Construction Management

Integrity

Honesty

Fairness

Service

An-Najah National University

Faculty Of Engineering
Civil Engineering Dept

Construction Management..
.. Graduation Project.

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إهـداء

إلى ربيع العمر
إلى الزهرة التي لا تذبل
إلى امي الغالية

إلى من علمني ورباني
إلى من وفر لي كل ما احتاج
إلى والدي العزيز

إلى من أستمد من عيونهم الأمل بالمستقبل
إلى أخواتي و إخواني الأعزاء

إلى أرضنا فلسطين الحبيـبـة
إلى من ترحل عيوننا اليها كل يوم ..
إلـــى الــقـدس العظــيمة

إلى اصدقائي الأعزاء
إلى أقاربي الاحباء

إلى أساتذتي الذين يقطفون ثمرة تعبهم
إلى الهيئة التدريسية في كلية الهندسة- جامعة النجاح الوطنية
واخص بالذكر أ. لؤي دويكات, أ. ابراهيم محاميد لمجهودهما الكبير

اليكم جميعا
أهدي عملي هذا

حسن حمادنه

اهــداء

إلى السنبلة الذهبيّة في بِلادي و بيّارات البرتقال
إلى كرومِ العِنَب و غصن الزيتون و دَم الشهداء و دَمعة الأطفال
إلى غزّة و مآسيها
إلى رغيف الطابون و ريح الزَعتر
إلى فِلسطين تِلك التي صَنعتني كَي أكونَ هُنا

إلى مَن علّمني كَيف الصعود و حَمل لي شُعلةً
تلذذ بحروقاتِها في يَديهِ لينيرَ لي دَربي
إلى ذاك الرَجل الذي عَلَمني العِزّة و كحّل عينيّ بالكِبرياء
إلى ذاكَ الذي ما زالت عينيه تَصنعني طِفلة حَتّى اللحظة!.
"إليكَ والدي"
و إليها..
و إلى الحضن المعبَق بأريج الوَطن
وِ اليَد التي اندّست في خِصال شِعري و صوتها الشجيّ يَروي لي حَكايا الجِدّ و النجاح قَبل النوم كَي أحلُم بِها
مَن علّمتي كَيف أقِف أمامَكم في لَحظةٍ تَتسابق فيها الدموع لمقلتيّ
"إليكِ أمّي"
إلى مَن اجتمعوا مَعي على دِفء مَوقِد الشِتاء و تَقاسموا مَعي ظلمَة ليلِ واحِدة
"إليكم إخوتي"
و لا أنسى مَن علّمني حَرفاً أن أكونَ لهُ عَبداً
و كلّ مَن سَبقني الطَريق و سيلحَقني إليها مِن طلاّب عِلم
لِجامعتي التِي تركتُ مذكّراتي عَلى مقاعِدها
لكم جَميعا أُهدي سَهري و تَعبي و جَهدي

هاشم حرزالله

اهــداء

إلى ... من كلّت أنامله ليقدم لي لحظة سعادة
إلى ... من حصد الأشواك عن دربي ليمهد لي طريق العلم
إلى ... القلب الكبير ... والدي العزيز

إلى ... من أرضعتني الحب والحنان
إلى ... رمز الحب وبلسم الشفاء
إلى ... القلب الناصع بالبياض ... والدتي الحبيبة

إلى ...القلوب الطاهرة الرقيقة والنفوس البريئة إلى رياحين حياتي ... إخوتي

إلى ... الارواح التي سكنت روحي

إلى ... من كانوا ملاذي وملجئي

الى ... من احمل اسمك بكل فخر

إلى ... من علموني علم الحياة .... اساتذة العطاء

واخص بالذكر أ. لؤي دويكات, أ. ابراهيم محاميد لمجهودهما الكبير

إلى الذين أحببتهم وأحبوني ... أصدقائي

اليكم جميعا
أهدي عملي هذا

مشرف عدنان ابو زبيده

اهداء

الى رب وفقني وانار لي الدرب في رحلاتي..................

