An-Najah National University
Faculty of Engineering and Information Technology

جامعة النجاح الوطنية
كلية الهندسة و تكنولوجيا المعلومات

Graduation Project Report II

{Assessment of Al-Manara Mall}
{Quantity Surveying and Cost Estimate}

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Submitted in partial fulfillment of the requirements for Bachelor degree in Civil Engineering

Fall / Spring 2019

بسم الله الرحمن الرحيم

بدانا بأكثر من يد وقاسينا أكثر من هم وعانينا الكثير من الصعوبات وهانحن اليوم والحمد لله نطوي سهر الليالي وتعب الإيام وخلاصة مشوارنا بين دفتي هذا العمل المتواضع.

نحمد الله العليم الحكيم الذي علمنا من علمه مالم نعلم وفضل علينا بنعمة العقل و الدين, القائل في محكم التنزيل **"وَفَوْقَ كُلِّ ذِي عِلْمٍ عليم"**

نهدي انجازنا هذا الى منارة العلم والامام المصطفي إلى الأمي الذي علم التعلمين إلى سيد الخلق إلى رسولنا الكريم سيدنا محمد صلى الله عليه وسلم.

إلى الينبوع الذي لا يمل العطاء إلى من حاكت سعادتي بخيوط منسوجة من قلبها إلى والدتي العزيزة..

إلى من سعى وشقى لأنعم بالراحة والهناء الذي لم يبخل بشئ من أجل دفعي في طريق النجاح الذي علمني أن أرتقي سلم الحياة بحكمة وصبر إلى والدي العزيز

إلى من حبهم يجري في عروقي ويلهج بذكراهم فؤادي إلى أخواتي وأخواني

إلى من سرنا سوياً ونحن نشق الطريق معاً نحو النجاح والإبداع إلى من تكا تفنا يداً بيد ونحن نقطف زهرة وتعلمنا إلى اصدقائي وزملائي

إلى من علمونا حروفا من ذهب وكلمات من درر وعبارات من أسمى وأجلى عبارات في العلم إلى من صاغوالنا علمهم حروفا ومن فكرهم منارة تنير لنا سيرة العلم والنجاح إلى أساتذتنا الكرام.

ACKNOWLEGEMENT

All thanks to almighty Allah who facilitate us to accomplish this project and gave us a strength to overcome the difficulties we faced.

We would like to extent our profound thanks to our dear teachers in the civil engineering department who provided us with valuable references during the project, and never scared us by any of their huge knowledge and science.

Our deepest gratitude to our supervisor Mrs. Reema Nassar for her unwavering support, mentorship and for her constructive comments and suggestions that have been effective throughout this project, she paved the road for us.

We wish also to thank our parents who always provided us with full support as well as our friends as they stood by our side.

DISCLAIMER

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ABSTRACT:

Construction is one of the most important economic sectors in the world and it plays a major role in the development of any nation; for many centuries, it was considered one of the major indicators for measuring the economic growth of countries.

The construction industry is different from other industries because of its unique characteristics, which include the construction process, project management methods, working environment and conditions and worker behaviors.

The construction sector is one of the key economic sectors and is the main force motivating the Palestinian national economy. The construction sector has occupied a very important position relative to the rest of the economy, attracting investments and creating new jobs.

AL-Manara project is massive mall with multiple services, which covers management functions of projects and how-to breakdown the structure to small activates, so it was necessary to work time table of the project schedule and estimating cost by using Primavera P6 project.

This project is about the Assessment of AL-Manara in Ramallah city, which is under construction in this year, this assessment will include:

- Studying the construction documents of the project,
- Prepare a work breakdown structure for the project,
- Estimate the time schedule for the project using Primavera P6 project,
- Conduct systematic quantity survey for the project,
- Estimate the detailed cost for the project

The main target of this report is to make sure the possibility of solving any problems that might face the contractor within fulfillment the project. In addition, we have to make sure that the project committed to the estimated cost, quality and scheduled time.

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CHAPTER ONE

INTRODUCTION

CHAPTER ONE: INTRODUCTION

1.1 Palestinian economy

As the political situation worsened in recent years and external and internal shocks increased, there was a clear impact and direct repercussions on the Palestinian economy.

By taking a quick look at the current situation of the Palestinian economy, it is clear to the individual that this economy is one of the world's weakest and most unstable economies, despite the existence of the natural resources, factors and production factors of Palestinian society.

The Palestinian economy is classified by the World Bank as "the lowest segment of middle-income countries". The reasons for the weakness and instability of the Palestinian economy are attributed to several main reasons, including political and security, including economic ones.

1.2 Construction in Palestine

Construction is one of the most important economic sectors in the world and it plays a major role in the development of any nation; for many centuries, it was considered one of the major indicators for measuring the economic growth of countries (Alzahrani and Emsley, 2013).

The construction industry is different from other industries because of its unique characteristics, which include the construction process, project management methods, working environment and conditions and worker behaviors (Fang and Wu, 2013).

The construction sector is one of the key economic sectors and is the main force motivating the Palestinian national economy. Upon the establishment of the Palestinian National Authority (PNA) and the assumption of its power over the Palestinian territories in 1994, the construction sector has witnessed noticeable expansion and activities. This has resulted in the recovery of the construction contracting profession and subsidiary industries, encouraged the investment of Palestinian expatriates in the local construction sector and contributed to the creation of jobs for thousands of Palestinians. Therefore, the construction sector has occupied a very important position relative to the rest of the economy, attracting investments and creating new jobs (Palestinian Contractors Union (PCU), 2003/1). The Palestinian Central Bureau of Statistics (PCBS) shows that the construction sector contribution to the Palestinian GDP has increased since the PNA establishment to reach 11.1% of the Palestinian GDP in 2010. This is a large

proportion that positively affect various other economic, social, educational and vocational sectors and Palestinian institutions (PCBS, 2011/1)

Unemployment in all regions of the world is a time bomb that threatens economic and social stability. In Palestine According to a report issued by the Palestinian Statistics Center.

The unemployment rate in the West Bank and Gaza Strip reached about 27% by the end of last year. The Palestinian Unemployment Rate among the individuals participating in the labor force reached 338 thousand unemployed, 24% for males and 38% for females. The number of unemployed in the West Bank reached 143 thousand unemployed, About 18%, while the number of 195 thousand unemployed in the Gaza Strip by about 44% of the workforce. It should be noted here that the labor force in Palestine reached the end of 2017 about 618 thousand workers, 331 thousand workers in the West Bank, 188 thousand workers in the Gaza Strip, 78 thousand workers working in the areas of Israel, and 21 thousand working in the settlements, In agriculture. In this context, it is worth mentioning that the public sector is the most active sector for workers in the Gaza Strip at 55% compared to 45% of wage earners working in the private sector.

CHAPTER TWO

PROJECT MANAGEMENT

CHAPTER TWO: PROJECT MANAGEMENT

2.1 The Project

a project is an assignment/task/job that has to be undertaken and completed within a set time, budget, recourses and performance specifications designed to meet the needs of stakeholder and beneficiaries

2.2 Project Management

2.2.1 Introduction

“Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements. It has always been practiced informally but began to emerge as a distinct profession in the mid-20th century.” (Client et al., n.d.)

PMI’s a Guide to the Project Management Body Of Knowledge (PMBOK® Guide) identifies its recurring elements:

Project management processes fall into five groups:

- Initiating
- Planning
- Executing
- Monitoring and Controlling
- Closing
- Project management knowledge draws on ten areas:
- Integration
- Scope
- Time
- Cost
- Quality
- Procurement
- Human resources
- Communications

- Risk management
- Stakeholder management

All management is concerned with these, but project management brings a unique focus shaped by the goals, resources and schedule of each project. The value of that focus is proved by the rapid, worldwide growth of project management.

- Plan should consider all of these before starting
- Manager needs to track them during project

2.2.2 Function of management

According to Henry Fayol, “To manage is to forecast and plan, to organize, to command & to control”. (Henry Fayol,1916)

Whereas Luther Gulick has given a keyword ’POSDCORB’ where P stands for Planning, O for Organizing, S for Staffing, D for Directing, Co for Co-ordination, R for reporting & B for Budgeting. But the most widely accepted are functions of management given by Koontz and O’Donnell i.e. Planning, Organizing, Staffing, Directing and Controlling.

Planning

Is the basic function of management, it deals with chalking out a future course of action & deciding in advance the most appropriate course of actions for achievement of pre-determined goals. Thus, planning is a systematic thinking about ways & means for accomplishment of pre-determined goals. A plan is a future course of actions. It is an exercise in problem solving & decision making. It is necessary to ensure proper utilization of human & non-human resources also it is an intellectual activity helps in avoiding confusion, uncertainties, risks, wastages etc.

Organizing

Is the process of bringing together physical, financial and human resources and developing productive relationship amongst them for achievement of organizational goals?

Organizing as a process involves:

- Identification of activities.
- Classification of grouping of activities.
- Assignment of duties.

- Delegation of authority and creation of responsibility.
- Coordinating authority and responsibility relationships

- *Staffing*

It is the function of manning the organization structure and keeping it manned. Staffing has assumed greater importance in the recent years due to advancement of technology, increase in size of business, complexity of human behavior etc. The main purpose of staffing is to put right man on right job i.e. square pegs in square holes and round pegs in round holes.

- *Directing*

Is that part of managerial function which actuates the organizational methods to work efficiently for achievement of organizational purposes? It is considered life-spark of the enterprise which sets it in motion the action of people because planning, organizing and staffing are the mere preparations for doing the work. Direction is that inert-personnel aspect of management which deals directly with influencing, guiding, supervising, motivating sub-ordinate for the achievement of organizational goals.

- *Controlling*

It implies measurement of accomplishment against the standards and correction of deviation if any to ensure achievement of organizational goals. The purpose of controlling is to ensure that everything occurs in conformities with the standards. An efficient system of control helps to predict deviations before they actually occur.

Since the construction industries are becoming larger and more complex, managing their contracts is the main root of their success. Engineering Management is a specialized form of management that is required to successfully lead engineering or technical personnel and projects.

“Engineering project management provides a clear description of the aims of project management, based on best practice, and discusses the theory and practice in relation to multi-disciplinary engineering projects, both large and small. It is also the application of the practice of management to the practice of engineering.” (Thomsett, 2010)

It is a term that can be used to describe either functional management or project management, so it is a career that brings together the technological problem-solving savvy of engineering

and the organizational, administrative, and planning abilities of management in order to oversee the operational performance of complex engineering driven enterprises.

Engineering managers typically require training and experience in both general management and the specific engineering disciplines that will be used by the engineering team to be managed.

The successful engineering manager must have the skills necessary to coach, mentor and motivate technical professionals; skills which are often very different from those required the effectively manage individuals in other fields.

2.3 Key Participant

2.3.1 Owner

The project owner is typically, but not always, the head of the business unit receiving the product, and bears business responsibility for successful project implementation. The project owner may often act as a "champion" to the project, in partnership with the sponsor. The project owner will assist the project manager in providing leadership towards the completion of project tasks, and may sometimes even maintain a portion of the project plan.

2.3.1.1 Define the Project Owner Should Be

- Enthusiastic about the project, the value, and the final deliverable(s)
- Able to articulate the project's value, and in a position to encourage buy in with stakeholders
- Is directly impacted by the results of the project

2.3.1.2 Owner Responsibilities

- Assists the PM in providing leadership for, and managing the team's performance of project activities
- Actively encourages buy in from project stakeholders

2.3.2 Contractor

The general contractor is a manager and possibly a tradesman that is employed by the client on the advice of the architect, engineer or the client him/herself if acting as the manager. A general

contractor is responsible for the overall coordination of a project. A general contractor must first assess the project-specific documents (referred to as bid, proposal or tender documents). In the case of renovations, a site visit is required to get a better understanding of the project. Depending on the project delivery method, the contractor will submit a fixed price proposal or bid, cost plus price or an estimate. The general contractor considers the cost of home office overhead, general conditions, materials, and equipment as well as the cost of labor to provide the owner with a price for the project.

Contract documents include drawings, project manual (including general, supplementary or special conditions and specifications), addendum or modifications issued prior to proposal/ bidding ad prepared by a design professional such as an architect. The general contractor may be the construction manager or construction manager at high risk.

A general contractor is responsible for providing all of the material, labor, equipment (such as engineering vehicles and tools) and services necessary for the construction of the project. The general contractor hires specialized subcontractors to perform all or portions of the construction work.

The General Contractor is also responsible for the quality of all work performed by any and all subcontractors. The General Contractor's number one priority is safety on the jobsite.

Responsibilities may include applying for building permits, advising the person they are hired by, securing the property, providing temporary utilities on site, managing personnel on site, providing site surveying and engineering, disposing or recycling of construction waste, monitoring schedules, and cash flows, and maintaining accurate records

2.3.3 Consultant

A construction consultant is someone who is hired to assess and advise on structural issues. These consultants are experts in construction, with a degree in engineering or a related field. They usually have several years of experience in construction and are familiar with all aspects of the construction trade. Most work for consulting firms, but they may also work for legal firms, government agencies, or as individual contractors.

Construction consultants do many different things. Some assist companies with administration tasks; they make sure everything is running smoothly, and on time, so that the site owner and managers can concentrate on other business matters. A construction consultant may be hired

to keep a project running on budget and handle any problems that may appear. This may also mean working as an in-between for the owner of the site and the construction crew.

2.4 Delivery System

“Project delivery systems refer to the overall processes by which a project is designed, constructed, and/or maintained. In the public sector, this has traditionally entailed the almost exclusive use of the design-bid build system, involving the separation of design and construction services and sequential performance of design and construction. In recent years, however, the public sector has begun experimenting with alternative methods to improve the speed and efficiency of the project delivery process. These alternative systems move closer to the integrated services approach to project delivery favored in the private sector. To illustrate this concept, the innovative delivery systems have been arranged below on a continuum, with the traditional design-bid-build approach appearing on the left and the more innovative systems arranged from left to right according to increasing similarity to the private sector model in terms of greater responsibility and risk shifted to the constructor, and less separation between design and construction services.” (Trauner Consulting Services, 2007)

2.4.1 Design-Bid-Build

Design-Bid-Build (DBB), or design then bid then build, is the traditional delivery system for the public sector, in which an agency will use in-house staff (or, alternatively, use consultants) to prepare fully completed plans and specifications that are then incorporated into a bid package. Contractors competitively bid the project based on these completed plans and specifications. The agency evaluates the bids received, awards the contract to the lowest responsible and responsive bidder, uses prescriptive or method specifications for construction, and retains significant responsibility for quality, cost, and time performance.

Advantages

- Applicable to a wide range of projects
- Well established and easily understood
- Clearly defined roles for all parties
- Provides the lowest initial price that responsible, competitive bidders can offer
- Extensive litigation has resulted in well-established legal precedents

- No legal barriers in procurement and licensing
- Insurance and bonding are well defined
- Discourages favoritism in spending public funds while stimulating competition in the private sector
- As construction features are typically fully specified, DBB provides agencies with significant control over the end product (however, this may come at the expense of increased agency inspection efforts)

Disadvantages

- Tends to yield base level quality
- Least-cost approach requires higher level of inspection by the agency
- Initial low bid might not result in ultimate lowest cost or final best value
- Designers may have limited knowledge of the true cost and scheduling ramifications of design decisions
- Lack of input from the construction industry during the design stage exposes the agency to claims related to design and constructability issues
- Tends to create an adversarial relationship among the contracting parties, rather than foster a cooperative atmosphere in which issues can be resolved efficiently and effectively
- Agency bears design adequacy risk
- No built-in incentives for contractors to provide enhanced performance (cost, time, quality, or combination thereof)
- Greatest potential for cost/time growth (in comparison to other delivery methods) • Often prone to adversarial positions that lead to disputes and claims

2.4.2 Design Build

Design-build is a project delivery system involving a single contract between the project owner and a design-build contractor covering both the design and construction of a project. The design-builder performs design, construction engineering, and construction according to design parameters, performance criteria, and other requirements established by the agency.

Advantages

- Single point responsibility for design and construction
- Accelerated project delivery by: - Fast-tracking design and construction - Close coordination between designer and contractor - Early contractor involvement to enhance constructability of plans
- Cost containment by minimizing owner's exposure to design errors and omissions
- Earlier schedule and cost certainty
- Innovation and quality improvements through: - Alternative designs and construction methods suited to the contractor's capabilities - Flexibility in the selection of design, materials, and construction methods
- Disadvantages
- Reduced opportunities for smaller, local construction firms
- Fewer competitors and increased risk may result in higher initial costs
- Elimination of traditional checks and balances. Designer is no longer agency's advocate. Quality may be subordinated by cost or schedule considerations.
- Less agency control over final design
- Higher procurement costs
- Traditional funding may not support fast-tracking construction or may require accelerated cash flow.
- Accelerated construction can potentially overextend the workforce.

2.5 Construction Contract

2.5.1 Introduction

Contracts documents are very important pieces of information that make a binding obligation between two or more parties, thus being evidence that a contract exists. These contracts documents usually take the form of an agreement, some general conditions, drawings, specifications, all sufficient to show the extent and nature of the contract they represent. These documents are used by architects, engineers and contractors to convey technical and legal messages and ideas to various parties to the contract. Due to these reasons, it is desirable that a uniform approach to the production and interpretation of contract documents be fostered throughout the construction industry. (Gofhamodimo, 1999)

2.5.2 Type of Contract

The types of contracts most often encountered on construction projects are identified as follows:

- Lump-sum contract
- Unit-rate contract
- Cost-plus-fee contract

2.5.2.1 Lump-Sum Contract

This is a very common method of contracting, where the contractor undertakes to complete the project for a lump sum according to the design prepared by an architect or engineer at the outset. For him to be able to do this, the information provided to him by the designer must be very accurate and essentially complete, subject only to explanatory details and limited provisional items. It is only logical that the contractor in this kind of contract, should escalate his prices to be more than enough to cover all the expenses and perhaps the contingencies too. This could cover for the unforeseen circumstances and some profit as well. The contractor determines the probable cost by carefully doing the estimates. (Gofhamodimo, 1999)

Advantages of Lump Sum

The owner or client carries very little risk in this type of contract because she knows the probable cost of the project from the outset.

Disadvantages of Lump Sum

- It is relatively expensive and difficult to make changes in the project once the project is underway.
- The contractor does not have the input during the design stage where he can implement his knowledge and experience.
- The contractor may attempt to cut corners to save some money.
- The contractor carries the greater proportion of financial risk. He agrees to do his part of the bargain for the stated sum of money, no matter what problems may be encountered during the scope of the contract. The risk to the contractor is that, at the time of making an offer or bid, he can only estimate what anticipated costs will be. The

exact costs can only be known at the end of the project. If the agreed amount is less than the actual cost of the project, then the contractor suffers a loss.

