	1144855
	d) Ø 12mm deformed bar / Cost		RiskVary(ProjectFieldVal,-24.02,15.59,0,5,"Triang",RiskCategory("B Sub rebar"))	ETB27,836.03	ETB35,606.53	42347.55
	e) Ø 14mm deformed bar / Cost		RiskVary(ProjectFieldVal,-24.02,15.59,0,5,"Triang",RiskCategory("B Sub rebar"))	ETB447,023.20	ETB571,810.80	680065.9
	f) Ø 16mm deformed bar / Cost		RiskVary(ProjectFieldVal,-24.02,15.59,0,5,"Triang",RiskCategory("B Sub rebar"))	ETB1,071,936.00	ETB1,371,169.00	1630759
	g) Ø 20mm deformed bar / Cost		RiskVary(ProjectFieldVal,-24.02,15.59,0,5,"Triang",RiskCategory("B Sub rebar"))	ETB1,575,598.00	ETB2,015,430.00	2396991
	g) Ø 24mm deformed bar / Cost		RiskVary(ProjectFieldVal,-24.02,15.59,0,5,"Triang",RiskCategory("B Sub rebar"))	ETB1,100,033.00	ETB1,407,110.00	1673504
Category: Block B Sup con						
	In Elevation column / Cost		RiskVary(ProjectFieldVal,-119.72,19.06,0,5,"Uniform",RiskCategory("B Sup con"))	-ETB170,779.10	ETB430,152.10	1031083
	In Floor & top tie Beams / Cost		RiskVary(ProjectFieldVal,-119.72,19.06,0,5,"Uniform",RiskCategory("B Sup con"))	-ETB207,631.50	ETB522,974.40	1253580
	In 150mm thick suspended floor slab / Cost		RiskVary(ProjectFieldVal,-119.72,19.06,0,5,"Uniform",RiskCategory("B Sup con"))	-ETB462,134.00	ETB1,164,006.00	2790146
	In 200mm thick suspended floor slab / Cost		RiskVary(ProjectFieldVal,-119.72,19.06,0,5,"Uniform",RiskCategory("B Sup con"))	-ETB51,376.20	ETB129,404.50	310185.1
	In 200mm thick roof slab / Cost		RiskVary(ProjectFieldVal,-119.72,19.06,0,5,"Uniform",RiskCategory("B Sup con"))	-ETB7,387.43	ETB18,607.18	44601.78
	In RC gutter / Cost		RiskVary(ProjectFieldVal,-119.72,19.06,0,5,"Uniform",RiskCategory("B Sup con"))	-ETB10,379.03	ETB26,142.31	62663.66
Category: Block B Sup form						
	To Floor & Top tie Beams / Cost		RiskVary(ProjectFieldVal,-214.98,138.44,0,5,"Normal",RiskCategory("B Sup form"))	-∞	ETB568,546.00	+∞
	To Elevation Column / Cost		RiskVary(ProjectFieldVal,-214.98,138.44,0,5,"Normal",RiskCategory("B Sup form"))	-∞	ETB412,077.60	+∞
	To suspended floor slab / Cost		RiskVary(ProjectFieldVal,-214.98,138.44,0,5,"Normal",RiskCategory("B Sup form"))	-∞	ETB1,128,389.00	+∞

	To roof slab / Cost		RiskVary(ProjectFieldVal,-214.98,138.44,0,5,"Normal",RiskCategory("B Sup form"))	-∞	ETB12,487.20	+∞
	To RC gutter / Cost		RiskVary(ProjectFieldVal,-214.98,138.44,0,5,"Normal",RiskCategory("B Sup form"))	-∞	ETB63,855.00	+∞
Category: Block B Sup rebar						
	a) Ø 6mm plain bar / Cost		RiskVary(ProjectFieldVal,-54.88,15.25,0,5,"Uniform",RiskCategory("B Sup rebar"))	ETB4,594.30	ETB8,164.76	11735.22
	b) Ø 8mm deformed bar / Cost		RiskVary(ProjectFieldVal,-54.88,15.25,0,5,"Uniform",RiskCategory("B Sup rebar"))	ETB1,131,113.00	ETB2,010,158.00	2889202
	c) Ø 10mm deformed bar / Cost		RiskVary(ProjectFieldVal,-54.88,15.25,0,5,"Uniform",RiskCategory("B Sup rebar"))	ETB401,395.80	ETB713,340.50	1025285
	d) Ø 12mm deformed bar / Cost		RiskVary(ProjectFieldVal,-54.88,15.25,0,5,"Uniform",RiskCategory("B Sup rebar"))	ETB87,431.37	ETB155,378.60	223325.9
	e) Ø 14mm deformed bar / Cost		RiskVary(ProjectFieldVal,-54.88,15.25,0,5,"Uniform",RiskCategory("B Sup rebar"))	ETB425,578.00	ETB756,315.80	1087054
	f) Ø 16mm deformed bar / Cost		RiskVary(ProjectFieldVal,-54.88,15.25,0,5,"Uniform",RiskCategory("B Sup rebar"))	ETB638,685.10	ETB1,135,039.00	1631393
	g) Ø 20mm deformed bar / Cost		RiskVary(ProjectFieldVal,-54.88,15.25,0,5,"Uniform",RiskCategory("B Sup rebar"))	ETB373,845.60	ETB664,379.60	ETB954,913.60
	g) Ø 24mm deformed bar / Cost		RiskVary(ProjectFieldVal,-54.88,15.25,0,5,"Uniform",RiskCategory("B Sup rebar"))	ETB448,627.10	ETB797,277.50	1145928
Category: Time Risks: Block Work (For all blocks)						
	2.1 20cm thick H.C.B wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Block time"))	89.1 days	119.7 days	180
	2.2 15cm thick H.C.B / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Block time"))	29.7 days	39.9 days	60
	2.3 10cm thick H.C.B wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Block time"))	5.94 days	7.98 days	12
	2.1 20cm thick H.C.B wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Block time"))	47.52 days	63.84 days	96
	2.2 15cm thick H.C.B / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Block time"))	13.86 days	18.62 days	28
	2.3 10cm thick H.C.B wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Block time"))	2.97 days	3.99 days	6
	2.1 20cm thick H.C.B wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Block time"))	24.75 days	33.25 days	50
	2.2 15cm thick H.C.B / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Block time"))	7.92 days	10.64 days	16
	2.3 10cm thick H.C.B wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Block time"))	1.98 days	2.66 days	4
Category: Block C excavation and earth work						
	Bulk and Pit excavations and Cartaway c / Cost		RiskVary(ProjectFieldVal,-99.98,25.61,0,5,"Triang",RiskCategory("C exca"))	ETB295.64	ETB1,111,756.00	1856770
	Fill under hard core / Cost		RiskVary(ProjectFieldVal,-99.98,25.61,0,5,"Triang",RiskCategory("C exca"))	ETB67.51	ETB253,871.40	423996.6
	Fill around foundation / Cost		RiskVary(ProjectFieldVal,-99.98,25.61,0,5,"Triang",RiskCategory("C exca"))	ETB290.66	ETB1,093,038.00	1825508
	Cart away surplus excavated materials / Cost		RiskVary(ProjectFieldVal,-99.98,25.61,0,5,"Triang",RiskCategory("C exca"))	ETB200.57	ETB754,240.50	1259675