الى ام سهرت وربت وبكت عيونها فرحا بنجاحاتي............

الى اب تعب وربى وانحنى ظهره تحقيقا لطموحاتي...................

الى اخ واخت ساندانى وتعانقت دعواتهم مع دعواتي...............

الى معلم لم يبخل بعلمه وعطاءه في زيادة علاماتي............

الى صديق قوى عزيمتي وشاركني في اسعد لحظاتي..............

الى من اشعلت نور ظلامي وخطت بعبيرها اجمل حكياتي...........

صادق حرزالله.

Contents

PART ONE

Section One

CH 1

Define The Project

1.1 Preface

"**work** " was first scientifically studied by Fredrick Taylor (1856-1915), who also was the first to consider process design. But not until the early of 1950s were many project management techniques assembles into a single , coherent system: the focus of that enormously complex effort was the U.S. Defense Department's development of the Polaris missile . The techniques , which included Henry Gantt's chart , which he created manage Army logistics , were essential to managing the intricacies of how work among an array of specialists would be handed off, and how the schedule itself would be managed . At the center of this effort was literally a project "war room" , which prominently displayed huge Program Evaluation Review Techniques (PERT) charts.

Following quickly in military's footsteps were the automotive and movie industries, and private and public engineering organizations. All shared the need for creating unique outcomes, and they found that the project management techniques helped cross-functional teams define, manage, and execute the work needed to accomplish these ends. Along with such techniques as histograms and network diagrams, early practitioners of project management also employed the concept of a project life cycle and began to incorporate that thinking when generating more complex Work Breakdown Structures (WBSs). A WBS comprehensively identifies the *individual* tasks required to achieve an objective.

More recently, new project management techniques (e.g., for creating cross-functional schedules, managing shared resources, and aligning project portfolios), the widespread use of personal computers, and the growing sophistication and availability of project management software tools have all increased the effectiveness of a *methodology* for addressing a variety of project problems. [Harvard Business School Project Management Book]

1.2 Over View

1.2.1 Introduction

Imagine; that you've just been given the job of completing a very large project. Your sources are limited, your budget is very small, and your deadline is short. The precise goals of the job have not been defined as well as you'd like, and you don't know where to start.

This situation challenges your management skill on many levels. You'll have to ask for a definition of just what you're expected to achieve. Then you'll need to plan well enough so that you will accomplish the desired result, by the deadline and within budget. Rarely will you be given a well-defined, fully budgeted project and asked merely to pilot your resources through to the end result. More likely you will be given an assignment that includes nothing beyond the demand for a generalized end result. The rest is up to you.

This project shows you how to take charge of a big project, define it, and then break it down into smaller, more manageable phases. And how to control a budget and schedule and lead a project team through to successful completion.

You will find out how to anticipate problems and plan for them during the various project phases. And establishing clear objectives for your project, even when they are not defined at the point of assignment. Because it's a long-term process, project management causes even well-organized managers to experience difficulty.

However, the context is different: First, a project is nonrecurring, so problems and solutions are not matters of routine; second, unlike the limitations on your department's range of tasks, a project often crosses departmental and authority lines; third, a project is planned and organized over several months, whereas recurring tasks are projected ahead only for a few days or weeks.

Managing a project doesn't require any skills you don't already possess; you will employ the same management skills you use elsewhere. The planning, organizing, and execution steps just require greater flexibility and a long-term view than your recurring tasks do, and the project is an exception to the daily or monthly routine.

Running a project is like starting up a new department. What distinguishes both activities from your other tasks is that there's no historical budget, no predictable pattern to the problems or resistance points, and no cycle on which to base today's actions.
Here you'll create. That structure will take on a style, character, and arrangement of its own, but it must rest on a solid base of organizational skills, definition, and control.