2.5.2.2 Cost-Plus-Fee Contract

The cost-plus-fee contract is one of the methods of contracting which are suitable where it is intended that the design stage and the construction stage overlap. In its purest form it is based on the prime cost plus the fixed fee (or percentage) fee and has been used all over the world for many years. (Gofhamodimo, 1999)

Advantages of Cost-Plus-Fee-Contract

- The construction work can be started at a very much earlier stage than in the Lump sum and Unit rate contracts because complete drawings and specifications are not very necessary to get the job started.
- The arrangement is more flexible and allows variations as the work proceeds.
- The contractors' expertise can be put to use to assist with possible solutions to construction problems.
- Disadvantages of Cost-Plus-Fee-Contract
- The liabilities of several subcontractors responsible for overlapping delays can often lead to disputes and arbitration or litigation.
- the contractor may not try to be as efficient as he might be in the lump sum contract, because he knows that all costs are chargeable to the client.

- There is little opportunity to predict the probable costs that might arise in any given period while the job is underway.
- The contractor cannot always predict accurately what the margin or disposition of resources may be for the foreseeable future.

2.5.2.3 Unit-Price Contract

The unit price contract permits the contractor to make firm tenders for the projects in which the exact amount of work cannot be determined at the outset, and for which the client wishes to have a fairly accurate idea of what the final cost might be.

"There are always some parts of the building where the exact cost cannot be determined until the actual work is done. This particularly applies to the substructure, such as in excavations, foundations and drainage systems. These provisional items are re-measurable and will be remeasured at the end, therefore it is necessary to determine the unit price in advance, for doing such work as it arises in order to be able to adjust the contract sum to pay for the works. The very obvious reason for doing so, is that the foundation elevations and details which were assumed for design purposes cannot be possible in practice. The soil and ground conditions may have not been investigated first, but assumed to be normal, therefore if the soil and ground conditions turn to be different." (Gofhamodimo, 1999)

There are two main issues involved in the establishment of unit prices:

- Determination of basis of measurement of the works to be done. The quantities of works for which the prices will be applied must be capable of being accurately determined to everyone's satisfaction.
- The basis of payment must be clearly stated; everything that has to be included in the unit price must be clearly identified and described.

Advantages of Unit Price Contract

Ease of making changes in the amount of work to be done at the unit rate quoted. • The risk is fairly distributed amongst the parties the owner has good control over the amount of work to be done, the contractor has good control over the prices for which he is willing to do the work.

Disadvantages of Unit Price Contract

- Difficulty in precisely describing the work to be done, the method of measurement to be used to determine the actual quantities of work, and the basis of payment or extent of work included within each unit price.
- It could be costly for the client to produce the bill of quantities, especially if the project is of a complicated nature.

2.6 Risk Management

"Risk management is an important field of construction industry and has gained more importance internationally due to the latest researches carried out on a large scale. However, this relatively new field requires more attention to bring some benefit. Construction projects are facing a number of risks which have negative effects on project objects such as time, cost and quality." (ShahidIQBAL, 2014)

Risk analysis and management are an important part of the decision-making process in construction industry. Construction industry and its clients are widely associated with high degree of risks due to the nature of micro-, meso- and macro-environments particular to construction (Zavadskas et al. 2010a); however, construction industry has poor reputation in coping with risks as many projects fail to meet deadlines and cost targets (Shevchenko et al. 2008). Clients, contractors, the public and others have suffered as a result (Zavadskas et al. 2012, 2010b). Thus, construction business is related to high risk, which affects each of its participant; while effective analysis and management of construction associated risks remain a big challenge to practitioners of the industry (Kapliński 2009a).

"The analysis reveals that financial and economic factors, followed by quality, are the more is important risks, and the industry generally tries to avoid or transfer these risks (Choudhry, Iqbal 2013). As risk perception is an important aspect of risk management, the attitude toward and the barriers to risk management and the benefits perceived are prerequisites for the analysis and management of risks. Although numerous papers have been written on the subject of risk management, most of the surveys are conducted in the developed countries and little information exists on the perception of risk in developing countries" (Hameed, Woo 2007).

For effective management of risks, it is important how people in this industry perceive each risk. The main goal of this paper is to know the attitude of construction practitioners toward

different types of risk and respective responsibility. In addition, the paper presents the most effective techniques in preventing/mitigating different types of risk.

Risk management is a system which aims to identify and quantify all risks, to which a business or project is exposed, so that a conscious decision can be taken on how to manage the risks (Markmann et al. 2013). PMBOK lists risk management as one of nine focuses in project management and explains it as a systematic process of identifying, analyzing and responding to project risks. It includes maximization of the probability and consequences of positive events and minimization of the probability and consequences of events adverse to project objectives.

High importance of project selection in the project life cycle while solving bid/no-bid problems, especially in the construction industry, have been analyzed by Abbasianjahromi and Rajaie (2012). Risk can be analyzed with the help of the following methods: based on fuzzy TOPSIS bid/no-bid model (Ravanshadnia, Rajaie 2013); in fuzzy environment, applying TOPSIS-F method (Tamošaitienė et al. 2013); based on intelligent agents (Smeureanu et al. 2012); RAMCAP (Risk Analysis and Management for Critical Asset Protection) by introducing new parameters that affect risk value (Yazdani et al. 2011); and Fuzzy Synthetic Model (Abdul-Rahman et al. 2013). In terms of risk management, it is important to consider the following issues: – the origin of risk context; – identify and allocate processes (Li et al. 2013; Jaskowski, Sobotka 2012; Hanna et al. 2013); – analyze information (Zavadskas et al. 2010a, 2010b); – analyze the flexibility of results (Jaskowski, Sobotka 2012; Ustinovičius et al. 2010; Kapliński 2008); – risk assessment and evaluation (El-Sayegh 2007; Ke et al. 2012; Markmann et al. 2013; Skinner et al. 2014); – treatment; – function or process of risk (Zavadskas et al. 2010a; Kapliński 2009b, 2013); and – monitoring and communication of risks associated with any activity (Xianbo et al. 2014). All above-mentioned activity aims to minimize losses and maximize opportunities. Extensive literature is available on the importance of risk and its management. The exchange and interest rate risks should be undertaken by the owner (Jaskowski, Sobotka 2012; Hanna et al. 2013).

0/0/0/The risk assessment in construction projects has been applied differently from project to project, using various models of risk assessment to evaluate the risk in certain activities of the projects. Many researchers have proposed various types of risk assessment models for precise activities in the construction project assessment (Yafai et al. 2014). This study is aimed at highlighting the main risks that construction projects are facing and the risk management techniques used to manage these risks. It also describes the perception of professionals

regarding the significance of these risks and risk management techniques used for their management.

Risk priority is utilized during response planning and risk monitoring. It is critical to understand the priority for each risk as it allows the project team to properly understand the relative importance of each risk.

An effective risk management process encourages the construction company to identify and quantify risks and to consider risk containment and risk reduction policies. Construction companies that manage risk effectively and efficiently enjoy financial savings, and greater productivity, improved success rates of new projects and better decision making. Risk

management in the construction project management context is a comprehensive and systematic way of identifying, analyzing and responding to risks to achieve the project objectives. To management the risk effectively and efficiently, the contractor must understand risk responsibilities, risk event conditions, risk preference, and risk management capabilities.

CHAPTER THREE

QUANTITY SURVEY AND COST ESTIMATE

CHAPTER THREE: QUANTITY SURVEY AND COST ESTIMATE

3.1 Work Break Down Structure (WBS)

“Construction project planning is a method of determining “What” is going to be done, “How” things are going to be done, “Who” will be doing activities and “How much” activities will cost. In this sense planning does not cover scheduling, which addresses the “When”, but once planning is complete scheduling can be done.”) De Marco, 2011)

for the planning process Work Breakdown WBS (What), Structure OBS (Who) Organizational Breakdown Structure CBS (How Much), Cost Breakdown Structure SCHEDULING.

3.1.1 Work Breakdown Structure – “What"

When projects are simple, consisting of few defined activities, it might be possible for a single person to grasp the total construction effort with little difficulty. Unfortunately, most projects for which formal plans are prepared tend to be defined with dozens or even hundreds or thousands of activities the larger the project, the greater the number of activities and higher the level of detail managers have to handle.

When a project plan consists of numerous activities, it is often advisable to organize the activities in some way to allow communication of plan information to others and to maintain an understanding of the various aspects of the project. While there are many ways that a plan can be organized, one common practice is the Work Breakdown Structure (WBS).

“The WBS is a convenient method for decomposing the project complexity in a rational manner into work packages and elementary activities. Some firms prefer to use a standard means of identifying work packages common to all similar projects. These work packages are then coded so that both costs and the schedule can be controlled. A common numerical accounting system is then applied to the activities, so that the coding indicates factors such as the type of material involved or the physical location within the project.” (Rabner, 2012)

In essence, the WBS divides and subdivides a project into different components, whether by area, phase, function, or other considerations. The highest level in the WBS consists of a single element, the project. At the next level, there may be only a few elements or items. Naturally,

the further one goes down within the WBS, the greater the granularity of decomposition and the amount of detail. Regardless of the means used to define the elements, individual tasks are to be defined for the lowest level in the hierarchy or at the greatest level of detail that is required to adequately manage and control the construction process. The level of detail used will be determined by the scheduling needs and the roles of the people viewing the WBS.

Commonly there are three main types of WBS, namely, the Project WBS, Standard WBS and Contract WBS. The Project WBS is an operational tool usually prepared by contractors to monitor and control the work. A standard WBS is a breakdown structure of activities carried out in the past for a similar project: the past project WBS can that can be used as a template for the new one. Figure 3.1 shows the highest levels of a sample template WBS that might be used for turn-key construction of an ordinary industrial building.

"A contract WBS is agreed between owner and contractor. This is a decomposition of the scope of work into" the main elements that will be used for progress measurement, control and payment of the contract price. It may include less detail than a Project WBS. To summarize, WBS is a deliverable-oriented decomposition of the project scope (Project Management Institute 2008) until a sufficient level of granularity enables easy definition of all information required to execute and manage detailed tasks." (De Marco, 2011)

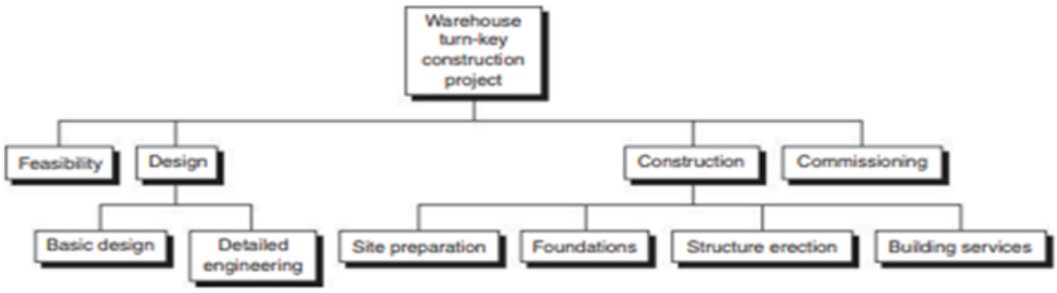

Figure 3.1 example of standard WBS for a warehouse construction project

3.1.2 Organizational Breakdown Structure – "Who"

Once what needs to be done is defined, it is necessary that all human resources required to perform the project are identified. Depending on the portions of work scope, the project may need engineering skills, procurement capabilities, construction labor, management staff, etc.

The Organization Breakdown Structure is a practical method to decompose the pool of human resources needed to execute all of the tasks into different competence areas and then into project roles, independently of the number of individuals that will be assigned the specified

role (Fig. 3.2). The OBS is prepared with the idea that each task in the WBS must be assigned to a role or committee of roles. In other words, roles are allocated to detailed tasks. with a specified number of resources and related estimated work load required to perform the task.

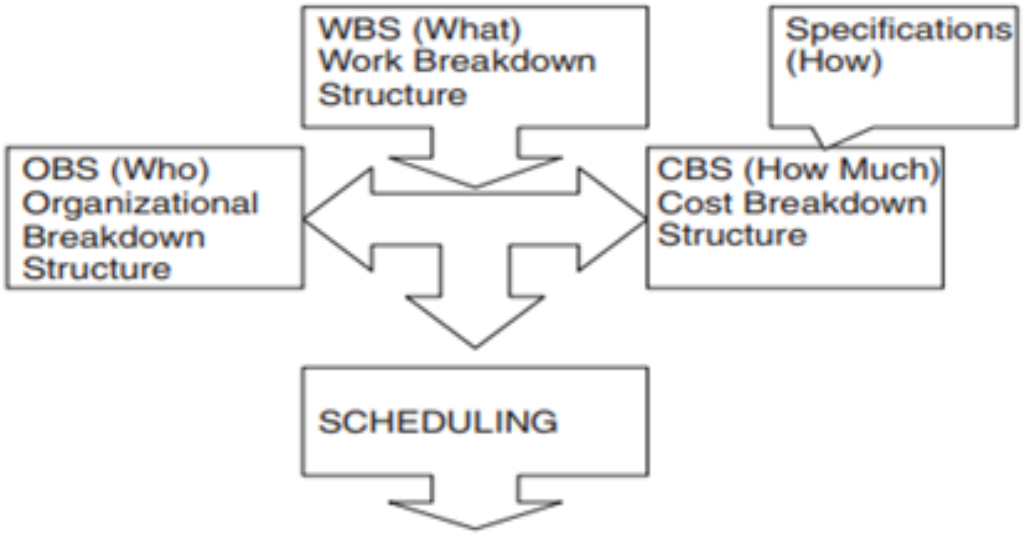

Figure 3.2General framework for the planning process

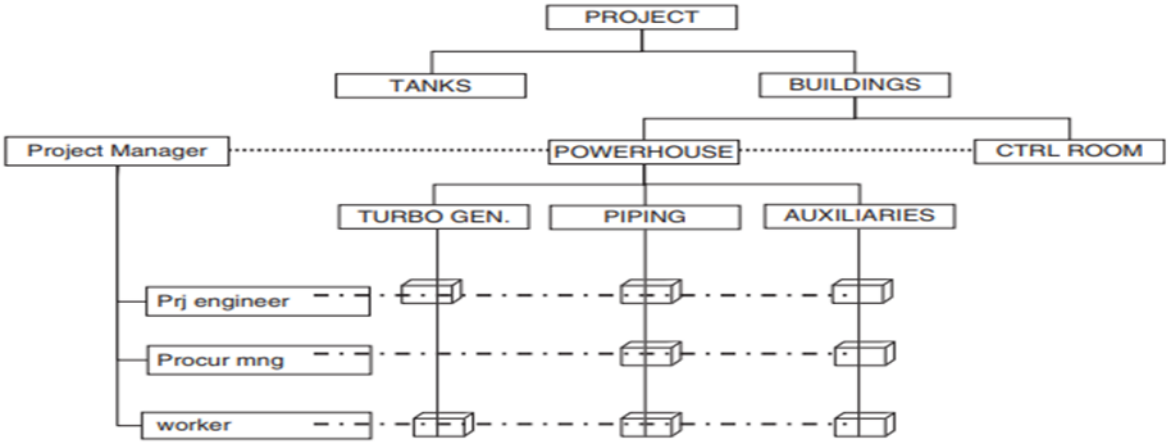

Figure 3.3Example of WBS/OBS allocation matrix for station construction project

Figure 3.3 is a simplified depiction of how a WBS and OBS correlate. It is imperative during the monitoring and controlling phase of the construction project that there is a responsible person for each activity. To summarize the planning process thus far, we have created the WBS and have now incorporated a responsible committee or person to each element of the WBS. In essence, from activities developed in the WBS we have allocated resources through the OBS.

3.1.3 Organizational Breakdown Structure – "How Much"

Now that we have discussed "what" is going to be accomplished through the WBS and "who" is going to perform activities through the OBS, owners and contractors want to know how much things will cost. Determining the cost is done through the Cost Breakdown Structure (CBS).

The CBS is a system for dividing a project into hardware elements and sub elements, functions and sub functions and cost categories. It is a hierarchical structure that classifies resources into cost accounts, typically labor, materials, and other direct costs. In addition, it represents the economic breakdown of the project into budgets per work package. This will allow the project manager to track project progress and expenditure according to planning breakdown of activities and responsibilities.

A CBS includes all direct full cost of labor, material, as well as the so-called project overhead, which is still a direct cost required to execute the project. Project overhead embraces the cost of construction equipment (usually under the terms of average amortization of construction assets), project management, design services, permits and insurance fees.

CBS does not have to include the company's overhead not associated with the project, such as general office salaries, utilities, insurance, taxes, interest, and other expenses out of the direct control of the project team, but rather inherent with corporate top management's action. There are two main approaches to direct cost breakdown structuring. Which is used in a particular circumstance depends on the different purposes of cost accounting. The first one makes use of the WBS as the project cost control structure, so that the CBS and WBS are the same structure and each cost account is consistent with a work package or detailed task. In other words, the accounting structure is the same WBS that has been filled with cost information, the end result is a hierarchical structure of cost to be used by the project team for both budgeting, accounting and control.

With this kind of CBS, Activity Based Costing (ABC) method drives both estimation of budget and accounting of actual expenditures. The advantage is that project budgeting and tracking develop on the WBS exactly in the way the facility is going to be built, with detailed analysis at the final level of decomposition of the WBS: the cost of an elementary activity may include a combined summation of full cost of labor, quantity of material, equipment, and lump-sum cost of subcontract or service. To define the budget, a different methodology may apply to parts of the breakdown depending on the specific nature of items or elements.

Subcontractor quotes are of practical use when a specialized subcontractor is assigned a job. Quantity takeoffs are obtained by multiplying the measured quantities by the unit cost, which includes material, equipment and labor as a whole. Challenges here are the tremendous detail complexity of line items, the dependence of the estimated quantities on construction methods, and the determination of unit cost based on historical data. Material takeoff estimation is needed when data about unit costs for complete installation of materials are unknown. For each line item in the cost breakdown, a quantity of material required, Q, must be determined. For each item the unit cost of material, M, can be estimated using quotes from local material suppliers. For most line items equipment is involved in the construction process, and an equipment rate of cost, EM (cost per unit of material), must be determined. In addition, labor costs – which are often greater than material cost – must be incorporated by multiplying the hourly wage rate, W, and the labor cost per unit of material (productivity) L. Combining these factors in the following equation produces an estimate of the direct cost for a given item: Total cost $ = Q * (M + EM + W * L)

Regardless of the method applied, careful consideration of wages and productivity has to be taken into account for appropriate detailed budgeting. Labor cost estimation W) is affected by several components, namely wages, insurance, social security, benefits and premiums. Productivity (L) impacts a project in many ways.

“At the beginning of a job workers will typically have lower productivity on account of inexperienced with the particular routine to be followed. As time progresses, they become more efficient in their work with repetition due to the effects of learning: an effect expressed in learning curves.” (Kerzner 2001).