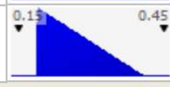
	Hard basaltic hard core c / Cost		RiskVary(ProjectFieldVal,-99.98,25.61,0,5,"Triang",RiskCategory("C exca"))	ETB41.32	ETB155,395.10	259529.1
Category: Block C mason						
	50cm thick masonry foundation wall below GL c / Cost		RiskVary(ProjectFieldVal,-114.12,56.64,0,5,"Uniform",RiskCategory("C mason"))	-ETB31,001.59	ETB156,457.00	343915.7
	50cm thick stone masonry foundation wall above GL / Cost		RiskVary(ProjectFieldVal,-114.12,56.64,0,5,"Uniform",RiskCategory("C mason"))	-ETB19,125.54	ETB96,521.67	212168.9
	Verical sufaces of coulomns and beams / Cost		RiskVary(ProjectFieldVal,-114.12,56.64,0,5,"Uniform",RiskCategory("C mason"))	-ETB38,557.09	ETB194,587.70	427732.5
	under basement floor slabs c2 / Cost		RiskVary(ProjectFieldVal,-114.12,56.64,0,5,"Uniform",RiskCategory("C mason"))	-ETB46,455.03	ETB234,446.50	515348.1
	to retaining walls / Cost		RiskVary(ProjectFieldVal,-114.12,56.64,0,5,"Uniform",RiskCategory("C mason"))	-ETB24,772.13	ETB125,018.50	274809.2
	60cm thick Brick wall / Cost		RiskVary(ProjectFieldVal,-114.12,56.64,0,5,"Uniform",RiskCategory("C mason"))	-ETB28,384.73	ETB143,250.40	314885.6
	Two coats of plastering c / Cost		RiskVary(ProjectFieldVal,-114.12,56.64,0,5,"Uniform",RiskCategory("C mason"))	-ETB29,416.90	ETB148,459.50	326335.9
	Dia 160 perforated UPVC pipe PN-4 / Cost		RiskVary(ProjectFieldVal,-114.12,56.64,0,5,"Uniform",RiskCategory("C mason"))	-ETB12,014.48	ETB60,633.99	133282.5
	Supply and fix 30x20mm rubber expedite / Cost		RiskVary(ProjectFieldVal,-114.12,56.64,0,5,"Uniform",RiskCategory("C mason"))	-ETB31,481.25	ETB158,877.70	349236.7
	Supply & fix 200-250mm width water bar / Cost		RiskVary(ProjectFieldVal,-114.12,56.64,0,5,"Uniform",RiskCategory("C mason"))	-ETB910.74	ETB4,596.27	10103.28
	3.3 Supply & apply poly sulphide joint sealant / Cost		RiskVary(ProjectFieldVal,-114.12,56.64,0,5,"Uniform",RiskCategory("C mason"))	-ETB11,198.46	ETB56,515.73	124229.9
Category: Block C sub con						
	b) UnderFooting Pad C. / Cost		RiskVary(ProjectFieldVal,-189.6,174.69,0,5,"Normal",RiskCategory("C sub con"))	-∞	ETB22,845.90	+∞
	c) Under retaining wall / Cost		RiskVary(ProjectFieldVal,-189.6,174.69,0,5,"Normal",RiskCategory("C sub con"))	-∞	ETB14,757.60	+∞
	Under basement and ground floor slab / Cost		RiskVary(ProjectFieldVal,-189.6,174.69,0,5,"Normal",RiskCategory("C sub con"))	-∞	ETB256,022.00	+∞
	Under grade beam / Cost		RiskVary(ProjectFieldVal,-189.6,174.69,0,5,"Normal",RiskCategory("C sub con"))	-∞	ETB8,273.20	+∞
	Under Masonary wall / Cost		RiskVary(ProjectFieldVal,-189.6,174.69,0,5,"Normal",RiskCategory("C sub con"))	-∞	ETB7,826.00	+∞
	In Footing Pad C / Cost		RiskVary(ProjectFieldVal,-189.6,174.69,0,5,"Normal",RiskCategory("C sub con"))	-∞	ETB169,936.00	+∞
	In foundation column / Cost		RiskVary(ProjectFieldVal,-189.6,174.69,0,5,"Normal",RiskCategory("C sub con"))	-∞	ETB49,020.00	+∞
	In retaining walls and bases / Cost		RiskVary(ProjectFieldVal,-189.6,174.69,0,5,"Normal",RiskCategory("C sub con"))	-∞	ETB127,452.00	+∞
	In basement floor elevation column / Cost		RiskVary(ProjectFieldVal,-189.6,174.69,0,5,"Normal",RiskCategory("C sub con"))	-∞	ETB35,948.00	+∞
	In 100mm thick basement floor slabs / Cost		RiskVary(ProjectFieldVal,-189.6,174.69,0,5,"Normal",RiskCategory("C sub con"))	-∞	ETB330,059.40	+∞
	In Stair Cases / Cost		RiskVary(ProjectFieldVal,-189.6,174.69,0,5,"Normal",RiskCategory("C sub con"))	-∞	ETB28,380.00	+∞
	In ground floor beams c / Cost		RiskVary(ProjectFieldVal,-189.6,174.69,0,5,"Normal",RiskCategory("C sub con"))	-∞	ETB130,548.00	+∞