1.2.2 What Is Project & Project Management

A project is defined as a problem scheduled for solution, done only once, whereas most jobs are ongoing or repetitive, and managing one-time jobs is different from managing ongoing ones. For one thing, the people who work on a project may be reassigned to other jobs once the project is completed, so the team is temporary. Often the team members do not report to the project manager on a regular basis, meaning that the project manager has no direct authority over them, a situation that presents its own set of problems.

Project management is the planning, scheduling, and controlling of project activities to meet project objectives. The major objectives that must be met include performance, cost, and time goals, while at the same time you control or maintain the scope of the project at the correct level.
Ideally, the scope of a project should remain constant throughout the life of the job. Naturally, this seldom happens. In most cases the magnitude (scope) of the work increases as a result of overlooked details, unforeseen problems, or an inadequately defined problem. The most common reason for scope changes is that something is forgotten. Scope generally increases. In fact, about the only time project scope decreases is when the budget is cut and some of the originally planned work is put on hold. The problem with scope changes is that they tend to be small and incremental; if a number of them occur, the project budget or schedule may suffer. This is a fairly common cause of project failures. [James P. Lewis - Fundamentals of Project Management].

A project manager should advise stakeholders (especially customers) of the impact on the project of a change in scope so that decisions can be made about how to handle such changes. If a customer is told that a requested change will result in a 20% increase in project costs, the customer may opt to defer the change. If the impact is not made clear, the customer may ask for the change, thinking the costs will not increase significantly, and be very dismayed at the end of the job to learn of the true impact. A project manager has a responsibility to keep stakeholders informed about the impact of scope changes on the project, protecting them from surprises at the end of the job and protecting the project manager from being evaluated on original targets rather than on revised ones. [James P. Lewis - Fundamentals of Project Management].

Figure (1.1).

Figure (1–1) is a pictorial representation of project management. The objective of the figure is to show that project management is designed to manage or control company resources on a given activity, within time, within cost, and within performance. Time, cost, and performance are the constraints on the project. If the project is to be accomplished for an outside customer, then the project has a fourth constraint: good customer relations. The reader should immediately realize that it is possible to manage a project internally within time, cost, and performance and then alienate the customer to such a degree that no further business will be forthcoming. Executives often select project managers based on who the customer is and what kind of customer relations will be necessary.

1.2.3 Project Parameters

The most important element of any project plan is knowing the project's objectives and deliverables. The purpose of the define the project parameters step is to ensure that the "right" project is being done. The "right" project is defined in terms of the expected outcomes or scope, the schedule, and the resources expended. Which include the powerful "Is/Is Not" process.

The Project Objective Statement (POS); describes what the project is to accomplish, when it is to be accomplished, and how much it will take to accomplish it. These are referred to the scope, schedule, and resources of the project. All POS's should have these three parameters.

The scope; Project size, goals, requirements, portion of the POS captures the essence of the desired results. Most literature on project management speaks of the need to manage and balance three elements: people, time, and money. However, the fourth element is the most important and it is the first and last task for a successful project manager. First and foremost you have to manage the project scope. Scope generally increases. In fact, about the only time project scope decreases is when the budget is cut and some of the originally planned work is put on hold. The problem with scope changes is that they tend to be small and incremental; if a number of them occur, the project budget or schedule may suffer. This is a fairly common cause of project failures.

When you have the project scope clearly identified and associated to the timeline and budget, you can begin to manage the project resources. These include the people, equipment, and material needed to complete the project.

The resources; portion of the POS captures of resources to the project;

- People:
  Project employees, vendor staff, subcontract labor.
- Equipment:
  Cranes, trucks, backhoes, other heavy equipment or
  Development, test, and staging servers, CD burners or
  Recording studio, tape decks, mixers, microphones and speakers.
- Material:
  Concrete, pipe, rebar, insulation or
  CD blanks, computers, jewel cases, instruction manuals.

Managing the people resources means having the right people, with the right skills and the proper tools, in the right quantity at the right time. It also means ensuring that they know what needs to be done, when, and how. And it means motivating them to take ownership in the project too.