However, some projects have little repetitive tasks, and therefore must account for this factor in the project estimate. When productivity is less than initially expecting a project may begin to fall behind schedule. As a result, the project manager may increase pressure in order to finish more quickly. However, as hours per day of work increase, worker productivity per hour is known to decrease. Productivity also suffers greatly over the medium- and long-term as workers become fatigued and lose motivation. This reciprocal process can be damaging to the success of a project if it is not realized. Productivity can be measured, but the results of corrective actions are highly uncertain. In this realm, a project manager with good experience and a good understanding of his personnel can identify problems and attempt to remedy them – ideally before the time such problems begin to be evident in project reports and failure to meet the schedule of values. Lost time due to low productivity can be incorporated into an

updated cost estimation, but prior to construction this additional cost is most easily calculated as a contingency. Applying probabilistic models to estimation calculations allows planners to gain a deeper insight into the effects of uncertainty in costs."

3.2 Quantity surveying

A quantity surveyor manages all costs relating to building and civil engineering projects, from the initial calculations to the final figures. They seek to minimize the costs of a project and enhance value for money, while still achieving the required standards and quality. This includes ensuring statutory building regulations are met.

As a quantity surveyor you could work for either the client or the contractor, in an office or on site. You will be involved in a project from the start, preparing estimates and costs of the work. When the project is in progress, you'll keep track of any variations to the contract that may affect costs and create reports to show profitability.

3.2.1 Responsibilities

To successfully carry out your role, you'll need to:

- prepare tender and contract documents, including bills of quantities with the architect and/or the client;
- undertake cost analysis for repair and maintenance project work;
- assist in establishing a client's requirements and undertake feasibility studies;
- perform risk, value management and cost control;
- advise on a procurement strategy;
- identify, analysis and develop responses to commercial risks;
- prepare and analysis costings for tenders;
- allocate work to subcontractors;
- provide advice on contractual claims;
- analysis outcomes and write detailed progress reports;
- value completed work and arrange payments;
- maintain awareness of the different building contracts in current use;
- understand the implications of health and safety regulations.

3.2.2 Importance of quantity survey

- Is essential before the construction the probable cost of construction for the complete work.
- Is required to estimate the quantities of the various materials required and the labor involved for satisfactory completion of a construction project.
- It is also useful to check the work done by contractors during and after the execution. Also, the payment to the contractor is done according to the actual measurements of the completed part of each item of work.

3.2.3 Types of quantity surveyor

- Contractor's Quantity Surveyor: Responsibility includes subcontractor formations and calculations of all related costs of the project. The professional is also responsible for keeping the project within budget at all times and creation of reports that each member must adhere to throughout the project.
- Senior Quantity Surveyor: This title is the most needed type of Quantity Surveyor. This professional is expected to take ownership and responsibility for the teams supported and reports daily to the lead partner. This person supports the senior staff within several teams and is responsible for building and developing successful relationships quickly.
- Mechanical and Electrical (M&E) Quantity Surveyor: Manages the financial performance and maintenance contracts related to all Mechanical and Electrical work. The Surveyor creates contracts for large governmental clients mainly. This type of surveyor is extensively knowledgeable in maintenance projects and commercial projects.
- Project Quantity Surveyor: Provides project estimates, tender appraisals, prepares bills of quantities, finalizes projects and writes project reviews. The professional partners with other members of the team to ensure all aspects of the project are reviewed and changed if necessary to remain in compliance.

3.2.4 Types of estimates and quantity survey

- Preliminarily or approximate estimate: this is find out an approximate cost is a short time. It is used to give an idea of the cost of a proposed project. This estimate helps the client or sanctioning authority to make decision of the administrative approval.

- Detailed estimate: after getting the administrative approval, this estimate is prepared in detail prior to inviting of tenders. The whole projects is divided into sub-works, and the quantities of each sub-work are calculated separately. The dimensions of the required work are taken from the drawing of the project.
- Quantity estimates: this is a complete of quantity for all items during project implementation.
- Resaved estimate: prepared if the estimate exceeds by 5% due to rates being found insufficient or due to some other reason.

3.2.5 Quantity take-off (QTO)

(QTO) are a detailed measurement of materials and labor needed to complete a construction project. They are developed by an estimator during the preconstruction phase. These measurements are used to format a bid on the scope of construction. It is an important part of the cost estimate, it must be as accurate as possible and should be based on all available engineering and design data. Use of appropriate automation tools is highly recommended.

Accuracy and completeness are critical factors in all cost estimates. An accurate and complete estimate establishes accountability and credibility of the cost engineer, therefore, providing greater confidence in the cost estimate. The estimate contingencies for programming purposes reflect the estimate confidence.

An estimating is very much important for contractor to record a description to calculate material, man hours, labor, equipment and subcontractors totals.

Estimators review drawings, specifications, and models to find these quantities. Experienced estimators have developed procedures to help them quantify their work. Many programs have been developed to aid in the efficacy of these processes.

In a general bidding process of any construction work, the project estimation is the most vital thing to win the process. An almost accurate quantity takeoff sheet helps the architects, engineers and contractors to win any bid, so it is very important to get an almost accurate estimation of the project.

The quantity of material in a project can be accurately determined from the drawings and the estimator must review each sheet of the drawings, calculate the quantity of material and record the amount and unit of measure. Each estimator must develop a system of quantity takeoff that ensures that a quantity is not omitted or calculated twice.

A well-organized check-list of work will help reducing the chances of omitting an item. The estimator must also add an appropriate percentage for waste for those items where waste is likely to occur during construction.

The material quantity takeoff is extremely important for cost estimating because it often establishes the quantity and unit of measure for the costs of labor and contractor's equipment.

3.2.6 Quantity Development

After knowing the construction project tasks, each task must be quantified prior to pricing. Equal emphasis should be placed on both accurate quantity calculation and accurate pricing. Quantities should be shown in standard units of measure and should be consistent with design units.

Assistance for preparing "takeoffs" may be provided by others within the organization in support of cost engineering; however, the responsibility for the accuracy of the quantities remains with the cost engineer. Distinction should be made between "net" quantities without waste versus quantities that include waste or loss. This is necessary to ensure duplication does not occur within the estimate.

The detail to which the quantities are prepared for each task is dependent on the level of design detail. Quantity calculations beyond design details are often necessary to determine a reasonable price to complete the overall scope of work for the cost estimate.

A simple example would be fabrication waste material that is a material cost to the project. Project notes will be added at the appropriate level in the estimate to explain the basis for the quantity calculations, to clearly show assumed quantity allowances or quantity contingencies, and to record quantities determined by cost engineering judgment that will be reconciled upon design refinement.

The recommended guidelines in quantity development are to coordinate the quantity takeoff process and planning with the estimator and ensure full project scope that is reflected within the estimate, include a list of materials in quantity takeoffs, where to utilize a process that easily records the quantity development, i.e., document source and date, estimator name and date, location within the project, demonstrated calculations and additions such as waste or loss.

Using a systematic approach similar to the construction methodology required, checking scales and dimensions on each drawing sheet and to highlight or mark drawing areas where quantities

have been determined to ensure all scope is captured but not double counted are the most recommended guidelines for the quantity development.

Much more advances to develop it, such as considering items that have no material but still require cost, e.g., job office overhead (JOOH), task setup, training and certifications and labor preparation, also to develop quantities within a reasonable range for the work using decimals, where critical. and adding a certain amount of waste, loss, drop off, or length related to the material purchases for a bulk order where ensuring this addition is separate from the original quantity measured. Select a natural stopping point during work interruptions and coordinate with designers if the design appears in error, if a better approach is discovered, or a value engineering process is warranted.

3.3 Project Description

Al -Manara building is located in downtown Ramallah city in a lot of 2632 m2 area, the building is boarded from the northeast side "YohannaMemadan" street and from the southwest side "GourgeSaa" street.

The building has many entries which reaches different floors to make the accessibility easier, also it contains two stairwells, 5 elevators and electrical drawer to move between first and second floor.

Table 1.1 function and area for each of Al_Manara Mall

Floor	Description	Area	Height
Fifth basement	Contains car parking which can accommodate 17 cars, and electrical mechanical control rooms also contains entrance and exit for car movement.	1886 m^2	3.12
Fourth basement	Contains car parking which can accommodate 44 cars.	1875 m^2	3.12
Third Basement	Contains car parking which can accommodate 44 cars.	1875 m^2	3.12
Second Basement	Contains car parking which can accommodate 44 cars.	1882 m^2	3.12
First Basement	Contains car parking which can accommodate 34 cars. also contains police station, bathrooms and 7 commercial shops.	1986 m^2	3.76
Ground Floor	Contains police station, internal commercial shops and chute for cars movement between the floors.	1895 m^2	3.64
First Floor	Contains public service center and chute for cars movement.	1939 m^2	3.64
Second Floor	Contains car parking which can accommodate 35 cars and service rooms.	1908 m^2	3.12
Third Floor	Contains car parking which can accommodate 45 cars.	1732 m^2	3.12
Fourth Floor	Contains car parking which can accommodate 45 cars.	1492 m^2	4.12

Fifth Floor	Contains car parking which can accommodate 35 cars.	1732 m^2	3.12
Sixth Floor	Contains offices.	1482 m^2	3.38
Seventh Floor	Contains offices.	1419 m^2	3.38
Eighth Floor	Contains offices and terrace.	1193 m^2	3.38
Ninth Floor	Contains offices.	1193 m^2	3.64
Roof exit (staircase)		90 m^2	2.86

CHAPTER FOUR

QUANTITIES SURVEYING USING REVIT SOFTWARE (CONCRETE ONLY)

CHAPTER FOUR: QUANTITIES SURVEYING USING REVIT SOFTWARE (CONCRETE ONLY)

4.1 General Introduction

Autodesk Revit is building information modeling software for architects, structural engineers, MEP engineers, designers and contractors developed by Autodesk. It allows users to design a building and structure and its components in 3D, annotate the model with 2D drafting elements, and access building information from the building model's database. Revit is 4D BIM capable with tools to plan and track various stages in the building's lifecycle, from concept to construction and later maintenance or demolition.

This software allows making detailed 3D model for the building and the software can calculate all the parameters needed to find volumes and weights of the materials in the building, so we can make a quantity surveying for all elements.

4.2 Models Build Up in Revit

4.2.1 Levels Definition in Revit

This step represents the first step in the modeling, where each floor in the building define as a level in Revit where the deference between two levels equal high story, the following table shows the elevation for each story:

Table 4.2.1Floors high.

Floor Number	High(m)
B5	3.12
B4	3.12
B3	3.12
B2	3.12
B1	3.76
GF	3.64
F1	3.64

F2	3.12
F3	3.12
F4	4.12
F5	3.12
F6	3.38
F7	3.38
F8	3.38
F9	3.64
Roof exit (staircase)	2.86

The following figures shows the levels in Revit:

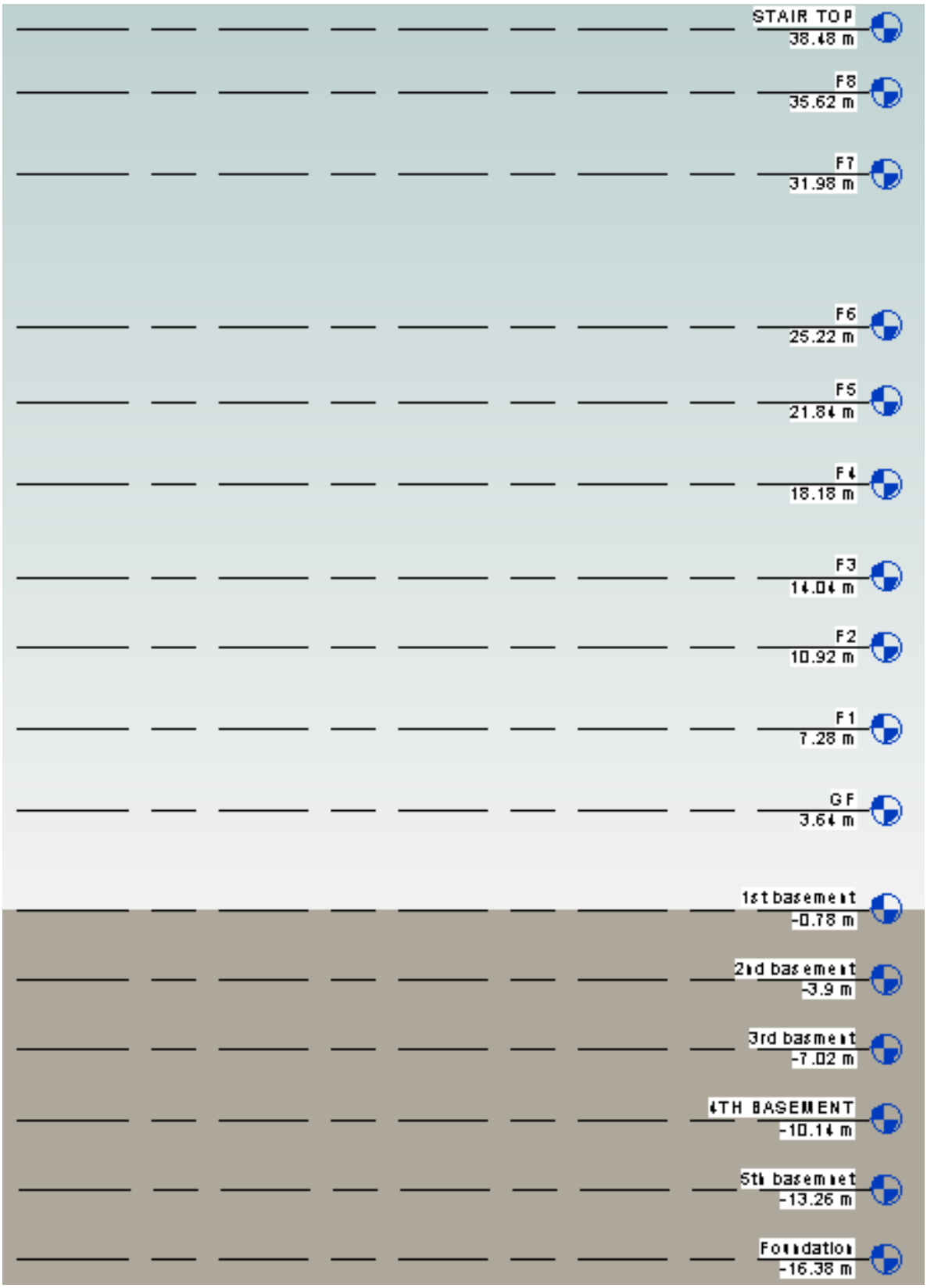

Figure 4.2.2Floors levels in Revit

4.2.2 Link CAD Importing for Drawing

Link cad is a photo form of the AutoCAD files represents a link between Revit and AutoCAD for easier drawing in Revit, the following figure shows a link Cad example imported to Revit:

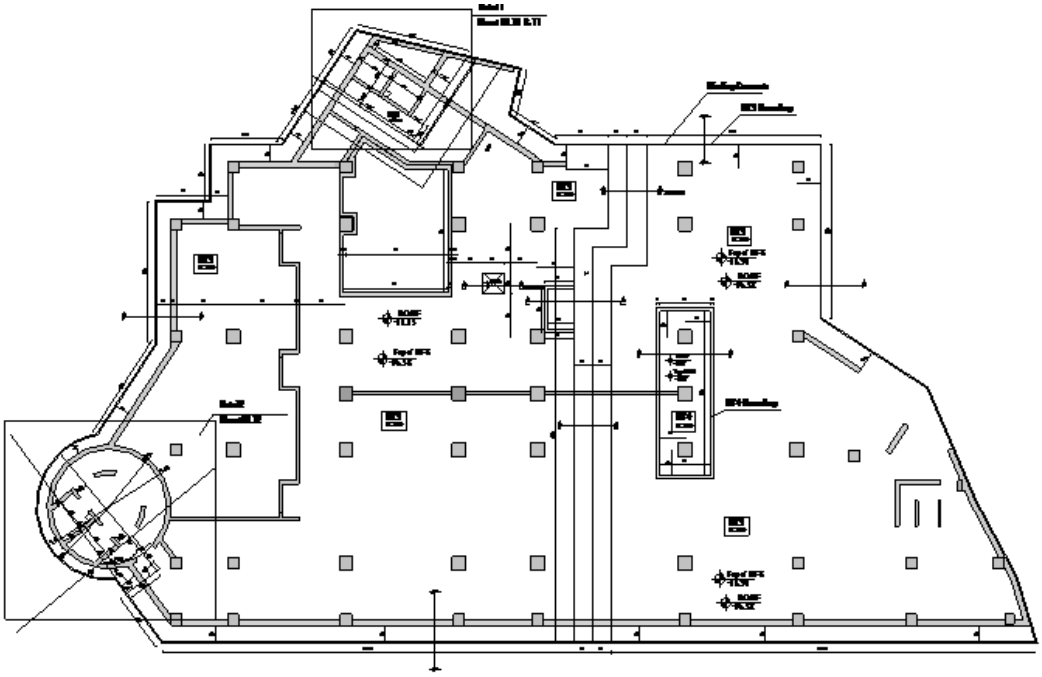

Figure 2.2.2Link CAD Example Imported to Revit

4.2.3 Drawing Stages

4.2.3.1 Mat Draw

According to the structural plans, the following figure shows the mat draw in Revit:

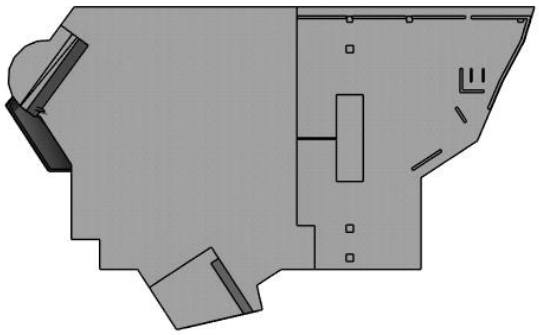

Figure 4.2.3 Mat Draw

4.2.3.2 Columns Draw

According to the structural plans, the following figure show the columns draw in Revit:

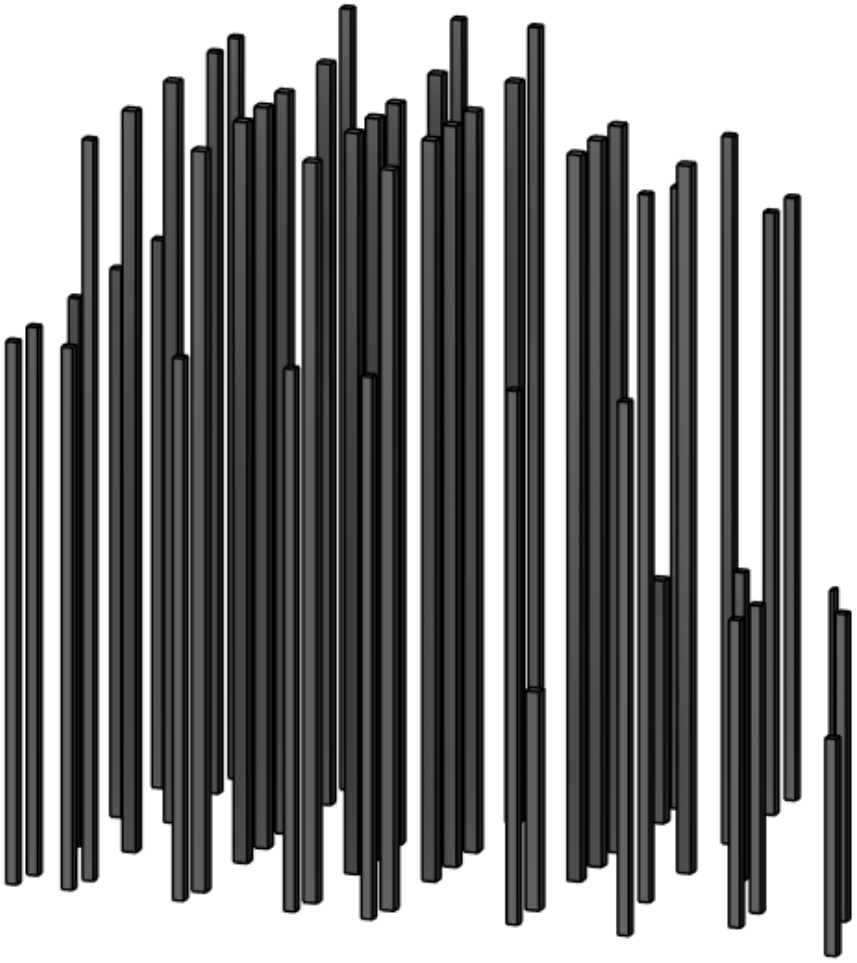

Figure 4.2.3.2 Columns Draw

4.2.3.3 Cover Slabs Draw

According to the structural plans, the following figure shows the cover slabs draw in Revit:

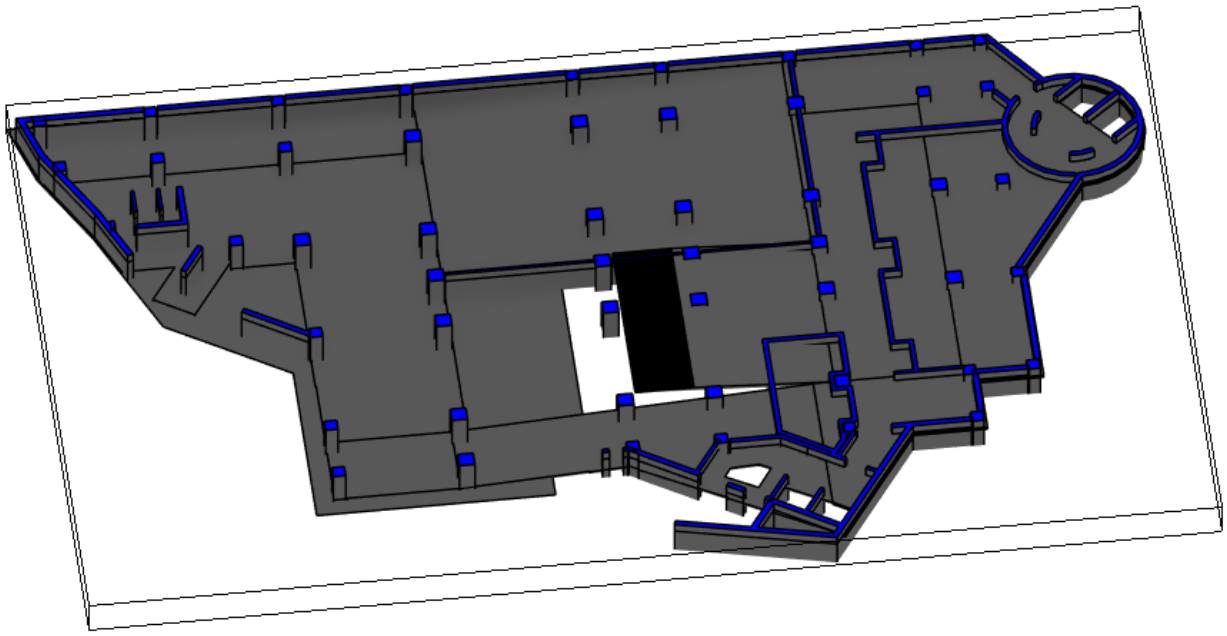

Figure 4.2.3.3 Cover Slab Draw

4.2.3.4 Partition Walls Draw

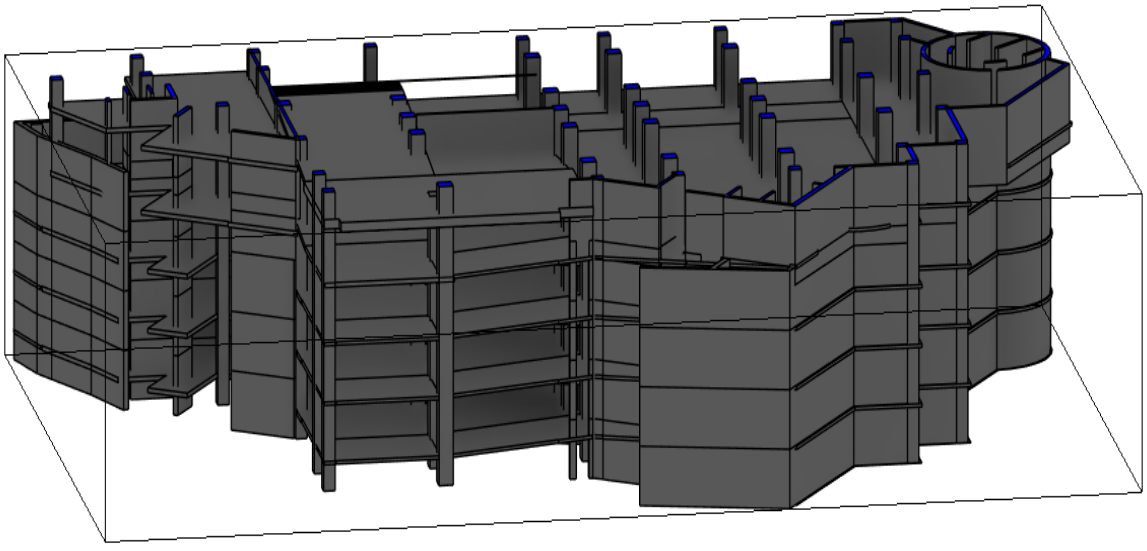

Figure 4.2.3.4 Partition Walls Draw

4.2.4 3-D Model for Mall in Revit

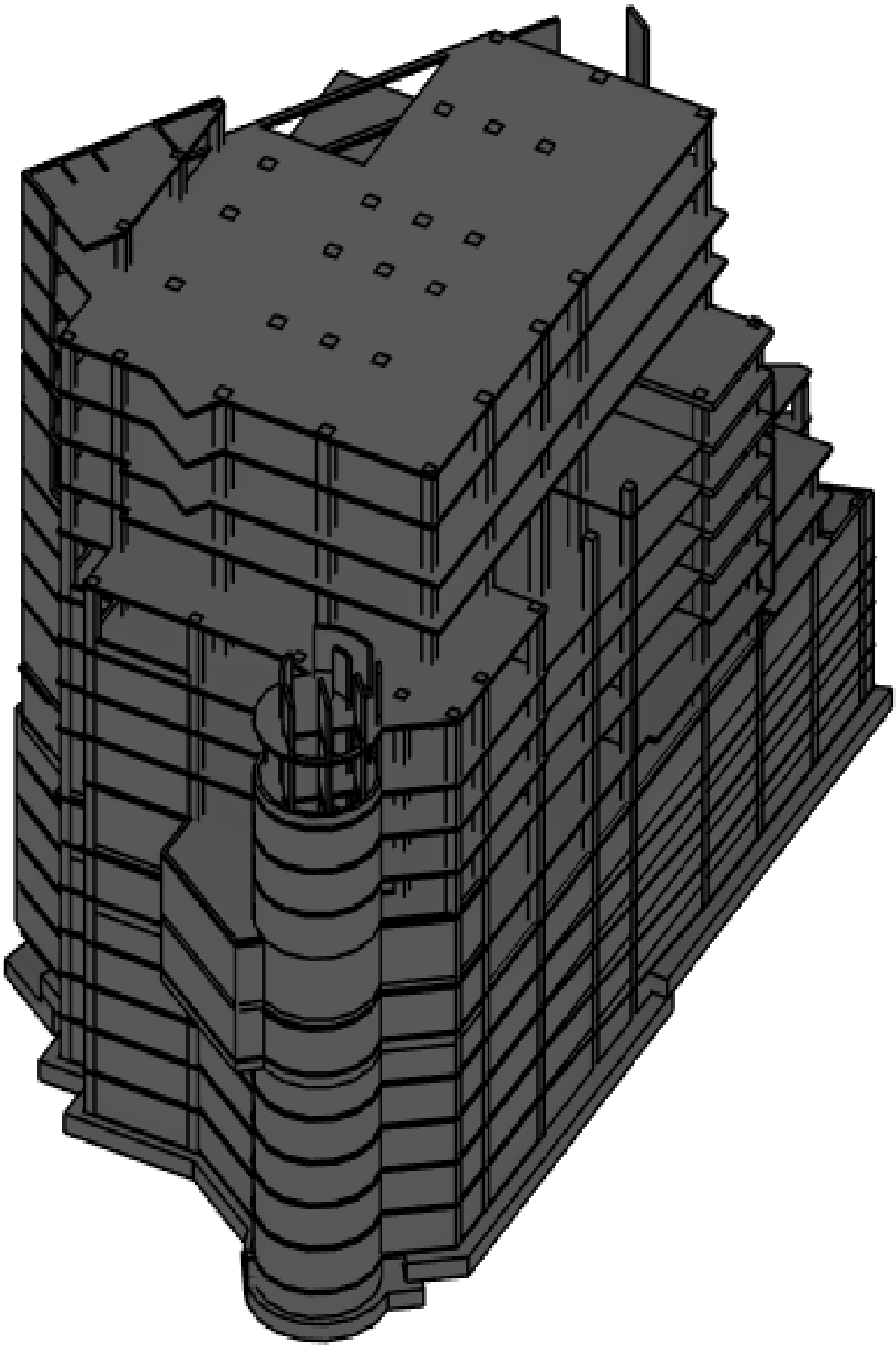

Figure 4.2.4 3-D View for mall

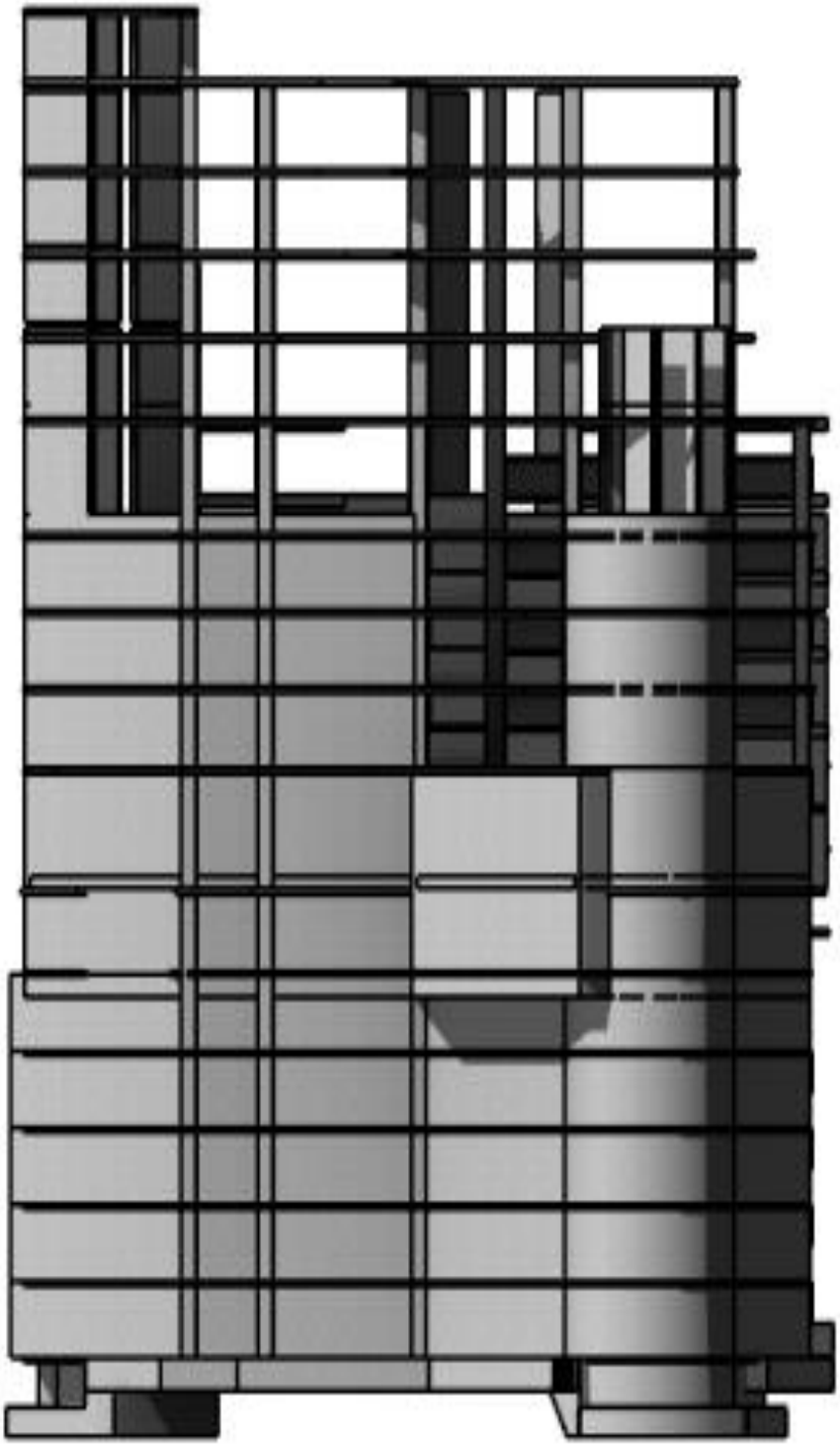

Figure 4.2.5 south west View

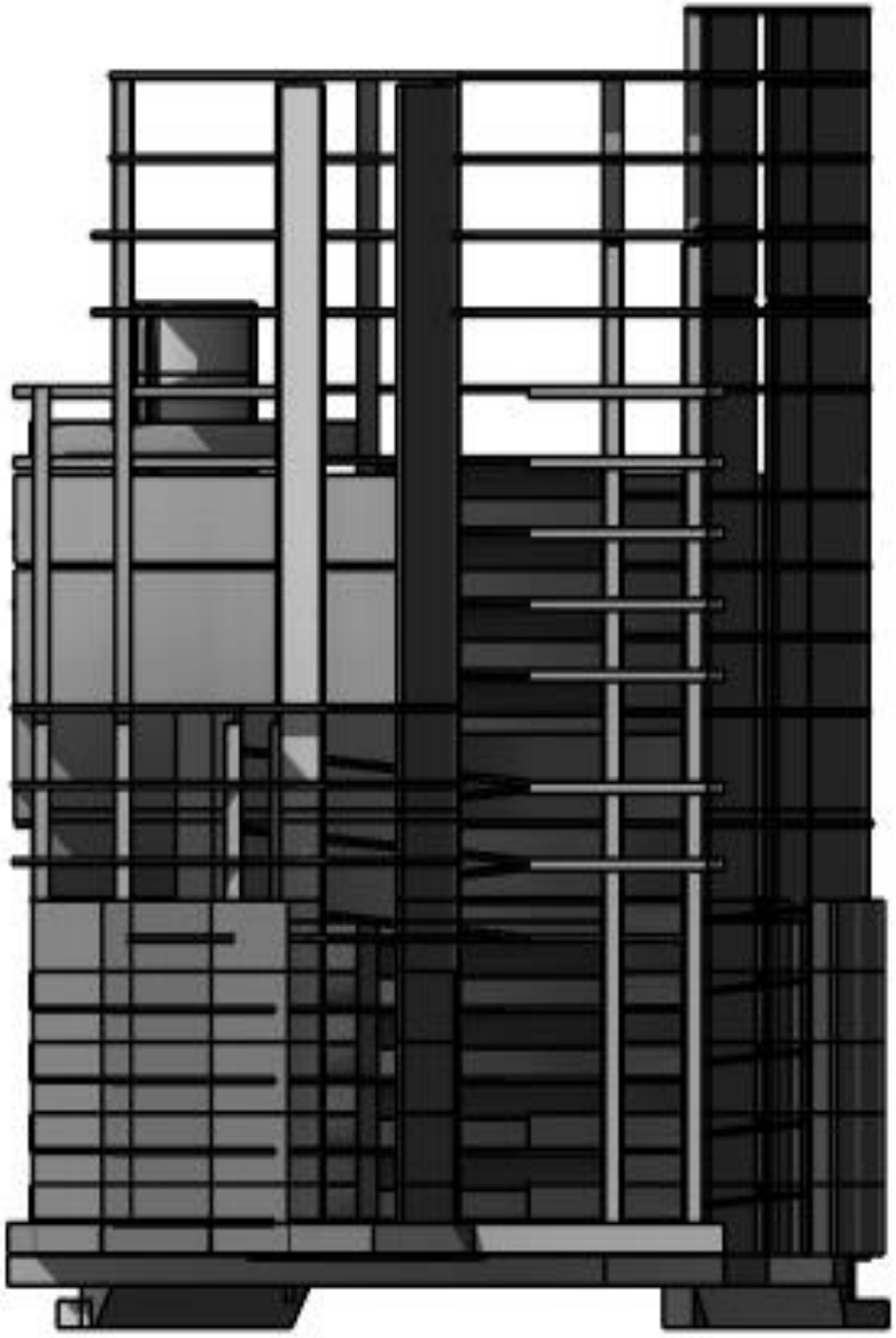

Figure 4.2.6 North East View

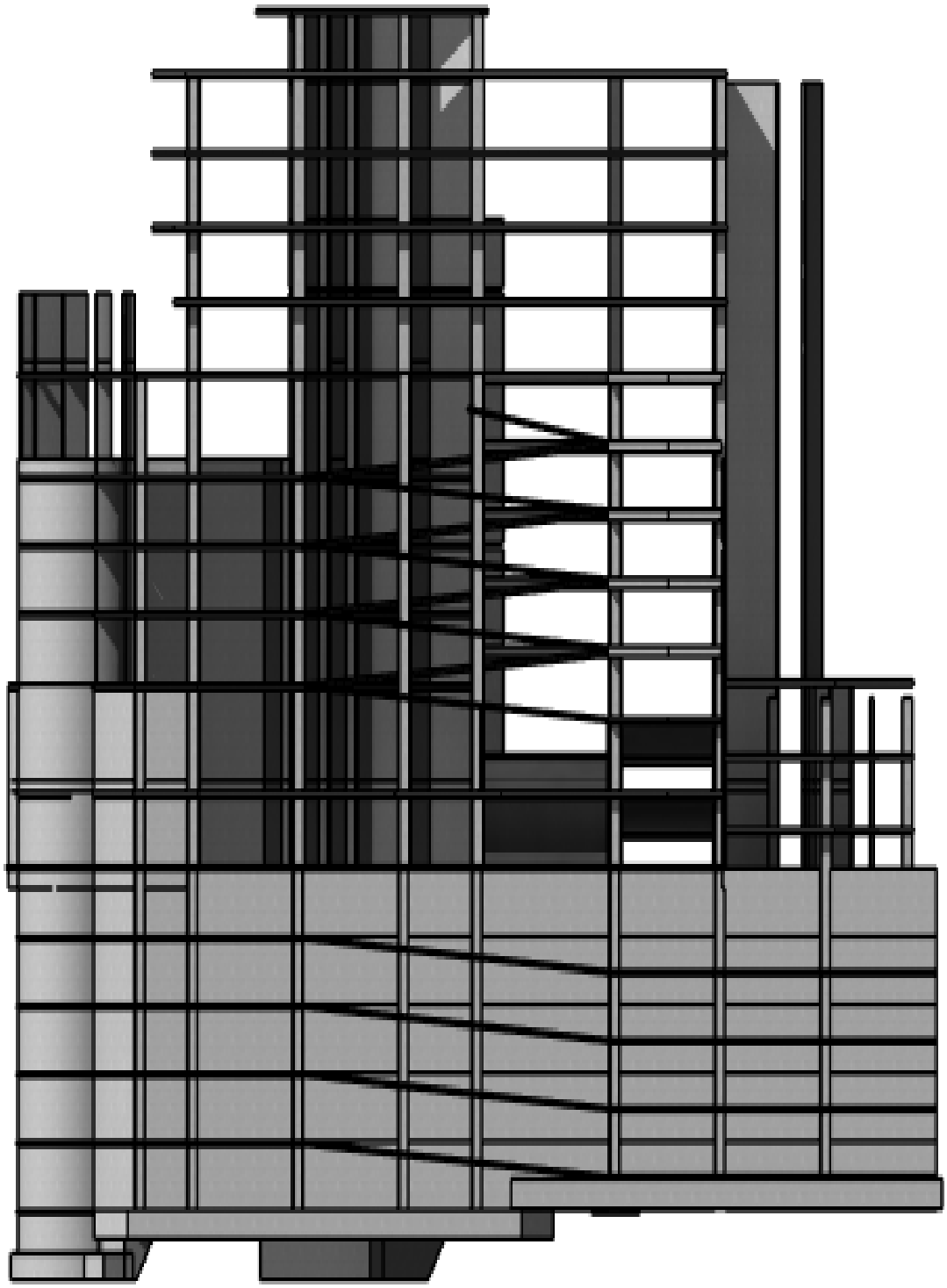

Figure 4.2.7 South East view

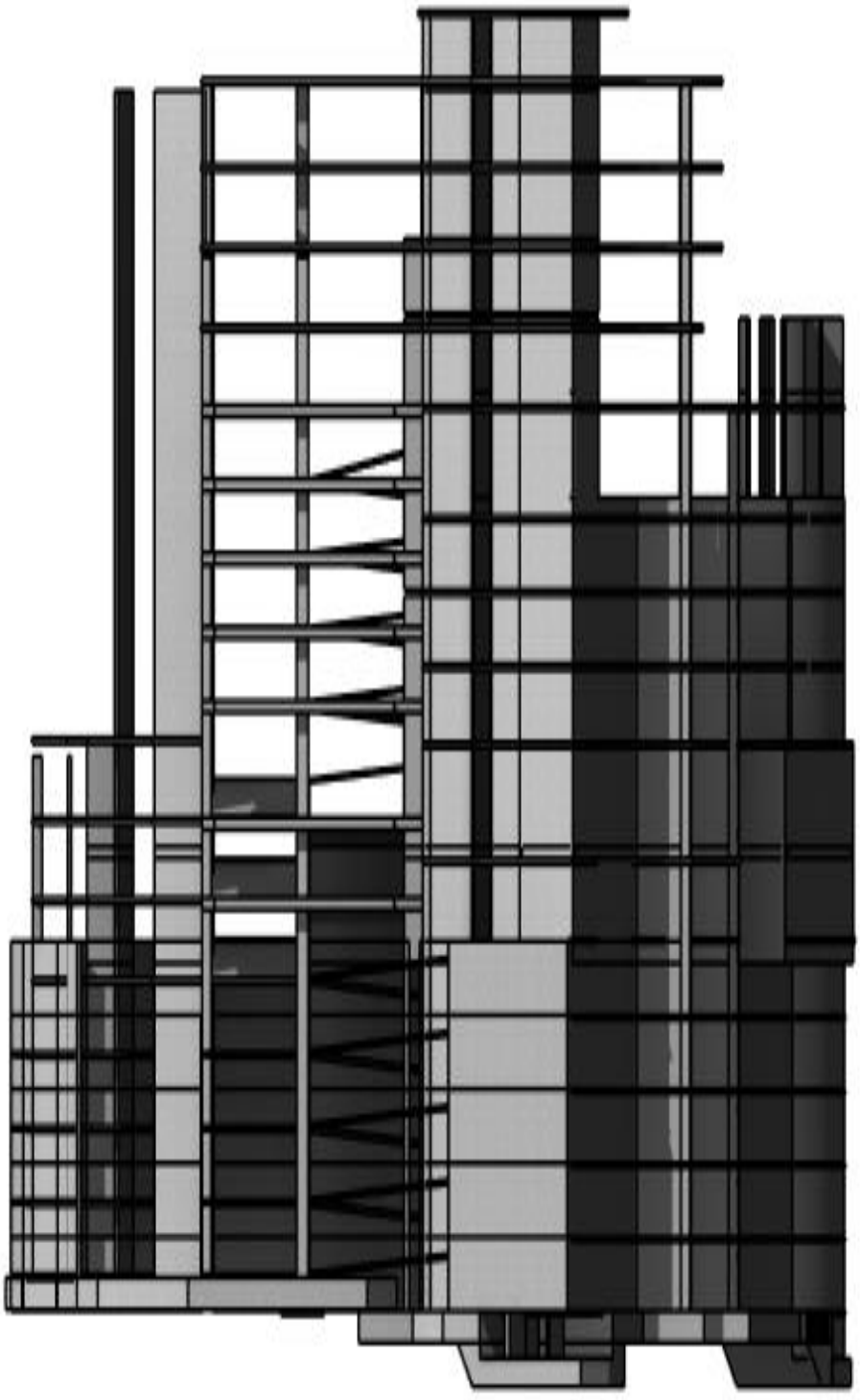

Figure 4.2.8 North West view

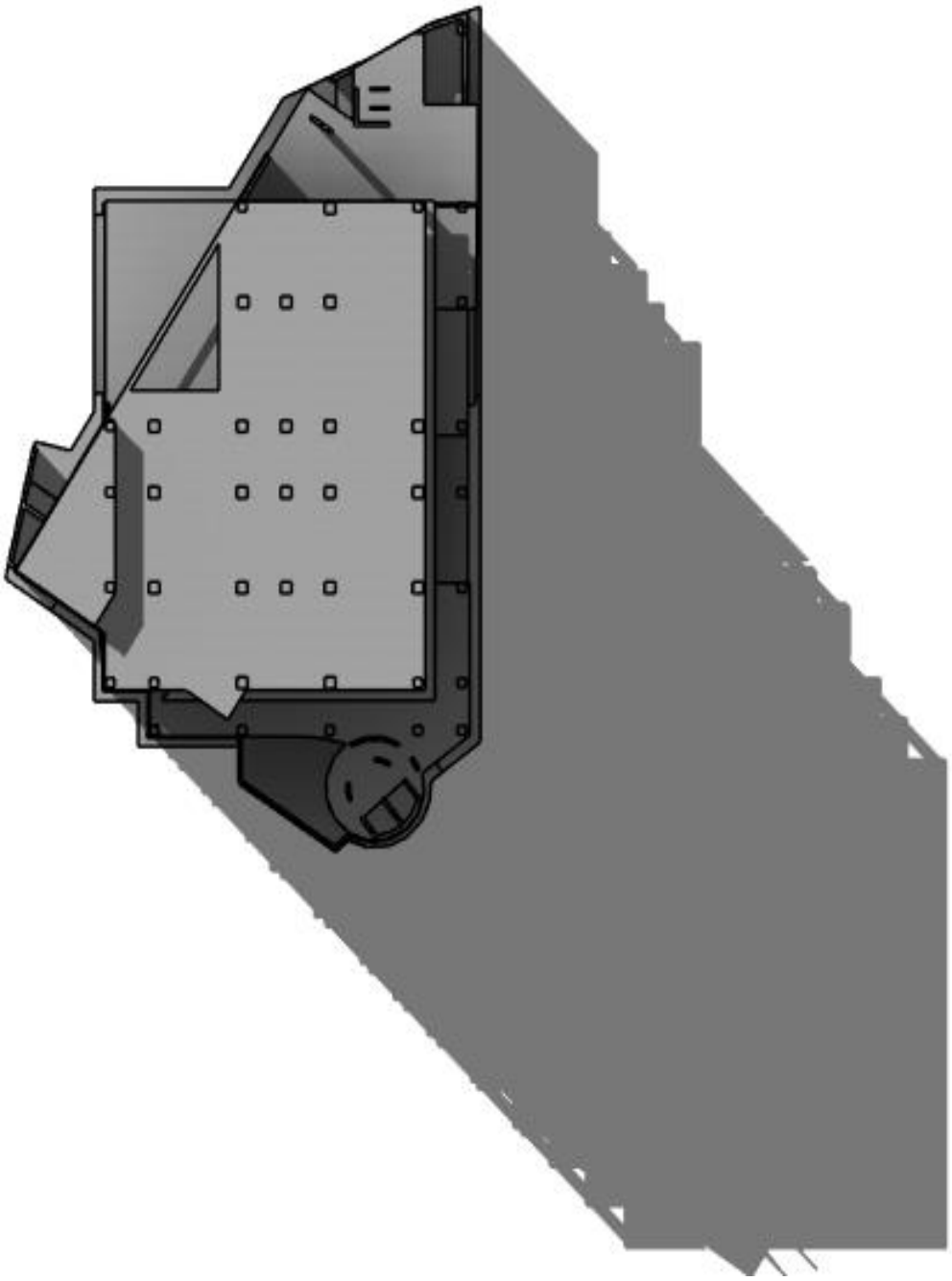

Figure 4.2.9 Top View

CHAPTER FIVE

HAND CALCULATIONS

CHAPTER FIVE: HAND CALCULATIONS

5.1 General Introduction

There many programs to calculate quantities but to be in the safe side we make check on concrete calculations and we calculate the steel with hand calculations.

The bellow checks show how we calculate the steel reinforcement and the concrete check after Revit software.

5.2Concrete volumes

5.2.1 Mat Foundation

For example

Building volume = Area * Building Thickness

We have different thicknesses of the foundation as example we take 155 cm thickness.

Volume = 1.55 * 900

= 1395 m^3

5.2.2 Shear Walls Concrete Volume

We take type 25 cm

Concrete Volume = Length * Width * Hight

= 17 * 0.25 * 3.20

= 13.6 m^3

5.2.3 Columns Nick Concrete Volume

Concrete Volume = Length * Width * Hight

= 0.8 * 0.8 * 1.86

= 1.19 m^3

5.2.4 Columns Concrete Volume

Concrete Volume = Length * Width * Hight

= 0.8 *0.8 * 3.38

= 2.16 m^3

5.2.5 Beams Concrete Volume

Concrete Volume = Length * Width * Hight

= 0.8 * 0.5 * 6.6

= 2.64 m^3

5.2.6 Slabs Concrete Volume

We have many types of slabs as solid, ribbed and waffle, we take 18 cm thickness solid slab.

The thickness of the slab = 18 cm

And the cover = 25 mm

So, the concrete volume

Concrete Volume = Length * Width * Thickness

= 3.30 * 7.30 * 0.18

= 4.33 m^3

5.3 Reinforcement Weight

5.3.1 Foundation Reinforcement

We take F1 to show

Weight of bars along x-direction

= ($Diameter^2$* Bars length * Number of bars) / (162)

= (252 * 8.65 * 60) / 162+ (252 * 6.25 * 43) / 162 + (252 * 10.40 * 43) / 162

=4764.45Kg

Weight of bars along y-direction

= ($Diameter^2$* Bars length * Number of bars) / (162)

= (252 * 7.5 * 73) / 162 + (252 * 7.5* 104) / 162

=5121.5 Kg

Net weight of the bars

=4764.45 + 5121.5 = 9885.95 Kg

5.3.2 Columns Reinforcement

We take C1 in the four-level floor to show

Weight of the main bars

= ($Diameter^2$* Bars length * Number of bars) / (162)

= (20^2 * 2.83 * 24) /162

= 169.8 Kg

Weight of stirrups

= ($Diameter^2$* Bars length * Number of bars) / (162)

= (10^2 * 5.06 * 18) /162

= 56.2 Kg

Net weight = 169.8 + 56.2 = 226 Kg

5.3.3 Beams Reinforcement

We take B14 in the ground floor to show

Weight of the top bars

= ($Diameter^2$* Bars length * Number of bars) / (162)

= (25^2 *11.5 *3) /162

= 133.1 Kg

Weight of bottom bars

= ($Diameter^2$* Bars length * Number of bars) / (162)

= (25^2 *11.5 *3) /162

= 133.1 Kg

Wight of middle bars

= ($Diameter^2$* Bars length * Number of bars) / (162)

= (16^2 * 11.5 * 2) / 162

= 36.34

Weight of stirrups

= ($Diameter^2$* Bars length * Number of bars) / (162)

= (102 * 1.40 * 84) / 162

= 72.6 Kg

Net weight of bars

= 113.1 + 113.1 + 36.34 + 72.6

= 335.14 Kg

5.3.4 Shear Wall Reinforcement

Weight of bars in horizontal

= ($Diameter^2$* Bars length * Number of bars) / (162)

= (12^2 * 7.4 * 37) /162

= 243.38 Kg

Weight of bars in vertical

= ($Diameter^2$* Bars length * Number of bars) / (162)

= (14^2 * 3.12 * 16) /162

= 60.4 Kg

Net weight of bars

= 243.38 + 60.4 = 303.78 Kg

5.3.5 Slab Reinforcement

We take one bars as example to show

= ($Diameter^2$* Bars length * Number of bars) / (162)

= (14^2 * 6.4 * 17) / 162

= 131.63 Kg

=5.6

CHAPTER SIX

TIME MANAGEMENT

CHAPTER SIX: TIME MANAGEMENT

Time management is important in any construction project. Without proper time management, many problems will occur such as extension of time or time overrun. Some of the researchers describe time overrun as delay and some of them describe that the time overrun is an effect from the construction delay, no matter what it was described, time overrun become the most general problem in construction industry worldwide. Time overrun occur when the actual progress of a construction project is slower than the planned schedule. Delay or time overrun will affect all parties involved in the project. It will affect the profits which would be obtained if the project can be completed on the schedule. But due to the time overrun, contractors had to spend more money on labor, plant and may lose the opportunity to get the next project. Hence, effective time management is very important and crucial to achieve successful completion of construction projects. The aim of the study is to investigate the common application of time management techniques and software packages in construction projects and determine the level of effectiveness both of them.

6.1 Deterministic Scheduling Principles

"Deterministic scheduling is just one of the many tools available to project managers during the planning stages of a project. However, it may be one of the most important because it both lowers chance of delay and assists in recovering from delay, resolving responsibility. Indeed, delays often result simply from poor planning. Accurate scheduling assists in reasoning about a huge number of details (e.g. thousands of activities), and determines a lot of things, including expenditure estimates for crews and materials, expected opening dates (there may be situations where a strict opening date is highly important, such as a new production facility), scheduling changes with sufficient flexibility to not affect the completion date, and others. Scheduling also allows for accountability. Setting milestones from the beginning allows for the project managers or the owners to pinpoint exactly what went wrong and who or what was responsible for a delay. A schedule is also a good communication tool, between the managers, the owners, investors, and the general public. Schedules give an overall sense of the project's expected progress. Without schedules, it's much more difficult to explain to someone unfamiliar with the project what is expected to take place." (De Marco, 2011)

A schedule can also be used a contractual tool. Some payment schemes are based on scheduling. Some offer incentives for finishing the job on time or ahead of schedule. With an

accurate schedule, these sorts of incentives can be offered fairly in the contract from the very beginning. Also, in the case of a lawsuit, a good schedule can serve as great evidence in support of the parties. To put a schedule into effect it is recommended to avoid any imbalanced use (such as to use it early on and discarding later), to game for liability reasons (i.e.: schedule as a biased document to support the originator's rights), or to use for central PM office only. In contrast, schedules should be used as shared management tools to get to an integrated point of view for both the owner and the contractor. Schedule documents can be subsumed mainly in two types. One is the Master Schedule that is used as the contract baseline, usually under the form of a milestone chart. (Memon, Rahman, Ismail, & Zainun, 2014)

The other is the Project Schedule which is used to monitor and control the actual progress of the project. This schedule is usually based on the WBS and is very meticulous. It usually includes detailed plans, such as engineering schedules, construction sequencing, quality-assurance activities, as well as procurement plans. For example, a procurement detailed schedule involves trying to schedule when materials will be ready and available on site for installation. This is often difficult to estimate, especially for custom built items, though it is very important to keep work on pace. Without the proper materials on site, workers may be sitting around and money will be spent on entertaining them. For the project schedule, typically there are revisions performed on a weekly, monthly, or other periodic system. Then, these revisions are used to track progress against the original schedule. This allows for the managers to make any changes. (De Marco, 2011)

6.1.1 Scheduling Systems

So how do we schedule? There are several forms of schedules and several methods used to determine accurately the schedule. The following methods will be discussed in greater detail in the following: task matrix, Gantt chart, network diagram, and line-of-balance scheduling

6.1.2 Gantt Chart Scheduling

The most common type of display is the bar or Gantt chart, named for Henry Gantt, who first utilized this procedure in the early 1900s. The bar chart is a means of displaying simple activities or events plotted against time or dollars. An activity represents the amount of work required to proceed.

from one point in time to another. Events are described as either the starting or ending 38

point for either one or several activities.