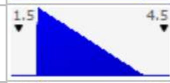
In 160mm thick suspended ground floor slab / Cost		RiskVary(ProjectFieldVal,-189.6,174.69,0,5,"Normal",RiskCategory("C sub con"))	-∞	ETB431,642.60	+∞
Category: Block C sub form					
To Footing Pad C / Cost		RiskVary(ProjectFieldVal,-136.67,99.18,0,5,"Normal",RiskCategory("C sub form"))	-∞	ETB28,173.60	+∞
to foundation column c / Cost		RiskVary(ProjectFieldVal,-136.67,99.18,0,5,"Normal",RiskCategory("C sub form"))	-∞	ETB30,229.00	+∞
to retaining walls and bases / Cost		RiskVary(ProjectFieldVal,-136.67,99.18,0,5,"Normal",RiskCategory("C sub form"))	-∞	ETB191,780.00	+∞
to basement floor elevation column / Cost		RiskVary(ProjectFieldVal,-136.67,99.18,0,5,"Normal",RiskCategory("C sub form"))	-∞	ETB29,704.40	+∞
to basement floor beams c / Cost		RiskVary(ProjectFieldVal,-136.67,99.18,0,5,"Normal",RiskCategory("C sub form"))	-∞	ETB73,598.80	+∞
to Stair Cases / Cost		RiskVary(ProjectFieldVal,-136.67,99.18,0,5,"Normal",RiskCategory("C sub form"))	-∞	ETB27,520.00	+∞
to ground floor beams c / Cost		RiskVary(ProjectFieldVal,-136.67,99.18,0,5,"Normal",RiskCategory("C sub form"))	-∞	ETB92,020.00	+∞
to 160mm thick suspended ground floor slab / Cost		RiskVary(ProjectFieldVal,-136.67,99.18,0,5,"Normal",RiskCategory("C sub form"))	-∞	ETB179,172.40	+∞
Category: Block C sup con form rebar					
In Elevation column / Cost		RiskVary(ProjectFieldVal,-107.98,99.8,0,5,"Normal",RiskCategory("C sup con form rebar"))	-∞	ETB55,556.00	+∞
In top tie Beams / Cost		RiskVary(ProjectFieldVal,-107.98,99.8,0,5,"Normal",RiskCategory("C sup con form rebar"))	-∞	ETB114,380.00	+∞
In 150mm thick roof slab / Cost		RiskVary(ProjectFieldVal,-107.98,99.8,0,5,"Normal",RiskCategory("C sup con form rebar"))	-∞	ETB76,961.40	+∞
In 100mm thick Parapet / Cost		RiskVary(ProjectFieldVal,-107.98,99.8,0,5,"Normal",RiskCategory("C sup con form rebar"))	-∞	ETB48,504.00	+∞
To Top tie Beams / Cost		RiskVary(ProjectFieldVal,-107.98,99.8,0,5,"Normal",RiskCategory("C sup con form rebar"))	-∞	ETB87,075.00	+∞
To Elevation Column / Cost		RiskVary(ProjectFieldVal,-107.98,99.8,0,5,"Normal",RiskCategory("C sup con form rebar"))	-∞	ETB35,191.20	+∞
To Prapet / Cost		RiskVary(ProjectFieldVal,-107.98,99.8,0,5,"Normal",RiskCategory("C sup con form rebar"))	-∞	ETB64,285.00	+∞
To roof slab c / Cost		RiskVary(ProjectFieldVal,-107.98,99.8,0,5,"Normal",RiskCategory("C sup con form rebar"))	-∞	ETB29,704.40	+∞
a) Ø 6mm plain bar / Cost		RiskVary(ProjectFieldVal,-107.98,99.8,0,5,"Normal",RiskCategory("C sup con form rebar"))	-∞	ETB10,182.40	+∞
b) Ø 8mm deformed bar / Cost		RiskVary(ProjectFieldVal,-107.98,99.8,0,5,"Normal",RiskCategory("C sup con form rebar"))	-∞	ETB123,324.00	+∞
c) Ø 10mm deformed bar / Cost		RiskVary(ProjectFieldVal,-107.98,99.8,0,5,"Normal",RiskCategory("C sup con form rebar"))	-∞	ETB40,351.20	+∞
d) Ø 12mm deformed bar / Cost		RiskVary(ProjectFieldVal,-107.98,99.8,0,5,"Normal",RiskCategory("C sup con form rebar"))	-∞	ETB34,400.00	+∞
e) Ø 14mm deformed bar / Cost		RiskVary(ProjectFieldVal,-107.98,99.8,0,5,"Normal",RiskCategory("C sup con form rebar"))	-∞	ETB135,192.00	+∞
Category: Fence					
Isolated excavation / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB51,973.71	ETB82,264.96	175315.6