The schedule portion of the POS captures the desired completion date for the project . Thus , the schedule portion of the moon shot POS was " by the end of the decade." While this captured people's imagination, as a schedule target for a project it is a little too vague "by the end of the decade" could mean a year early, or six month early, or the very last day of the decade.

1.3 Project Life Cycle

The term project lifecycle models how a project is planned, controlled, and monitored from its inception to its completion. The level of formality and complexity of the lifecycle for each project is constrained by any number of factors, including budgetary constraints, project team experience, project size, and project complexity.

Some experienced and highly respected project leaders and programmers consider rigid application of lifecycle plans to be a theory that does not work well in practice.

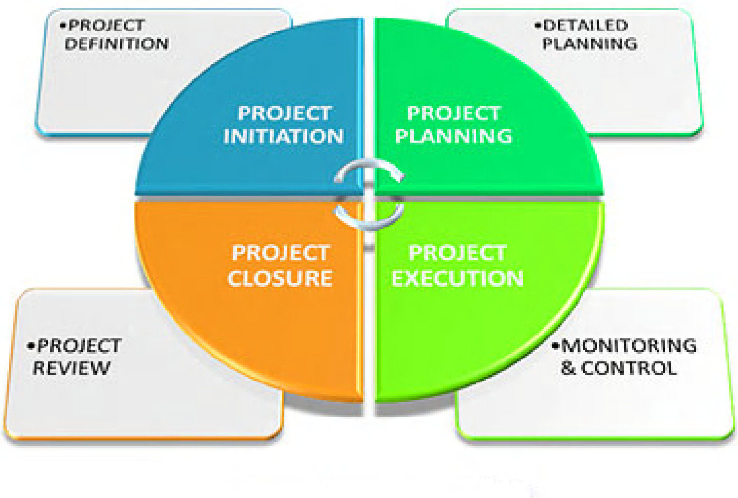


Figure (1.2).
Project Life cycle.

- *Project Initiation:*

Project Initiation is the first phase in the Project Life Cycle and essentially involves starting up the project. You initiate a project by defining its purpose and scope, the justification for initiating it and the solution to be implemented. You will also need to recruit a suitably skilled project team, set up a Project Office and perform an end of Phase Review.

- Project Planning:

After defining the project and appointing the project team, you're ready to enter the detailed Project Planning phase. This involves creating a suite of planning documents to help guide the team throughout the project delivery.

- Project Execution:

With a clear definition of the project and a suite of detailed project plans, you are now ready to enter the Execution phase of the project. This is the phase in which the deliverables are physically built and presented to the customer for acceptance. While each deliverable is being constructed, a suite of management processes are undertaken to monitor and control the deliverables being output by the project. These processes include managing time, cost, quality, change, risks, issues, suppliers, customers and communication.

Once all the deliverables have been produced and the customer has accepted the final solution, the project is ready for closure.

- Project Closure:

Project Closure involves releasing the final deliverables to the customer, handing over project documentation to the business, terminating supplier contracts, releasing project resources and communicating project closure to all stakeholders. The last remaining step is to undertake a Post Implementation Review to identify the level of project success and note any lessons learned for future projects. [http://www.publicprocurementguides.treasury.gov.cy/OHSEN/HTML/index.html?1_3_project_lifecycle.htm].

1.4 Study Objectives

Project management is an emerging profession. The primary purpose of this graduation project is to identify and describe project management items, and subjects that are applicable to most projects most of the time. The project management team is always responsible for determining what is appropriate for any given project.

This project is also intended to provide common terms within the profession and practice for talking and writing about project management. Project management is a relatively young profession, and while there is substantial commonality around what is done, there is relatively little commonality in the terms used.

This project provides a basic reference for anyone interested in the profession of project management, and improves your skills in cost estimating and scheduling, this includes, but not limited to:

- Using Work Breakdown Structure to plan a project.
- Establishing the schedule of a project, and time duration.
- Cost estimating.
- Resource management.
- Risk management.
- Quantification; bill of quantities (BOQ).
- Using Primavera software at scheduling and durations.
- Discuss management problems, some tricks and solutions.