Bar charts are most commonly used for exhibiting program progress or defining specific work required to accomplish an objective. Bar charts often include such items as listings of activities, activity duration, schedule dates, and progress-to-date. shows nine activities required to start up a production line for a new product.

Bar charts are advantageous in that they are simple to understand and easy to change.

They are the simplest and least complex means of portraying progress (or the lack of it) and can easily be expanded to identify specific elements that may be either behind or ahead of schedule.

Bar charts provide only a vague description of how the entire program or project

reacts as a system and have three major limitations. First, bar charts do not show the

interdependencies of the activities, and therefore do not represent a “network” of activities.

This relationship between activities is crucial for controlling program costs.

Without this relationship, bar charts have little predictive value. For example, does the

long-lead procurement activity requires that the contract be signed before.

Figure 6.1.2 shows a basic Gantt chart. Here we begin to see a clearer relationship between tasks, though not completely. For example, we know that design has to take place before construction, but construction could begin before the design is completed. So, there is some intuition as to which tasks are related, but not an explicit statement of dependencies. Each bar represents the amount of time that its respective task will take.

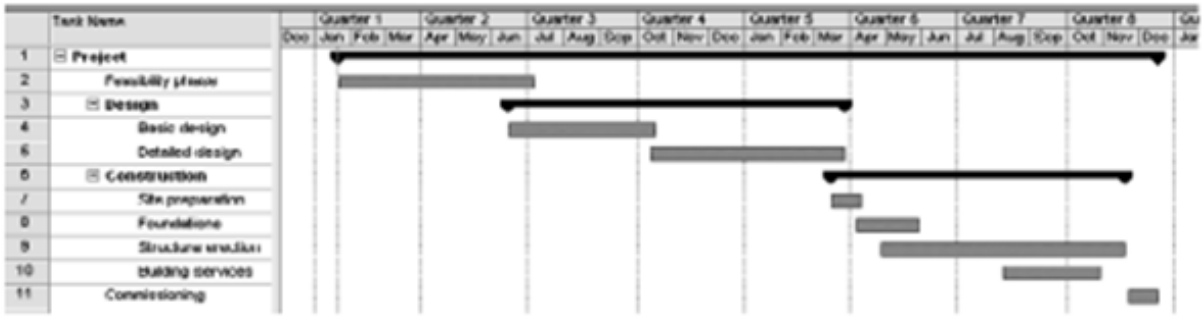

Figure 6.1.2 Grant Chart Schedule

“This form of scheduling is far superior to that of the matrix scheduling in that it’s more effective as a communication tool. This type of chart is very easy for anyone to understand and allows for the owner or manager to more effectively communicate how the project will proceed. There may also be WBS levels of scheduling. Figure 2.4 illustrates that idea. However, we need a more detailed way of showing relationships of activities.” (Rabner, 2012)

6.1.3 Network Diagramming

This method is a most robust way of showing and calculating a schedule. Using this method of scheduling, it is fairly easy to use software tools to calculate project duration and optimize allocation of labor and resources. It is also relatively easy to find the areas in the schedule which are more flexible to change. Basically, the process of constructing a network system is composed of the following stages:

- “First, the tasks are drawn from WBS work packages and assigned expected deterministic duration, estimate cost, and resources. The method for obtaining the deterministic durations may vary depending on the task, but mostly it’s a factor of amount of work to be performed, productivity, number of resources and equipment used. Costs can also be assigned to each task based on the original cost estimates or trough assignment of human resources, materials and equipment to each task. In any case, the common assumption in deterministic estimation is that all activity attributes can be determined as certain values with very little margin of error. “(De Marco, 2011)
- Second, each task is assigned precedence relationships with other tasks. In other words, if task B cannot be started until task A is finished, that relationship is defined in this method.
- Then, the network diagram is solved and optimized using various ways, such as Critical Path Method, Precedence Diagramming Method and Program Evaluation Review Technique. This often implies iteration: if the solution of the network acceptable in terms of total project duration and resource allocation, then terminate. If it is not acceptable, it is needed to impose dependencies or added/reduced resources.(Rabner, 2012)

6.1.4 Line-of-Balance Scheduling

another way for graphical representation of scheduling is the Line-of Balance (LOB) method otherwise called Chemins-de-Fer from the French national railroad company (SNCF Société

National des Chemins de Fer) who widely uses this technique to schedule linear works such as railroad tracks, roads, and tunnels.

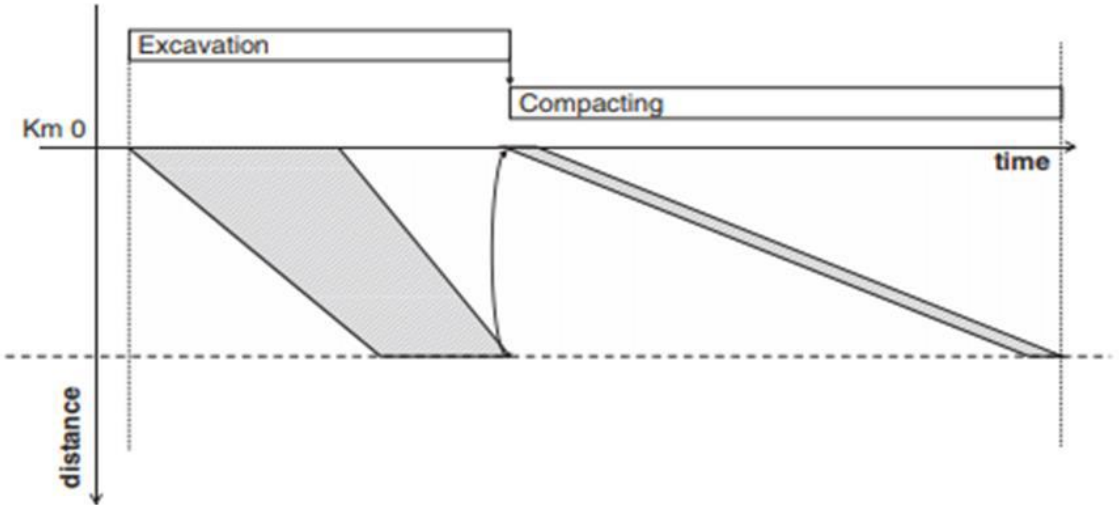

Figure 6.1.4 Line of Balance

In a LOB graph, time is usually plotted on the horizontal axis and space on the vertical one. This diagram allows for representing the production rate of an activity: the slope of the production line is expressed in terms of units of distance per time (i.e. km/day).

From the example in Fig, it is also clear that the production rate for each kilometer of excavation is variable depending on several parameters: as distance increases, time to perform excavation decreases. This may depend on several factors such as use of more resources, decrease in volumes of excavation (the dig may be less deep or narrower), or/and more efficient technologies.

6.2 Critical Path Method

“method (CPM) and its strictly derived Precedence Diagramming Method (PDM). The CPM consists of specifying the activities to be carried out and its associated information (such as duration) and running a scheduling algorithm in order to yield some scheduling recommendations and constraints. The CPM runs on a network-based scheduling system. The basic steps to follow are: define activities from WBS work packages, estimate the cost, duration and resources for each one of the activities and define the precedence relationships between them. Once all is clearly defined, the system needs to be iterated in order to optimize and manage the network, using the CPM algorithm. If the results obtained are acceptable, the iteration must stop. Otherwise, some extra dependencies need to be added or some additional resources need to be considered. The CPM algorithm runs either on AOA diagrams or on AON diagrams and it computes Early and Late Finish as well as Early and Late Start for each node.” (Kelly JE,1959)

Late Start and Late Finish for each activity is defined as those latest dates to start or complete an activity without delaying the project duration as a whole. For each activity, the difference between the Late Start and the Early Start (as well as between Late Finish and Early Finish) constitutes the so-called “Float”. The CPM algorithm consists of two phases or passes:

- Forward pass determines Early Start and Finish of activities. Because all preceding activities must finish before a successor, early start of a given node is the maximum of early finishes of preceding nodes. As a practical example, the forward pass determines the shortest time to complete a sequence of tasks.
- Backward pass determines Late Start and Finish dates. Because preceding activity must finish before any following activity, late finish of a given activity is minimum of late starts of successors. In practice, given the final completion time of a sequence of tasks, the backward pass allows calculating the latest point in time the sequence has to be initiated.

Both notions are quite common-sense reasoning that we use all the time for daily life tasks (e.g. we use the forward pass to figure out what is the earliest time we could meet someone or use the backward pass to know at what time we need to leave for making an airplane on time).

In all projects where the total finish date is calculated as the late duration of the network, there is at least one critical path, and the activities in this path must be completed on time, otherwise the entire project will be delayed.

Sometimes, projects have a later contract deadline than the one obtained from solving the network. In such fortunate circumstances, there is no critical path in a strict sense. Yet, it is opportune that a new project timeline is set to be finished with the longest path of activities, so that a time buffer, from timeline completion to contract deadline, is available as a contingency.

The CP determines the minimum time required to execute a project. However, two aspects of this algorithm need to be considered: first, we have to pay special attention to near-critical paths (those paths with low floats), and second, the critical path evolves over time as activity actual durations unfold.

Finally, since there is no float in the critical path, there is no flexibility and, thus, some contingency buffer should be planned ahead. Therefore, the notion of float assumes great importance. Intuitively, the float measures the leeway in scheduling: it is somewhat a degree of freedom in timing for performing a task. There are two different types of float:

- the Total Float of a path, represents the maximum amount of time that will not delay the overall project;
- the Free Float, for each activity, represents the amount of time an activity can be delayed without delaying the start of its successors. Closely similar is the Independent Float, which is defined as the Free Float in the worst-case finish of all its predecessors.

In light of this definition, a critical path is that with a total float equal to 0. Those paths with a total float greater than 0 are called sub-critical and those with a float less than 0 are called hyper-critical. In this latter case, it is necessary, either by increasing the number of resources and the productivity rate or by changing the equipment and the technology, to expedite the network and bring the hyper-critical paths to critical, at least.

6.2.1 Precedence Diagramming Method (PDM)

PDM is an AON network method and goes beyond the CPM by including other inter-activities relationships such as Start-to-Start (SS), Start-to-Finish (SF) and Finish-to-Finish (FF) apart from the conventional Finish to-Start (FS). It also includes the possibility of adding “lags” or “leads” (negative “lags”) between activities. If we consider that there is a relationship XY (SS, SF, FS or FF) with lag “t” between activities A and B, then event Y of activity B can occur no earlier than t units after event X occurs for activity A.

In the PDM, the user can also add some constraints as in the CPM by assigning a fix date to a particular activity (it works as a milestone). One just needs to remember that milestones are given priority over relationships or other kind of links, so pay special attention to give "reachable" milestones. Otherwise, the links one may propose will be broken. Also, the user can set dates under the form of "must start/finish" constraints or as-late-as-possible calculations (e.g. must start on, no early than, etc.).

Some caveat of PDM need to be pointed out. It is important that the user clearly understands all the different relationships between activities, especially concerning the "lead" and "lag" concepts, which usually lack a specific standard and change from software to software. It is

also, important to stress that for a same activity there may be two differing floats: The Start Float (Late Start – Early Start) and the Finish Float (Late Finish – Early Finish).

As far as the CP under a PDM notation is concerned, choices on the relationships between activities clearly impact the critical path and tracing the critical path may be difficult for various reasons. For example, non-critical activities may have a critical start or finish date. Also, the critical path of the network may go backward through an activity, with the result that increasing the activity time may actually decrease the project completion time. Such an activity is called "reverse critical" and this happens when the critical path enters the completion of an activity through a finish constraint, continues backward through the activity, and leaves through a start constraint, as in the example drawn in Fig. (the longer Activity 2 is, the smaller the critical path duration – and the quicker the project can be completed):

Furthermore, as far as different software packages display the critical path differently, it is of great importance for the scheduler to use the software package as a tool and not to completely rely on its outcomes (e.g.: Microsoft Project displays as-late-as-possible constrained activities as critical if the project is scheduled from the start date)

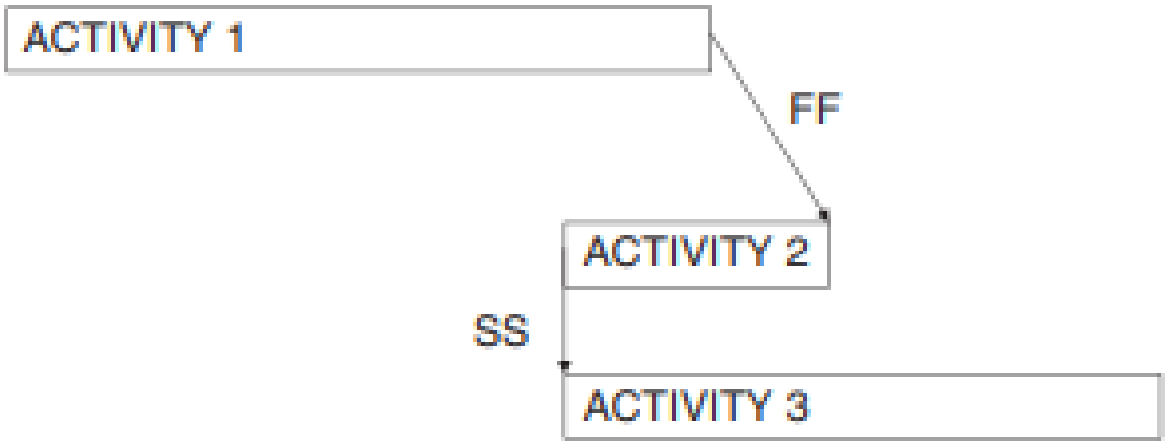

Figure 6.2.1 precedence diagramming method

6.3 Delay

6.3.1 Delay in Management

Delays in construction projects theme began to take substantial attention due to the complexity of the projects in terms of design and methods Implementation, and this is why many researchers to write on this subject, especially in the developing countries posed by the phenomenon of weight on development process on Government and private sector. The delay meant here is the amount of the difference Among the planned time for the construction project on the actual time of completion. In addition to a set of definitions as the implementation of work is later than expected, implementation is planned later and non-timely implementation.

Project delays can accrue any industry, any team and any individual project. One industry notorious for experiencing frequent and costly delays is the building and construction industry. A project delay can represent a costly occurrence for any organization. Therefore, it is important for an organization to understand what causes a delay and how to prevent delays from occurring.

Hinged identify activities that control the project end date on the following:

The project itself.

Contractor's plan and scheduling (particularly critical path method).

Contract requirements with regard to pursue business and stages.

Physical limitations for the project, how to perform work from a practical viewpoint. Regardless of how the project analysis and scheduling to create delays, an important criterion: careful analysis is taking into account contemporary information for those delays. "Information based on daily reports of contemporary scheduling realism, and any other data available and the business can show the circumstances surrounding the delays. The research and documentation true removes doubts and other hypotheses behind proactive conclusions or desired results.

6.3.2 Subcontractor Delays

A common cause of project delays is subcontractors and consultants. If a company contracts out labor for specific projects, certain delays may occur as a result of the contracted work, causing the project to become delayed. These situations are often difficult for an organization to anticipate and overcome and may require the organization to wait out the delay. A common cause of subcontractor delay results from subcontractors taking on too many projects at the same time.

6.3.3 Types of Delays in Projects

• Excusable Delays

Excusable delays are caused by conditions that are reasonably unforeseen and not within the contractor's / owner's control.

Examples of Excusable delays include:

- Labor strike
- Fires, floods, earthquakes and most natural disasters
- Changes requested by the owner
- Errors in the plans, design docs and specifications
- Differing site conditions or concealed conditions
- Lack of action by governmental or oversight bodies
- Intervention by outside agencies

Often the construction contract will outline valid excusable delay causes.

Excusable delays are those that are beyond the control of the owner/contractor and leaves them without fault or negligence.

• *Non-Excusable Delays*

Non-excusable delays are a result of a delay that was within control of the Owner/Contractor. The Owner/Contractor is fully responsible for the activity delays.

Examples of non-excusable delays include:

- Delayed packing
- Submission delays
- Overall delayed performance and implementation
- Late performance of subcontractors
- Delayed performance by suppliers
- Wrong work by contractor or subcontractor
- A specific labor strike for the project resulting from the unwillingness of the contractor to negotiate or through unfair employment practices

Non-excusable delays can be either compensable or non-compensable or can result in an extension of time.

• *Force Majeure Delay*

The delay resulting from force majeure is beyond the will of the contractor or the owner and it is agreed to solve the problem of forced delay between the owner and the contractor either by resorting to the judiciary or between them

6.3.4 Causes for Delays in Projects

They may be related to the following:

- inadequate estimations (budgets, timeframes, human resources)
- task complexity
- unexpected events
- organizational strategy prioritizing some projects over other due to strategic objectives
- inadequate coordination

There may be other causes as well as the ones cited here. But one should not forget that in a project, everything is related to everything else. Therefore, certain causes may be due to an interaction of other causes.

6.4 Crashing

Let us recall the critical path method: once activities are defined from WBS work packages and durations for each activity as well as cost and resources are estimated, then it is possible to plot the network and perform the CPM scheduling to estimate time, cost, and resource usage over the whole project.

If the total duration is compliant with the contract baseline, the schedule is terminated. If it is not acceptable, it is needed to impose other dependencies or added resources in order to reduce the project total duration ("project crashing"). Indeed, so far, scheduling has been referred to as time allocation; but, since time is a function of resource usage and the inherent related cost, possible tradeoffs exist between time and cost, and, more generally, between time and resources.

There are several ways to crash a project: supplying a higher number of human resources, using overtime or multiple shifts, and changing the technology.

Adding additional resources may not be possible or effective for several reasons. First, the available supply of a limited resource might be exhausted. Second, the wage for addition resources may be higher, or the resources might come in packages, such as a crew of 3 electricians. Thirdly, the productivity of additional resources might not be as high as the original resources. Training may be required, or limitations such as space or the nature of the task at hand might cause a slowdown of work.

Increasing the number of shifts avoids the problem of reduced productivity die to crowding, but has problems of its own, such as the increased cost of labor at night, and the natural fact that people are less productive overnight. Overtime is an option, but worker productivity drops dramatically after 40 h a week. Productivity rebounds slightly for a few weeks, but then drops off again. Overtime wages are also more costly than standard wages.

A change in technology can also reduce time and costs, but also has some drawbacks. More efficient equipment is most likely more expensive. Changing technology in a project might also create the need for some redesign or rework. In the end, the time saved by a technology

change might not be linear to the additional costs incurred. One thing that needs to be considered when scheduling is the type of task at hand. If the task has a fixed duration, such as the curing time of concrete, it cannot be crashed. In order to save time in this scenario, the technology might have to be changes to quick setting concrete.

As a result, project crashing inevitably increases the cost of the project: we call “crashed”, or accelerated, cost the cost associated with a crashed, or accelerated, duration of the network.