	Tench Excavation / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB2,063.74	ETB3,266.53	6961.33
	selected material fill around footing / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB56,101.20	ETB88,798.02	189238.3
	cart away surplus excavated materials / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB54,037.45	ETB85,531.49	182276.9
	a) under footing f / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB955.84	ETB1,512.92	3224.195
	b) under Grade beam / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB22,880.38	ETB36,215.50	77179.17
	c) under RC base / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB22,880.38	ETB36,215.50	77179.17
	a) In Footing pads f / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB8,363.59	ETB13,238.04	28211.71
	e) In Grade Beams f / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB76,467.07	ETB121,033.50	257935.6
	f) In RC base / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB57,350.30	ETB90,775.13	193451.7
	TO Footing pads. / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB1,173.07	ETB1,856.76	3956.967
	TO Grade Beams / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB17,610.60	ETB27,874.38	59403.35
	TO RC base / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB13,903.10	ETB22,006.09	46897.38
	6 mm deformed bar. / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB8,081.18	ETB12,791.04	27259.1
	8 mm deformed bar. / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB24,185.61	ETB38,281.43	81581.91
	10 mm deformed bar. / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB35,423.95	ETB56,069.69	119490.6
	12 mm deformed bar. / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB68,023.84	ETB107,669.40	229455.2
	16 mm deformed bar. / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB11,527.99	ETB18,246.72	38885.75
	50cm thick masonry foundation wall below GL f / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB390,210.20	ETB617,631.90	1316241
	50cm thick stone masonry foundation wall above GL / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB288,742.80	ETB457,027.60	973975.6
	In Elevation column f / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB53,765.91	ETB85,101.69	181361
	In Rc Coping / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB3,584.39	ETB5,673.45	12090.73
	To Elevation Column f / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB36,712.88	ETB58,109.84	123838.4
	To RC Coping / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB1,882.71	ETB2,979.99	6350.687
	a) Ø 6mm plain bar / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB8,689.44	ETB13,753.81	29310.86

b) Ø 8mm deformed bar / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB44,533.38	ETB70,488.27	150218.2
c) Ø 10mm deformed bar / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB41,781.72	ETB66,132.89	140936.4
d) Ø 12mm deformed bar / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB16,770.62	ETB26,544.85	56569.97
e) Ø 16mm deformed bar / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB7,328.09	ETB11,599.04	24718.83
20cm thick H.C.B wall / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB19,714.17	ETB31,203.95	66499.02
2.2 50cm thick dressed stone above ground / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB554,875.10	ETB878,266.60	1871682
well dressed stone cladding for columns / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB45,076.47	ETB71,347.88	152050.1
Doors f / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB75,073.14	ETB118,827.20	253233.7
RHS SIZE 40X0X2MM / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB272,739.80	ETB431,697.70	919994.8
Pointing to stone / Cost		RiskVary(ProjectFieldVal,-142.1,42.01,0,5,"Triang",RiskCategory("Fence"))	-ETB26,111.77	ETB41,330.19	88079.15
Category: Time Risks: Road fence guard generator					
Isolated excavation / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	8.91 days	11.97 days	18
Tench Excavation / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	2.97 days	3.99 days	6
selected material fill around footing / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	2.97 days	3.99 days	6
cart away surplus excavated materials / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	8.91 days	11.97 days	18
a) under footing f / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.198 days	0.266 days	0.4
b) under Grade beam / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	1.485 days	1.995 days	3
c) under RC base / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	1.485 days	1.995 days	3
a) In Footing pads f / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.495 days	0.665 days	1
e) In Grade Beams f / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	4.95 days	6.65 days	10
f) In RC base / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	3.96 days	5.32 days	8
TO Footing pads. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.495 days	0.665 days	1
TO Grade Beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	8.91 days	11.97 days	18
TO RC base / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	6.93 days	9.31 days	14
In Elevation column f / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	3.96 days	5.32 days	8