1.5 Methodology & Study Organization

Construction Project Management is the overall planning, co-ordination and control of a project from inception to completion aimed at meeting a client's requirements in order to produce a functionally and financially viable project that will be completed on time within authorized cost and to the required quality standards. Project management is the process by which a project is brought to a successful conclusion.

This project discuss the construction management items, get you the knowledge about construction management; define the project, how to plan it, and how to track and manage the projects, and how successful manager coordinate and supervise the construction process from the conceptual development stage through final construction, they oversee planning, scheduling, completion of projects.

The project consists from two parts; the first is theoretical part, and another is practical part.

- **Part (I), Theoretical Part:**

  This part talking about the items of construction management, define each item, developing it, discuss important issues about each items.

  And its divide into three sections:
  - **Section One**: Define & organize the project; one chapter show profile of projects and project management.
  - **Section Two**: Plan the project; contains many chapters of planning the projects like Work Breakdown Structure (WBS), Cost Estimating, Scheduling, Resource Management, and finally Risk Management.
  - **Section Three**: Track & manage the projects; two chapters talking about Quality Control, and next Discussion the project.
- **Part (II), Practical Part;**

  This part applies the theoretical part at an actual project, by doing WBS to the project, Quality Surveying; estimating and manages resources.

  At this part, managing is done using a computer software program which is Primavera software; this program is used for schedule and the durations of the project.