With this notion in hand, it is possible to optimize the network using the CPM. The first task is to schedule the project using a “normal” time frame and associated “normal” cost. The second step is to crash the project. This is done for two reasons: to reduce the normal finish date to less than the contract deadline if needed, and to establish the length of the project at minimum costs.

Crashing a project consists of reducing the time that it takes to complete the project. Usually this raises the cost of the project. In most cases, there are a few portions of the project that can be crashed, resulting in a high reduction in project time, but relatively small increases in cost. As more and more tasks get crashed, the relative gain in time to the increase in costs gets smaller. At some point it is no longer valuable to trade time for costs. The chart of Fig. 6.4.1 gives an example of this.

“When crashing a project, it is important to look at the critical path. There is no reason to crash tasks not on the critical path, because no time on the project will be saved, resulting in more cost with no time benefit. It is also important to watch how the critical path changes during crashing. After crashing a few tasks, the critical path might change, and then tasks not originally on the critical path will need to be crashed to reduce the project time. This makes a big difference in construction project management, as many managers would crash all the tasks” (Patrick, 2004) in a project to save time, when it is unnecessary to crash many of the tasks, as in the R point illustrated in Fig. 6.4.2.

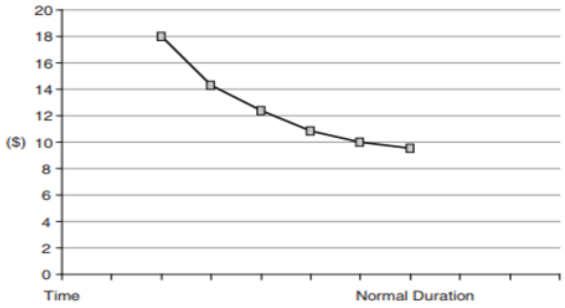

Figure 6.4.1 Crashing curve

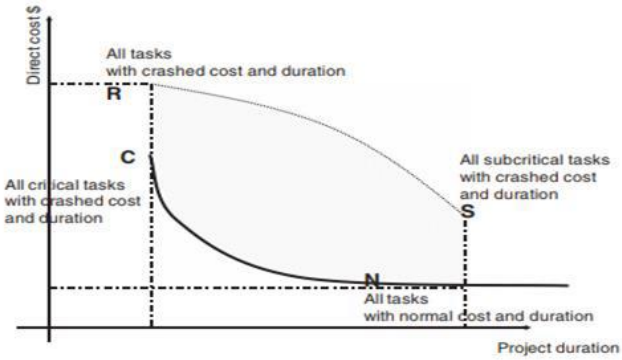

Figure 6.4.2 Time- cost configuration space resulting from all possible crashing of the project duration

CHAPTER SEVEN

RESOURCES

CHAPTER SEVEN: RESOURCES

A resource is a necessary asset whose main role is to help carry out a certain task or project. A resource can be a person, a team, a tool, finances, and time. Most projects require many different resources in order to be completed.

Resources should be assessed and allocated before a project begins. Poor resource planning can result in running out of resources midway through a project, delaying deadlines, and delivery of the final product or service.

7.1 Resource Management

Construction companies face the challenge of delivering often complex projects to a schedule, within a budget, and hopefully with a reasonable profit margin. Resource management is the process of planning the resources necessary to meet the objectives of the project, and to satisfy the client's requirements.

Without proper resource management, projects can fall behind schedule, or can become unprofitable. The objective is to ensure the adequate and timely supply of resources, whilst at the same time maximizing the utilization of resources between projects.

Construction resources might include:

- Products and materials.
- Construction plant, tools and equipment.
- Human resources.
- Space and facilities.
- Subcontractors.
- Finance.

Fundamental to resource management is real-time visibility of; what resources are needed, what resources are available, where resources are located, and the ability to reschedule those resources accordingly.

- A resource management plan can be used to:
- Ensure resource availability and resolve resource conflicts.
- Optimize time, effort and cost.

- Ensure workers with the right skills are available.
- Identify limitations, such as site access, weather conditions, and so on.
- Reassign resources in response to circumstances.
- Track resources utilization to avoid excessive resourcing or under-utilization.

It should list key information about the required resources for each activity:

Type of activity.

- Start date and duration of the activity.
- Activity owner.
- Resource type and quantity required.
- Source/supplier of each resource type.
- Equipment required.
- Cost estimates for each of the resources to be supplied.
- Risk mitigation.

7.2 Resource Leveling

In project management, resource leveling is defined by A Guide to the Project Management Body of Knowledge (PMBOK Guide) as "A technique in which start and finish dates are adjusted based on resource constraints with the goal of balancing demand for resources with the available supply". (Kerzner, 2001)

Project management is all about juggling your resources and your projects. Resource leveling allows project managers to balance resources over the course of a project and try to resolve conflicts between resources and leveling is a key component of project management.

Resource leveling is a technique in project management that overlooks resource allocation and resolves possible conflict arising from over-allocation. When project managers undertake a project, they need to plan their resources accordingly.

Resource leveling helps an organization to make use of the available resources to the maximum. The idea behind resource leveling is to reduce wastage of resources i.e., to stop over-allocation of resources.

Project manager will identify time that is unused by a resource and will take measures to prevent it or making an advantage out of it.

This will benefit the organization without having to face conflicts and not being able to deliver on time. Resource leveling is considered one of the key elements to resource management in the organization.

An organization starts to face problems if resources are not allocated properly i.e., some resource may be over-allocated whilst others will be under-allocated. Both will bring about a financial risk to the organization.

Resource leveling tries to take the available resources and compare them to the demands of ongoing projects. Often, many projects or tasks will overlap, creating strain on resources, especially manpower.

Resource leveling tries to take these competing demands and allocate resources effectively. Many times, this either means that a project will have to be delayed while other projects are completed. But sometimes this is not feasible. Often tasks need to be done for the project to be finished on time. A delay in one task could deeply affect the rest of the project.

Resource leveling is to lengthen the time it takes to finish a specific task. As opposed to a particular task taking one week, a project manager could extend that two weeks to make sure that there are enough resources to complete that particular task. Yet again, this could affect the overall project.

When leveling, the ultimate goal is always to fix over-allocation. Read Ronda Bowen's article about Resource Allocation for some ideas on ways you can achieve this goal.

While resource leveling can assure that money and manpower are available for all competing projects and tasks, it could affect your critical path. This can be a problem since you cannot tell in the beginning which tasks will be essential to the critical path. If a task that is delayed does affect your critical path, your project could become overdue and make for very unhappy clients. By default, the critical path is not displayed in a program like Microsoft Project. However, you can read Linda Richter's article, working with the Critical Path to learn how to display this helpful visual graph.

To make resource leveling more effective, a project manager should measure time in days and hours. This is easier to measure than any other dimension

7.2.1 Two Key Elements of Resource Leveling

As the main aim of resource leveling is to allocate resource efficiently, so that the project can be completed in the given time period. Hence, resource leveling can be broken down into two main areas; projects that can be completed by using up all resources, which are available and projects that can be completed with limited resources.

“Projects, which use limited resources can be extended for over a period of time until the resources required are available. If then again, the number of projects that an organization undertakes exceeds the resources available, then it's wiser to postpone the project for a later date.” (Rabner, 2012)

5.2.2 Structure of Resource Leveling

Many organizations have a structured hierarchy of resource leveling. A work-based structure is as Stages, phases and task\deliverable.

All of the above-mentioned layers will determine the scope of the project and find ways to organize tasks across the team. This will make it easier for the project team to complete the tasks.

In addition, depending on the three parameters above, the level of the resources required (seniority, experience, skills, etc.) may be different. Therefore, the resource requirement for a project is always a variable.

7.2.3 The Process of Assigning Resources

For resource leveling to take place, resources are delegated with tasks (deliverables), which needs execution. During the starting phase of a project, idealistically the roles are assigned to resources (human resources) at which point the resources are not identified. Later, these roles are assigned to specific tasks, which require specialization.

7.2.4 Resource Leveling Techniques

Critical path is a common type of technique used by project managers when it comes to resource leveling. The critical path represents for both the longest and shortest time duration paths in the network diagram to complete the project.

However, apart from the widely used critical path concept, project managers use fast tracking and crashing if things get out of hand.

- Fast tracking - This performs critical path tasks. This buy time. The prominent feature of this technique is that although the work is completed for the moment, possibility of rework is higher.
- Crashing - This refers to assigning resources in addition to existing resources to get work done faster, associated with additional cost such as labor, equipment, etc.

Resource leveling is aimed at increasing efficiency when undertaking projects by utilizing the resources available at hand. Proper resource leveling will not result in heavy expenditure.

The project manager needs to take into account several factors and identify critical to non-critical dependencies to avoid any last-minute delays of the project deliverables.

CHAPTER EIGHT

TIME MANAGEMENT USING PRIMAVERA SOFTWARE

ORACLE

PRIMAVERA P6

CHAPTER EIGHT: TIME MANAGEMENT USING PRIMAVERA SOFTWARE

8.1 General Introduction

Primavera is an enterprise project portfolio management software. It includes project management, product management, and collaboration and control capabilities. Primavera was launched in 1983 by Primavera Systems Incorporated, which was acquired by Oracle Corporation in 2008.

8.2 Entering the necessary data for the software

8.2.1 Project Definition

The parameters needed to define the project in Primavera software:

- Project ID: M.N.B
- Project Name: AL-Manara Project
- Project planned start date: 11 Jan 2017
- Major Rate type: Price /Unit

The following figure shows the project definition in Primavera:

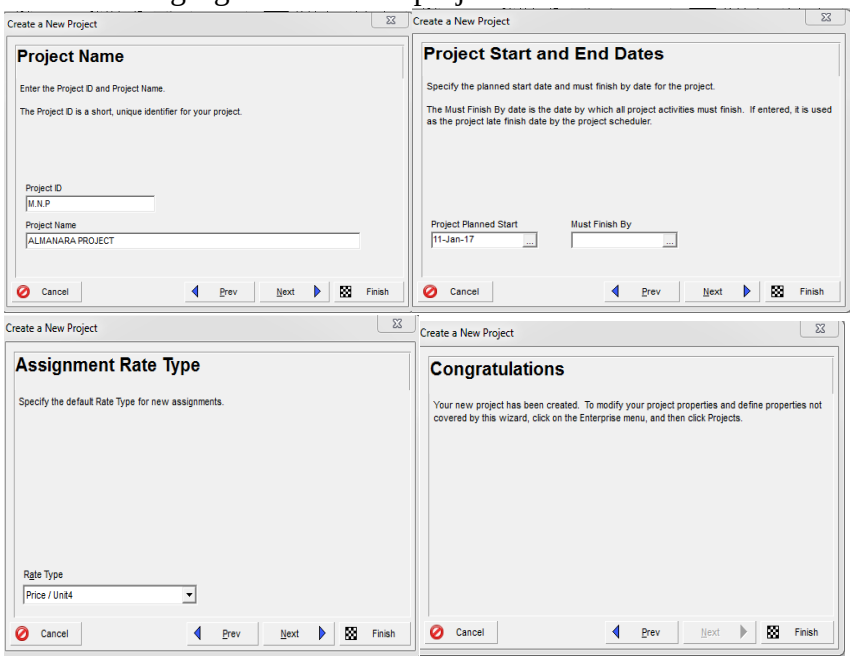

Figure 8.2.1 Project Definition Parameters in Primavera

8.2.2 Calendar Definition

The parameters needed to define the calendar in Primavera software:

Calendar Name: Nablus City Mall.

Work Hours per Day: 8.0 hr/d.

Calendar Weekly Hours: 8.0 hours for all week's days but Friday is holiday.

Hours per Time - Period: * 8.0 hr/day.

* 50.0 hr/ week.

* 300.0 hr/month.

* 3650 hr/year.

The following figure shows the calendar definition in Primavera:

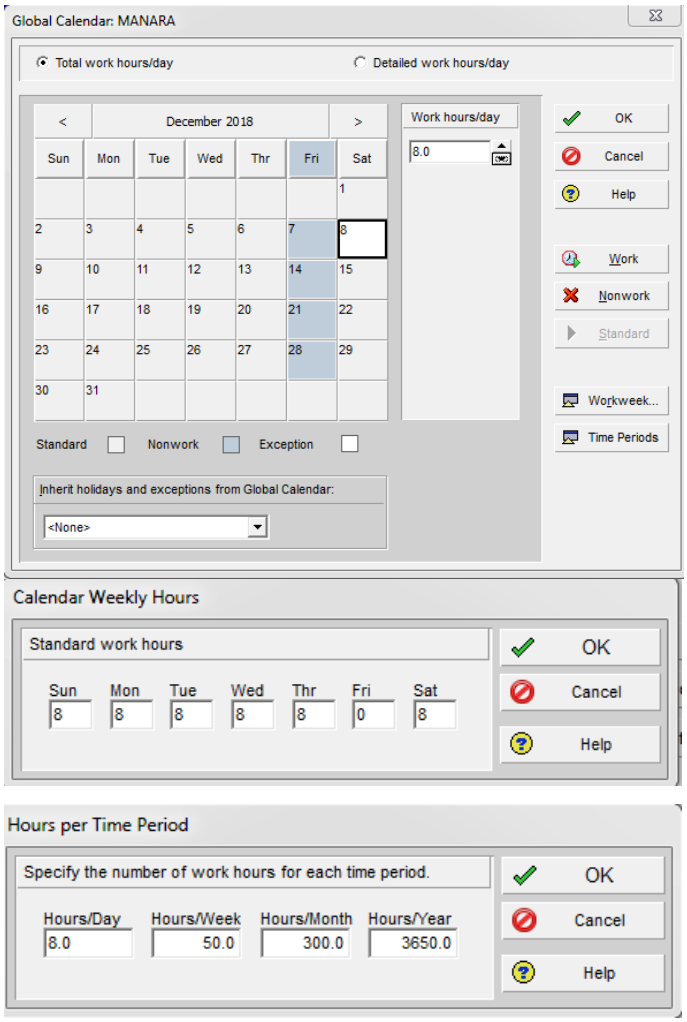

Figure 8.2.2 Calendar Definition Parameters in Primavera

8.2.3 Currency Definition

The parameters needed to define the currency in Primavera software:

- Currency ID: ISREAL.

- Currency Name: Shekel.

The following figure shows the currency definition in Primavera:

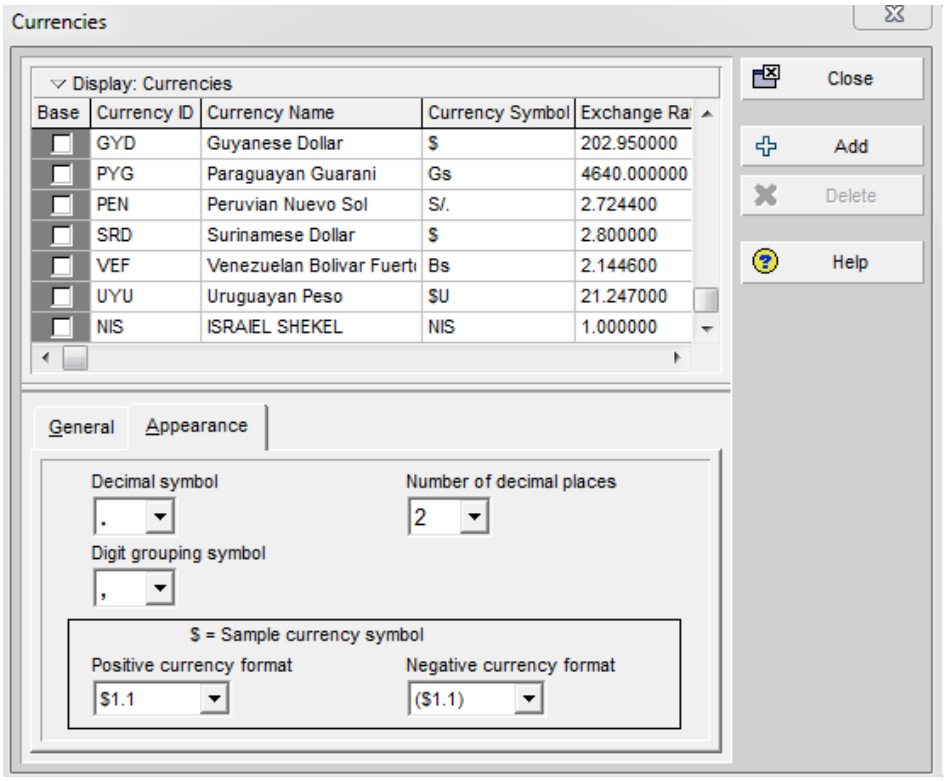

Figure 8.2.3Currency Definition Parameter in Primavera

8.2.4 Work Break down Structure (WBS) Assignment

The Following WBS levels used in the project as shown

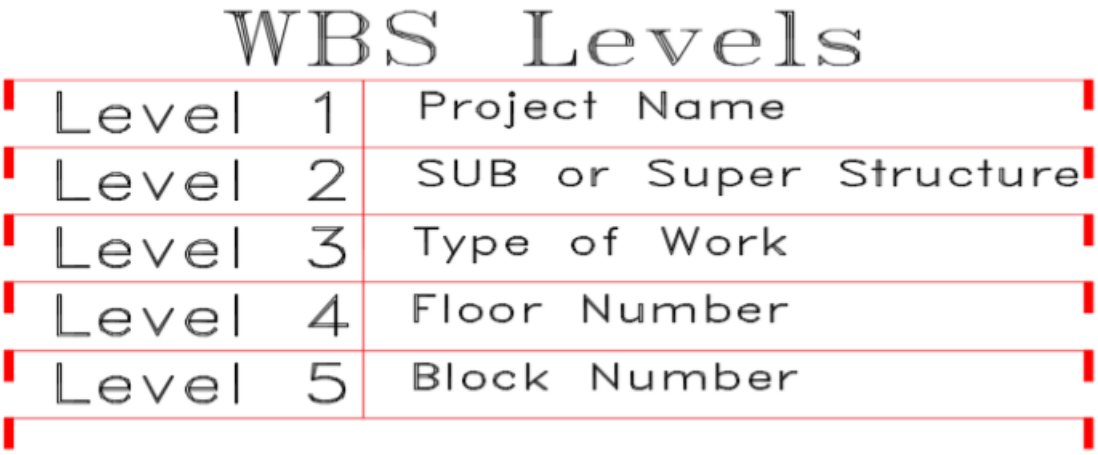

Figure 8.2.4 WBS Levels Used in the project

8.2.5 Activities Definition

After the work break down structure (WBS) assignment, the lowest level in WBS must divide to group of activities according to the work type, each activity has an ID, Name and Duration must assign them.