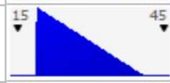
	In Rc Coping / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.2475 days	0.3325 days	0.5
	To Elevation Column f / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	16.83 days	22.61 days	34
	To RC Coping / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.99 day	1.33 day	2
	a) Ø 6mm plain bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.495 days	0.665 days	1
	b) Ø 8mm deformed bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	3.96 days	5.32 days	8
	c) Ø 10mm deformed bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	4.95 days	6.65 days	10
	d) Ø 12mm deformed bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	1.485 days	1.995 days	3
	e) Ø 16mm deformed bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	1.485 days	1.995 days	3
	well dressed stone cladding for columns / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	2.97 days	3.99 days	6
	Doors f / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	1.98 days	2.66 days	4
	RHS SIZE 40X0X2MM / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	14.85 days	19.95 days	30
	Pointing to stone / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	13.86 days	18.62 days	28
	Bulk and Pit excavations and Cartaway g / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	1.98 days	2.66 days	4
	Fill around foundation g / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.99 day	1.33 day	2
	Cart away surplus excavated materials / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	1.98 days	2.66 days	4
	Hard basaltic hard core g / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.99 day	1.33 day	2
	b) UnderFooting Pad g / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.099 days	0.133 days	0.2
	Under ground floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.099 days	0.133 days	0.2
	Under grade beam / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.198 days	0.266 days	0.4
	Under Masonary wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.099 days	0.133 days	0.2
	In Footing Pad g / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.099 days	0.133 days	0.2
	In foundation column g / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.099 days	0.133 days	0.2
	In grade beams G / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.099 days	0.133 days	0.2
	In 100mm thick ground floor slabs / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.198 days	0.266 days	0.4

	To Footing Pad g / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.495 days	0.665 days	1
	to foundation column g / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.99 day	1.33 day	2
	to grade beams g / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	1.188 days	1.596 days	2.4
	a) Ø 6mm plain bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.198 days	0.266 days	0.4
	b) Ø 8mm deformed bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Road fence guard generator "))	0.198 days	0.266 days	0.4
Category: Time Risks: Sub structure (Blocks A, B, C)						
	Bulk excavations and Cartaway / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	19.8 days	26.6 days	40
	Fill between hard core & mat foundation with borrowed selected granular material / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	12.87 days	17.29 days	26
	Fill between hard core & mat foundation with excavaed material / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	12.87 days	17.29 days	26
	Cart away surplus excavated materials / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	29.7 days	39.9 days	60
	Hard basaltic hard core / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	13.86 days	18.62 days	28
	Fill on top of mat beam with 10mm thick gravel pack . / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	2.97 days	3.99 days	6
	a) Under footing / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	2.97 days	3.99 days	6
	b) Under Mat foundation / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	1.98 days	2.66 days	4
	c) Under basement and ground floor slabs / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	0.99 day	1.33 day	2
	In foundation column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	0.99 day	1.33 day	2
	In 2nd basement floor elevation column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	3.96 days	5.32 days	8
	In 1st basement floor elevation column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	3.96 days	5.32 days	8
	In 200mm thick lift cores & RC partition wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	10.89 days	14.63 days	22
	In 300mm thick shear wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	0.99 day	1.33 day	2
	In retaining walls / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	3.96 days	5.32 days	8
	In footing Pad / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	0.99 day	1.33 day	2
	In mat foundation / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	3.96 days	5.32 days	8
	In mat beam / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	1.98 days	2.66 days	4
	In 150mm thick 2nd basement & ground floor slabs / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	3.96 days	5.32 days	8

	In staircase / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	0.495 days	0.665 days	1
	In 100mm thick Steps / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	0.495 days	0.665 days	1
	In 1st basement & ground floor beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	1.98 days	2.66 days	4
	In ground floor beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	1.98 days	2.66 days	4
	In 150mm thick suspended 1st basement floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	1.98 days	2.66 days	4
	In 200mm thick suspended 1st basement floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	0.99 day	1.33 day	2
	In 150mm thick suspended ground floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	1.98 days	2.66 days	4
	In 200mm thick suspended ground floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	0.99 day	1.33 day	2
	to footing pad / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	0.99 day	1.33 day	2
	to mat foundation / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	2.475 days	3.325 days	5
	to foundation column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	2.97 days	3.99 days	6
	to 1st & 2nd basement floor elevation columns / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	9.9 days	13.3 days	20
	to suspended Basement & Ground floor slabs / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	24.75 days	33.25 days	50
	to basement floor beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	10.89 days	14.63 days	22
	to mat beam / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	19.8 days	26.6 days	40
	to retaining wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	21.78 days	29.26 days	44
	to lift house core, RC wall & shear wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	17.82 days	23.94 days	36
	to staircase / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	5.94 days	7.98 days	12
	to side of ramp / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	1.485 days	1.995 days	3
	to Ground floor beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	4.95 days	6.65 days	10
	under basement floor slabs / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	9.9 days	13.3 days	20
	to retaining walls / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	4.95 days	6.65 days	10
	to mat foundations... / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	4.95 days	6.65 days	10
	Supply & fix 200-250mm width water bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Sub structure abc"))	6.93 days	9.31 days	14
Category: Time Risks: Super Structure (Blocks A,B,C)						