The following figure shows the activities groups according to the type of work:

ALMANARA PROJ.2 BEGINNINGS		50d	0%	11-Jan-17
A7360	Mobilization and site setup	10d	0%	11-Jan-17
A7370	Submittal and Approvals	40d	0%	25-Jan-17
A7380	Shop Drawing and Approval	30d	0%	11-Jan-17
A8110	Excavation,Backfilling & Site Works	50d	0%	11-Jan-17*
A8120	Site Excavation	49d	0%	11-Jan-17
A8130	Soil Testing	35d	0%	11-Jan-17
A8140	Excavation for foundations	16d	0%	11-Jan-17
A8150	Backfilling with single size	10d	0%	02-Feb-17

ALMANARA PROJ.4 Sub- Structure works		64d	0%	02-Feb-17
A7300	Blinding concrete	14d	0%	02-Feb-17
A7310	R.C for foundations	50d	0%	02-Feb-17
A7320	Insulation for foundations	2d	0%	13-Apr-17
A7330	Backfilling with selected material	4d	0%	17-Apr-17
A7340	R.C for wall necks(Elevetor walls)	5d	0%	21-Apr-17
A7350	Insulation for wall necks	3d	0%	28-Apr-17

ALMANARA PROJ.4.1 Earthing System		50d	0%	02-Feb-17
A8160	Welding the Strip Steel	30d	0%	02-Mar-17
A8170	Backfilling with base course	50d	0%	02-Feb-17
A8180	Perforated Pipes	8d	0%	02-Feb-17
A8190	Drainge System for W.C, basin, showers,kitchens, F.D anc	30d	0%	02-Mar-17
ALMANARA PROJ.4.2 Distribution Boards		4d	0%	11-Apr-17
A1420	Pipes and Sleeves	2d	0%	11-Apr-17
A1430	R.C for slab on grade	2d	0%	13-Apr-17

ALMANARA PROJ.5 5d Basement		113d	0%	17-Apr-17
A14520	R.Concrete for columns,walls and stairs	76d	0%	17-Apr-17
A14530	R.Concrete for slab	37d	0%	01-Aug-17
A14550	Insulation for exterior walls	20d	0%	01-Aug-17
A14560	Insulation for stone walls	3d	0%	29-Aug-17
A14570	Block walls for exterior walls -Inner side for stone walls	10d	0%	01-Aug-17
A14580	Block walls for exterior walls-outer side	10d	0%	29-Aug-17
A14590	First Fix	36d	0%	02-Aug-17
A14600	Drainge System for W.C, basin, showers,kitchens, F.D anc	3d	0%	18-Sep-17
A14610	UPVC Risers	3d	0%	27-Jul-17
A14620	Conduits and Draw Boxes	36d	0%	01-Aug-17
A14630	celing	4d	0%	15-Sep-17
A14640	Walls	8d	0%	20-Jul-17

Figure 8.2.5 Activities Groups in Primavera

8.2.6 Activates Relationships Assignment

According to sequence of activities, take one activity as an example, the following figure shows the relationships assignment between activates:

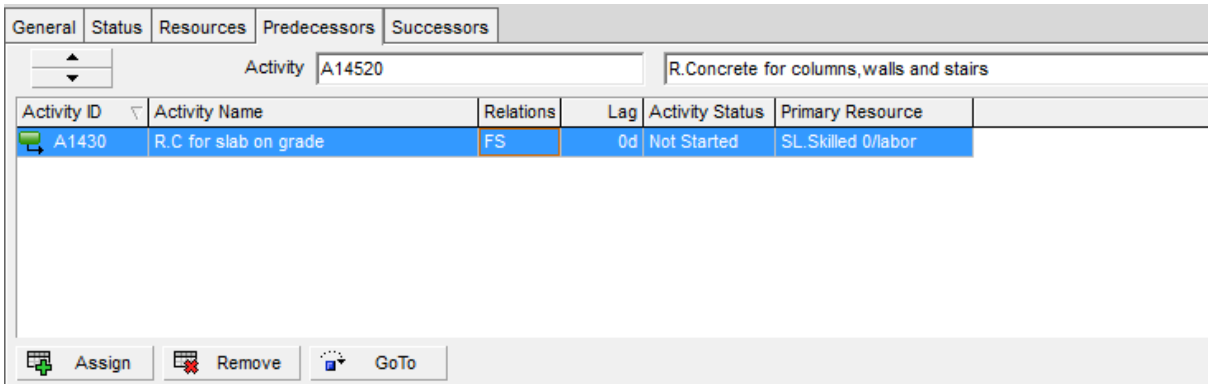

Figure 8.2.6 Relationships Assignment between Activates

8.2.7 Resources Assignment

The following parameters needed after assign the resource for each activity:

- Price / Unit for labors and materials resources.

- Budgeted unit for materials.

- Budgeted unit /Time for labor.

The following figure shows the parameter needed after assign the resources

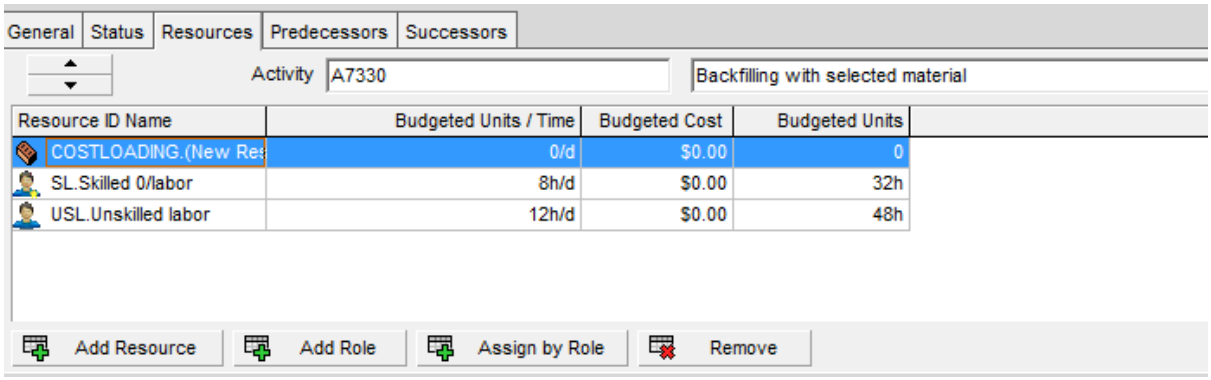

Figure 2.6.7 Relationships Assignment Between Activates

8.2.8 Schedule (Run)

After assign all parameters in the software, the last step makes the calculation-using schedule as shown:

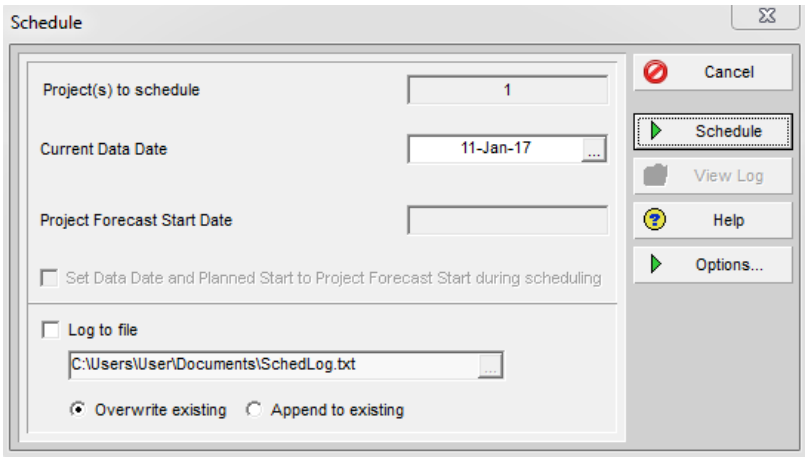

Figure 2.6.8 Scheduling Process Option in Primavera

CHAPTER NINE

COST AND PRICE ESTIMATE

CHAPTER NINE: COST AND PRICE ESTIMATE

9.1 Cost estimate

A project under estimation of resources and costs is one of the most common contributors to project failure. As such, project manager should be knowledgeable of and consider the variance industry techniques and tools in the definition and execution of project cost estimation. As defined by the project management body of knowledge (PMBOK), cost estimation is the iterative process of developing an approximation of the monetary resources needed to complete project activities. Project teams should estimate costs for all resources that will be charged to the project. This includes but it's not limited to labor, materials, equipment, services, hardware and facilities.

The following list includes common tools and techniques use in the project estimation:

- Expert judgment

Use of knowledge gained from past project management experience. Expert judgment, in conjunction with objective estimation techniques provides valuable information about the organizational environment and information from prior comparable projects.

- Analogues estimating

Use of the metrics from a previous, similar project as the basis of estimation for the current project. Analogues estimating takes the actual cost of previous, similar projects as the base line and then adjusts for known differences such as size complexity, duration, scope, etc.

- Parametric estimating

Use of a statistical relationship between historical data and other variable (for example, lines of code in software development) to calculate an estimate for activity parameters, such as scope, cost, budget and duration. Used correctly, this technique can produce high levels of accuracy.

- Bottom-up estimating

Estimating all individual work packages/ activities with the greatest level of detail, summarizing higher-level estimates with combination of the individual estimate. The accuracy of bottom-up estimating is optimized when individual work packages/activities are defined in detail.

9.2 Bill of quantity

9.2.1 Nature of Bills

Bills of Quantities comprise a list of items of work which are briefly described. The Bills also provide a measure of the extent of work and this allows the work to be priced. The work included in the item is defined in detail by the rules in the Method of Measurement. The item descriptions are therefore a shorthand to allow the relevant rules of the Method to be identified. The measure may be a single item or number, dimension (linear meter, square meter, cubic meter), time (hrs., weeks) or weight.

9.2.2 Function of bills

The Bills of Quantities may serve a number of functions as:

- A breakdown of the tendered price, with no contractual status, but providing information for the selection from tenderers.
- An estimate measure of the work for the tendered price, to be used to arrive at a revised contract price once the actual quantities of work carried out are measured. This is the remeasure form of contract.
- A schedule of rates as the contract basis for valuing variations in the work.
- A basis for measure of the value of work completed for interim payments.

9.2.3 Method of Measurement

Many contracts are let using Bills of Quantities, although this does not necessarily mean that the works are to be valued by re-measurement. The Bills of Quantities are required to be prepared using rules in a specified Method of Measurement. Many Standard Methods of Measurement are now in common use. The Method of Measurement will specify the division of work into categories. In the building industry the division is usually on the basis of different trades, and are generally very detailed. In the engineering industry the division is usually less complex and composite items are used describing the completed construction operation. There is normally a division for preliminary items such as mobilization, site set up and insurances. In contrast to the remainder of the Methods, preliminary items require large lump sums, in some cases time-related, but with little detail to allow the build-up to the item to be ascertained. Standard Methods of Measurement have become increasingly more complicated. They give

rise to claims for additional payment based on interpretation of the Method. The tendency has been for the Methods to provide detailed sub-division of work and therefore scope for claims based on ambiguities of interpretation, failure to measure the tendered Bills in accordance with the Method and the application of exceptions to measure.

9.2.4 Practice in *the Building Industry*

The item description simply identifies the extent of work priced, but the detailed requirements are to be found in the Specification and Drawings. The practice in the Building industry is to set out in the Bills of Quantities particulars required by the Conditions of Contract, with detailed specification for the work. Determining the precedence of such documents in interpreting the contract may create difficulties, since the Bills of Quantities will be a specially written or "one-off" document in contrast to the printed standard conditions. The normal rule (in absence of express terms) is that specially prepared documents will take precedence over standard printed conditions J Evans & Sons (Portsmouth) Ltd -v- Andrea Merzano Ltd (1976).

9.2.5 Mistakes in Bills

Mistakes in the bill descriptions or quantities are unlikely to be remedied as a legal rectification of the terms of the contract to reflect the true intention of the parties. It is more likely than not, that the common intention will be that the tendered price should prevail, rather than a price revised to account of the error. Most standard forms of contract which adopt Bills of Quantities make provision to deal with errors in bill descriptions and quantities, distinct from the effect of variations.

9.2.6 Standard Forms

The Standard Forms of contract normally used for civil engineering adopt the bills of quantities for re-measurement. In the building industry the price is usually a lump sum, and the bills are intended to be simply a guide to allow the price to be determined. However, matters are not so simple, and provisions for the adjustment if there are errors in the bills makes the standard JCT with quantities form effectively re-measure. All forms use the rates and prices in the bills as a schedule of rates for valuation of variation.

9.3 Direct and Indirect Cost

The quantities of the concrete were calculated by Revit and the steel reinforcement was calculated by Excel sheets.

So, the cost of the project was calculated by multiply the quantity and the unit price for each item.

Material type	Waste factor (%
Precast concrete piles	5
Steel piles	2.5
Wood piles	20
Cast iron pipes	10
Reinforced concrete pipes	6
Corrugated metal pipes	7.5
PVC pipes	6
Vitrified clay pipes	10
Chain link fencing	2.5
Wood fencing	5.5
Ready-mix concrete	7.3
Reinforcing steel bars, light weight, bar #10 and 15	5.7
Reinforcing Steel bars, medium weight, bar # 20 and 25	4
Reinforcing Steel bars, heavy weight, bar # 30 and up	3.3
Formwork	25
Bricks	6
Concrete masonry units	5
Mortar	13
Metal studs	10
Wood	17.9
Plywood	16.7
Fiberboard	16.7
Asphalt roofing shingles	10
Clay roofing tiles	12
Concrete Roofing tiles	15
Roofing felt	10
Built-up roofing	5
Metal roofing	15
Sheet metal—coping, gutter, downspout, flashing	15
Acoustical tile	8
Acoustical board	4
Acoustical panels	4
Acoustical ceiling grid, suspension system	3
Wood flooring—parquet	5
Resilient flooring—tile (vinyl and asphalt)	5
Resilient flooring—sheet (vinyl and linoleum)	10
Carpeting	8
Paint	10

Figure 9.1 Materials Waste Factor

9.4 Costing for each Item

9.4.1 Site Leveling and Foundation Excavation

The cost of site leveling and foundation excavation will be calculated as shown

Cost = Excavation quantity * unit price (Equipment's + material+ labor + profit)

Site Leveling and Excavation to reduced level.

= (9 + 3 + 6 + 10) * 22093.6

=618620.8 NIS

Excavation for Foundation

= (18 + 6 + 8 + 13) * 3216.24

= 144930.8 NIS

Imported fill

= (42 + 8) * 5939.45

= 296972.5 NIS

9.4.2 Blinding and Mat Foundation Price

The cost of the blinding concrete

Cost = Blinding quantity * unit price (Material + labor + profit)

= 223.84 * (320 +62 +50)

= 96698.88 NIS

The cost of Mat Foundation

Cost = quantity * unit price (Material + labor + profit)

= 3000 * ((320 + 272 + 140) +200 +230)

= 3486000 NIS

9.4.3 Walls and Columns Price

Cost = quantity * unit price (Material + labor + profit)

For wall thickness

= 2500 * ((320 + 272 +140) + 80 + 203)

=2537500 NIS

For column

= (420 + 320 + 208 +250 + 662) *1593

= 2962980 NIS

9.4.7 Bill of quantity for the project

Table 3.4.7 Bill of Quantities

Item Description	unit	Quantity	RATE (NIS)	AMOUNT (NIS)
Site Leveling and Excavation to reduced level.	C.M	22093.6	28.00	618620.8
Excavation for Foundation	C.M	3216.24	45.00	144730.8
Imported fill	C.M	5939.45	50.00	296972.5
Supply and cast plain concrete, blinding concrete grade B 200 under foundations and tie beams	C.M	223.84	432.00	96698.88
Mat foundation	C.M	3000	1162.00	3486000
Ground & Tie beams including concrete nibs for stone building where needed.	C.M	195.00	1315.00	256425
Column Necks.	C.M	387.00	1400.00	541800
Supply and cast reinforced concrete grade B400 for Columns	C.M	1860.00	1593.00	2962980
Reinforced Fair Face Concrete walls; (Shear walls)	C.M	2500	1015.00	2537500
Slab on Grade for Landscape and site works (15 cm) thick.	C.M	46.00	650.00	29900

18 cm Solid Slab	C.M	324.00	430.00	139320
20 cm Solid Slab	C.M	360.00	420.00	151200
25 cm Solid Slab	C.M	450.00	420.00	189000
32 cm Solid Slab	C.M	576.00	510.00	293760
50 cm Solid Slab	C.M	900.00	550.00	495000
Supply and Cast Reinforced Concrete Grade 'B300', with a minimum cement content of 300 Kg. per cubic meter for 28 cm thick suspended ribbed slabs	C.M	570.00	345.00	196650
Supply and Cast Reinforced Concrete Grade 'B300', for 50 cm thick suspended Waffle slab	C.M	400.00	354.00	141600
supply and apply monolithic surface hardener on the surface of parking floors	C.M	1500.00	18.00	27000
Supply and Cast Reinforced Concrete Grade B300 for stairs	C.M	640.00	1022.00	654080
Supply and Cast Reinforced Concrete Grade B300 for Circular stairs.	C.M	780.00	1350.00	1053000
10 cm thick walls (10X20X40)	M.S	2359.00	81.00	191079.00
15 cm thick walls (20X20X40)	M.S	39.00	113.00	4407.00
20 cm thick walls (20X20X40)	M.S	988.00	113.00	111644.00
10 cm thick for Exterior Walls thermal insulation inner side (10X20X40),	M.S	1651.00	100.00	165100.00
10 cm thick for Exterior Walls for Basement outer side (10X20X40), specifications and Engineer's instructions.	M.S	1934.00	100.00	193400.00
Stone Works : (25+1) cm course height stone façade for Building.	M.S	2139.00	420.00	898380.00
Supply and build stone walls local stone				
(25+1) cm course height stone façade for Building.	M.S	4190.00	530.00	2220700.00

(25+1) cm course height stone for Landscape walls and planters, at any size and texture as required by drawings.	M.S	415.00	470.00	195050.00
Copings, Supply and build 5 cm Stone Copping, for roof and terraces, openings, parapets	M.S	839.00	455.00	381745.00
Supply and build stone site walls	M.S	30.00	570.00	17100.00
Supply and Build 5 cm Stone Copping, for landscape walls, parapets, and other tops,	M.S	43.00	470.00	20210.00
Supply and install Stone Tiling Floor with Local stone tiles and granite	M.S	457.00	380.00	173660.00
Total cost				18884712.98

RESULTS AND CONCLUSIONS

As we said in the introduction of this chapter, we applied the principles of project management to analyze our project and we show what an expected life of project management is, so we gain from this project a lot of experience and information in how to deal with projects and manage it in time and cost.

First, we use Revit program to analyze the quantities then make the WBS and activity list and enter it into Primavera Project Planner (16.1) and run the program and take the results.

- The total project cost is 18,884,712.98 NIS.
- The project planning start at 11 Jan 2017, and the latest finish date is 1 Jan 2020.
- The duration for the project is 1091 calendar days and 778 working days.

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