3.1 50cm thick masonry foundation wall below GL / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	10.89 days	14.63 days	22
3.2 50cm thick stone masonry foundation wall above GL / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	3.96 days	5.32 days	8
3.3 60cm thick Brick wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	19.8 days	26.6 days	40
3.3 Two coats of plastering / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	19.8 days	26.6 days	40
3.3 Supply and fix 30x20mm rubber expedite / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	6.93 days	9.31 days	14
3.3 Supply & apply poly sulphide joint sealant / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
In Elevation column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	14.85 days	19.95 days	30
In lift shaft cores, CB, RC wall & Shear wall. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	9.9 days	13.3 days	20
In Floor & top tie Beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	13.86 days	18.62 days	28
In 150mm thick suspended floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	30.69 days	41.23 days	62
In 190mm thick suspended floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.97 days	3.99 days	6
In 200mm thick suspended floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	7.92 days	10.64 days	16
In 150mm thick roof slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.98 days	2.66 days	4
In 200mm thick roof slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
In stair case & landing / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	7.92 days	10.64 days	16
In RC gutter / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
In Vertical mullions / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.98 days	2.66 days	4
To Floor & Top tie Beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	87.12 days	117.04 days	176
To Elevation Column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	37.62 days	50.54 days	76
To suspended floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	94.05 days	126.35 days	190
To roof slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
To stair case & landing / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	15.84 days	21.28 days	32
To steps / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
To RC gutter / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	7.92 days	10.64 days	16

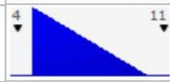
	To Vertical mullions / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	9.9 days	13.3 days	20
	To lift shaft & shear wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	72.27 days	97.09 days	146
	To all internal wall surfaces / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	89.1 days	119.7 days	180
	To RC wall, exposed beams and columns. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	77.22 days	103.74 days	156
	To R.C. ceiling & stair case soffit & sides. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	74.25 days	99.75 days	150
	To receive ceramic wall tile. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	19.8 days	26.6 days	40
	To receive Marble wall tile to external wall surface. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	49.5 days	66.5 days	100
	A. Trade of size (30x200cm) 96pcs / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	10.89 days	14.63 days	22
	B. Riser of size (16x200cm) 96 pcs / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	10.89 days	14.63 days	22
	Marble tile flooring / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	20.79 days	27.93 days	42
	Marble Skirting / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	9.9 days	13.3 days	20
	Marble Copping / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	Marble Walling / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	29.7 days	39.9 days	60
	Porcelain floor tiles / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	79.2 days	106.4 days	160
	Porcelain Skirting / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	27.72 days	37.24 days	56
	Cement Screed / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.98 days	2.66 days	4
	Cement Tile Skirting / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.97 days	3.99 days	6
	Ceramic Wall tile / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	19.8 days	26.6 days	40
	Marble Window Cill / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	Marble Treshold / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	7.92 days	10.64 days	16
	Supply and fix Armstrong or equivalent ceiling / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	8.91 days	11.97 days	18
	Skid proof porcelain tile flooring / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	6.93 days	9.31 days	14
	Curved aluminum frame with aluminum sky light / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	10mm thick Heavy Duty Gres (porcelain) tile flooring / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	30.69 days	41.23 days	62

100mm thick broom finished concrete pavement / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.98 days	2.66 days	4
To all internal wall surfaces2 / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	19.8 days	26.6 days	40
To RC wall, exposed beams and columns2 / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	19.8 days	26.6 days	40
To R.C. ceiling & stair case soffit & sides.2 / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	24.75 days	33.25 days	50
Bulk excavations and Cartaway B. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	29.7 days	39.9 days	60
Fill between hard core & mat foundation with borrowed selected granular material / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	12.87 days	17.29 days	26
Fill between hard core & mat foundation with excavaed material / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	12.87 days	17.29 days	26
Cart away surplus excavated materials / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	29.7 days	39.9 days	60
Hard basaltic hard core / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	13.86 days	18.62 days	28
Fill on top of mat beam with 10mm thick gravel pack . / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.97 days	3.99 days	6
b) Under Mat foundation B. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.98 days	2.66 days	4
c) Under basement and ground floor slabs / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
In foundation column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
In 2nd basement floor elevation column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.97 days	3.99 days	6
In 1st basement floor elevation column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.97 days	3.99 days	6
In retaining walls / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
In mat foundation B. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	3.96 days	5.32 days	8
In mat beam / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.98 days	2.66 days	4
In 150mm thick 2nd basement & ground floor slabs / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.97 days	3.99 days	6
In 100mm thick Steps / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.495 days	0.665 days	1
In 1st basement & ground floor beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.485 days	1.995 days	3
In ground floor beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.485 days	1.995 days	3
In 150mm thick suspended 1st basement floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.97 days	3.99 days	6
In 200mm thick suspended 1st basement floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.495 days	0.665 days	1

	In 150mm thick suspended ground floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.97 days	3.99 days	6
	In 200mm thick suspended ground floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.495 days	0.665 days	1
	to mat foundation / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	to foundation column B / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.485 days	1.995 days	3
	to 1st & 2nd basement floor elevation columns / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	14.85 days	19.95 days	30
	to suspended Basement & Ground floor slabs / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	19.8 days	26.6 days	40
	to basement floor beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	8.91 days	11.97 days	18
	to mat beam / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	22.77 days	30.59 days	46
	to retaining wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	29.7 days	39.9 days	60
	to side of steps / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	to Ground floor beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	6.93 days	9.31 days	14
	under basement floor slabs / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	12.87 days	17.29 days	26
	to retaining walls / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	6.93 days	9.31 days	14
	3.3 60cm thick Brick wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	25.74 days	34.58 days	52
	3.3 Two coats of plastering / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	25.74 days	34.58 days	52
	3.3 Supply and fix 30x20mm rubber expedite / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	8.91 days	11.97 days	18
	Supply & fix 200-250mm width water bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	8.91 days	11.97 days	18
	3.3 Supply & apply poly sulphide joint sealant / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	6.93 days	9.31 days	14
	In Elevation column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	7.92 days	10.64 days	16
	In Floor & top tie Beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	7.92 days	10.64 days	16
	In 150mm thick suspended floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	15.84 days	21.28 days	32
	In 200mm thick suspended floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	In 200mm thick roof slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.495 days	0.665 days	1
	In RC gutter / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.495 days	0.665 days	1

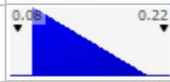
	To Floor & Top tie Beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	45.54 days	61.18 days	92
	To Elevation Column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	21.78 days	29.26 days	44
	To suspended floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	54.45 days	73.15 days	110
	To roof slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.97 days	3.99 days	6
	To RC gutter / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	To all internal wall surfaces B / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	54.45 days	73.15 days	110
	To RC wall, exposed beams and columns. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	55.44 days	74.48 days	112
	To R.C. ceiling & stair case soffit & sides. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	46.53 days	62.51 days	94
	To receive ceramic wall tile B / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	14.85 days	19.95 days	30
	To receive Clinker wall tile to external wall surface. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	41.58 days	55.86 days	84
	10mm thick Clinker wall tile / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	39.6 days	53.2 days	80
	200x300x6mm vitrified glazed ceramic wall tile / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	30 x 280mm white throated marble window cill / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	Parquet flooring / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	5.94 days	7.98 days	12
	Wood Skirting / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	Marble Copping / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.98 days	2.66 days	4
	Porcelain floor tiles / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	117.81 days	158.27 days	238
	Porcelain Skirtings / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	35.64 days	47.88 days	72
	Marble Treshold / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	3.96 days	5.32 days	8
	Supply and fix Armstrong or equivalent ceiling / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	15.84 days	21.28 days	32
	Skid proof porcelain tile flooring / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	10.89 days	14.63 days	22
	10mm thick Heavy Duty Gres (porcelain) tile flooring / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	28.71 days	38.57 days	58
	To all internal wall surfaces2 / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	14.85 days	19.95 days	30
	To RC wall, exposed beams and columns2 / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	14.85 days	19.95 days	30

	To R.C. ceiling & stair case soffit & sides.2 / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	15.84 days	21.28 days	32
	Bulk and Pit excavations and Cartaway c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	14.85 days	19.95 days	30
	Fill under hard core / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	5.94 days	7.98 days	12
	Fill around foundation / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	5.94 days	7.98 days	12
	Cart away surplus excavated materials / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	14.85 days	19.95 days	30
	Hard basaltic hard core c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	7.92 days	10.64 days	16
	b) UnderFooting Pad C. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.495 days	0.665 days	1
	c) Under retaining wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.495 days	0.665 days	1
	Under basement and ground floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.485 days	1.995 days	3
	Under grade beam / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.2475 days	0.3325 days	0.5
	Under Masonary wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.2475 days	0.3325 days	0.5
	In Footing Pad C / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.1483 days	2.8861 days	4.34
	In foundation column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	In retaining walls and bases / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	In basement floor elevation column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.495 days	0.665 days	1
	In 100mm thick basement floor slabs / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	In basement floor beams c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.98 days	2.66 days	4
	In Stair Cases / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.495 days	0.665 days	1
	In ground floor beams c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	In 160mm thick suspended ground floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.97 days	3.99 days	6
	To Footing Pad C / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	to foundation column c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	3.96 days	5.32 days	8
	to retaining walls and bases / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	11.88 days	15.96 days	24
	to basement floor elevation column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	3.96 days	5.32 days	8

	to basement floor beams c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	to Stair Cases / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.97 days	3.99 days	6
	to ground floor beams c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	to 160mm thick suspended ground floor slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	11.88 days	15.96 days	24
	50cm thick masonry foundation wall below GL c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	13.86 days	18.62 days	28
	50cm thick stone masonry foundation wall above GL / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	8.91 days	11.97 days	18
	Verical sufaces of coulomns and beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	under basement floor slabs c2 / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	8.91 days	11.97 days	18
	to retaining walls / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	60cm thick Brick wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	8.91 days	11.97 days	18
	Two coats of plastering c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	8.91 days	11.97 days	18
	Dia 160 perforated UPVC pipe PN-4 / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	Supply and fix 30x20mm rubber expedite / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	6.435 days	8.645 days	13
	Supply & fix 200-250mm width water bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	6.435 days	8.645 days	13
	3.3 Supply & apply poly sulphide joint sealant / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	In Elevation column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.485 days	1.995 days	3
	In top tie Beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.485 days	1.995 days	3
	In 150mm thick roof slab / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	In 100mm thick Parapet / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	To Top tie Beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	To Elevation Column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.97 days	3.99 days	6
	To Prapet / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	3.96 days	5.32 days	8
	To roof slab c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	3.96 days	5.32 days	8
	To all internal wall surfaces c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	16.83 days	22.61 days	34

	To RC wall, exposed beams and columns c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	14.85 days	19.95 days	30
	To R.C. ceiling & stair case soffit & sides. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	12.87 days	17.29 days	26
	To receive ceramic wall tile c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	3.96 days	5.32 days	8
	To receive Clinker wall tile to external wall surface c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	12.87 days	17.29 days	26
	A. Trade of size (30x200cm) 96pcs / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.455 days	5.985 days	9
	B. Riser of size (16x200cm) 96 pcs / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.455 days	5.985 days	9
	Marble flooring / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	10.89 days	14.63 days	22
	Marble Skirting / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	Marble Copping / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	Porcelain floor tiles / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	65.34 days	87.78 days	132
	Porcelain Skirtings / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	26.73 days	35.91 days	54
	Marble Cills / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	Marble Treshold c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.98 days	2.66 days	4
	Supply and fix Armstrong or equivalent ceiling / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	23.76 days	31.92 days	48
	Ceramic wall tiles / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	16.83 days	22.61 days	34
	Cliker Wall tiles / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	13.86 days	18.62 days	28
	6 mm deformed bar. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	8 mm deformed bar. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	3.96 days	5.32 days	8
	10 mm deformed bar. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	9.9 days	13.3 days	20
	12 mm deformed bar. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	11.88 days	15.96 days	24
	16 mm deformed bar. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	6.93 days	9.31 days	14
	50cm thick masonry foundation wall below GL f / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	63.36 days	85.12 days	128
	50cm thick stone masonry foundation wall above GL / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	53.46 days	71.82 days	108
	20cm thick H.C.B wall / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	6.93 days	9.31 days	14

	2.2 50cm thick dressed stone above ground / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	33.66 days	45.22 days	68
	c) Ø 10mm deformed bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.495 days	0.665 days	1
	d) Ø 12mm deformed bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.495 days	0.665 days	1
	To Top tie Beams / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.584 days	2.128 days	3.2
	To Elevation Column / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.584 days	2.128 days	3.2
	To Prapet / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.485 days	1.995 days	3
	To roof slab c / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	a) Ø 6mm plain bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.099 days	0.133 days	0.2
	b) Ø 8mm deformed bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.099 days	0.133 days	0.2
	c) Ø 10mm deformed bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.099 days	0.133 days	0.2
	d) Ø 12mm deformed bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.198 days	0.266 days	0.4
	e) Ø 14mm deformed bar / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.198 days	0.266 days	0.4
	2.1 20cm thick H.C.B wall g / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.455 days	5.985 days	9
	Dressed Stone / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	Average 50mm thick mass concrete / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.099 days	0.133 days	0.2
	Average 30mm thick smooth finished cement sand screed / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	Supply and lay 4mm thick water proofing material g / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	Windows (Top and Normal) g / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.485 days	1.995 days	3
	Doors / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	To all internal wall surfaces g / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.455 days	5.985 days	9
	To RC wall, exposed beams and columns g / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.376 days	3.192 days	4.8
	To R.C. ceiling & stair case soffit & sides. / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.485 days	1.995 days	3
	Pointings / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	Cement screed g / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.188 days	1.596 days	2.4

	window cill / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.495 days	0.665 days	1
	4mm thick clear sheet glass / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.099 days	0.133 days	0.2
	To all internal wall surfaces2 / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.099 days	0.133 days	0.2
	To RC wall, exposed beams and columns2 / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.099 days	0.133 days	0.2
	To R.C. ceiling & stair case soffit & sides.2 / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.099 days	0.133 days	0.2
	i) 0m up to 1.5m / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	3.96 days	5.32 days	8
	Extra over sub item 32.01(a) for excavation in rock irrespective of depth / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.97 days	3.99 days	6
	φ500mm R.C.Pipe on Class 'B' Bedding / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	20.79 days	27.93 days	42
	(17 x 40)cm Concrete Kerb / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	4.95 days	6.65 days	10
	(20 x 25)cm Concrete Kerb / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	12.87 days	17.29 days	26
	Manholes / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	9.9 days	13.3 days	20
	Manhole Covers / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.98 days	2.66 days	4
	i) Compacted to 93% of modified AASHTO density / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	6.93 days	9.31 days	14
	Extra over item 42.01 for excavating and breaking in common (normal) excavation to fill / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.485 days	1.995 days	3
	Extra over item 42.01 for excavating and breaking in rock (hard) excavation to fill / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	2.97 days	3.99 days	6
	material obtained from common (normal)excavation / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	5.445 days	7.315 days	11
	Gravel Sub base Material / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.485 days	1.995 days	3
	Crushed stone Base Course / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.485 days	1.995 days	3
	Prime Coot, MC-30, Cutback Bitumen (1 Lit/m2) / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	0.99 day	1.33 day	2
	Asphalt Concrete Surfacing (50mm) / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.98 days	2.66 days	4
	Road Marking White (10cm) / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	1.98 days	2.66 days	4
	Non Slippery Concrete tiles, (0.4x0.4*5cm thick) On Cement stabilized base / Duration		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	11.88 days	15.96 days	24
	Generator House		RiskVary(ProjectFieldVal,-1,100,0,5,"Triang",RiskCategory("Super time abc"))	59.4 days	79.8 days	120