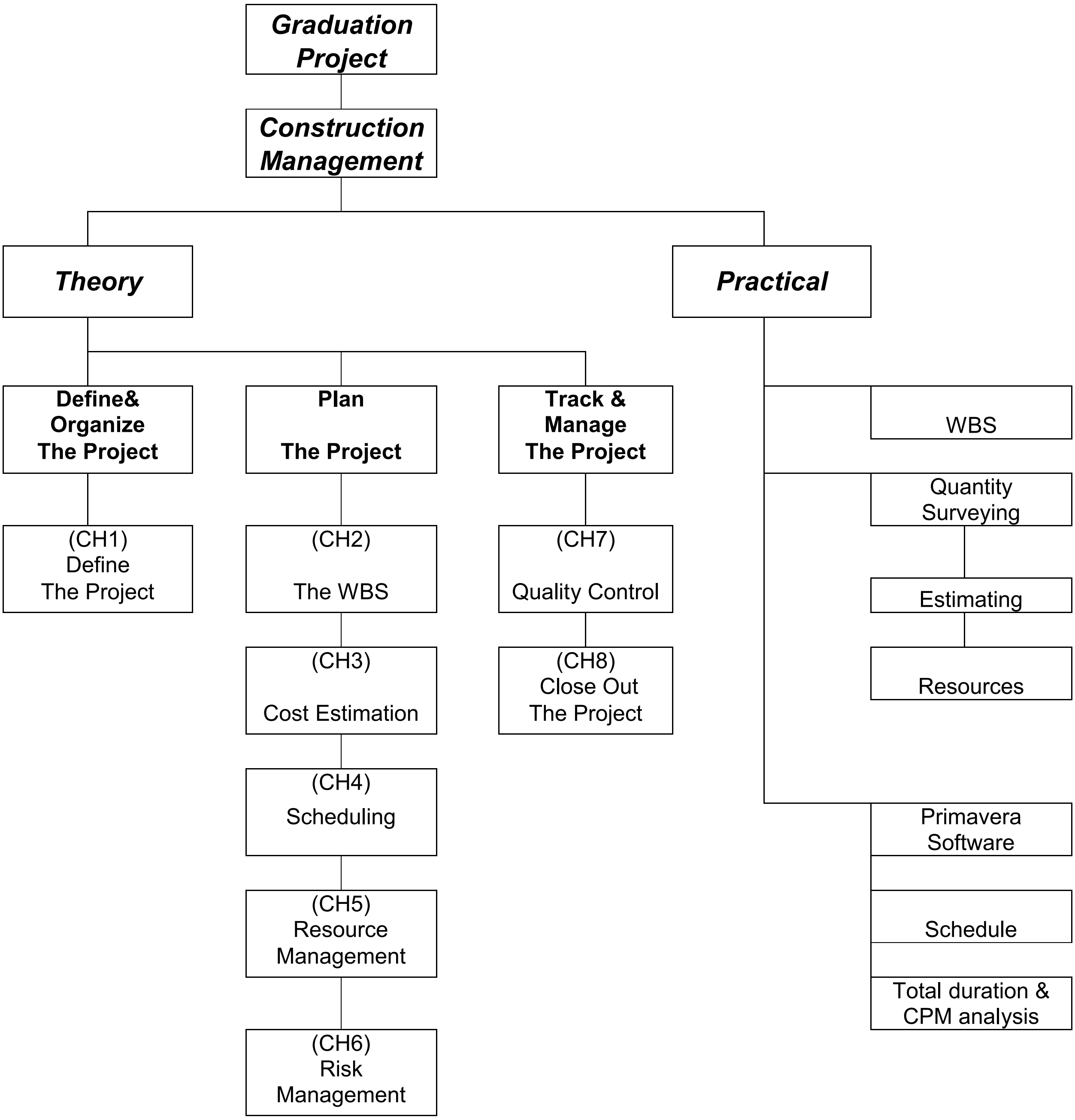


Figure (1.3): Study organization.

Section Two

Planning.

Introduction

The most important responsibilities of a project manager are planning, integrating, and executing plans. Almost all projects, because of their relatively short duration and often prioritized control of resources, require formal, detailed planning. The integration of the planning activities is necessary because each functional unit may develop its own planning documentation with little regard for other functional units.

Planning, in general, can best be described as the function of selecting the enterprise objectives and establishing the policies, procedures, and programs necessary for achieving them. Planning in a project environment may be described as establishing a predetermined course of action within a forecasted environment. The project's requirements set the major milestones, and the line managers hope that they can meet them. If the line manager cannot commit because the milestones are perceived as unrealistic, the project manager may have to develop alternatives, one of which may be to move the milestones. Upper-level management must become involved in the selection of alternatives during the planning stage. Planning is, of course, decision making, since it involves choosing among alternatives. Planning is a required management function to facilitate the comprehension of complex problems involving interacting factors.

The project manager is the key to successful project planning. It is desirable that the project manager be involved from project conception through execution. Project planning must be systematic, flexible enough to handle unique activities, disciplined through reviews and controls, and capable of accepting multifunctional inputs. Successful project managers realize that project planning is an iterative process and must be performed throughout the life of the project.

If the project is large and complex, then careful planning and analysis must be accomplished by both the direct- and indirect-labor-charging organizational units. The project organizational structure must be designed to fit the project; work plans and schedules must be established so that maximum allocation of resources can be made; resource costing and accounting systems must be developed; and a management information and reporting system must be established.

CH 2

Work Breakdown Structure.

2.1 Introduction

The first major step in the planning process after project requirements definition is the development of the work breakdown structure (WBS). A WBS is a product-oriented family tree subdivision of the hardware, services, and data required to produce the end product. The WBS is structured in accordance with the way the work will be performed and reflects the way in which project costs and data will be summarized and eventually reported. Preparation of the WBS also considers other areas that require structured data, such as scheduling, configuration management, contract funding, and technical performance parameters.

The WBS is the single most important element because it provides a common framework from which:

- The total program can be described as a summation of subdivided elements.
- Planning can be performed.
- Costs and budgets can be established.
- Time, cost, and performance can be tracked.
- Objectives can be linked to company resources in a logical manner.
- Schedules and status-reporting procedures can be established.
- Network construction and control planning can be initiated.
- The responsibility assignments for each element can be established.

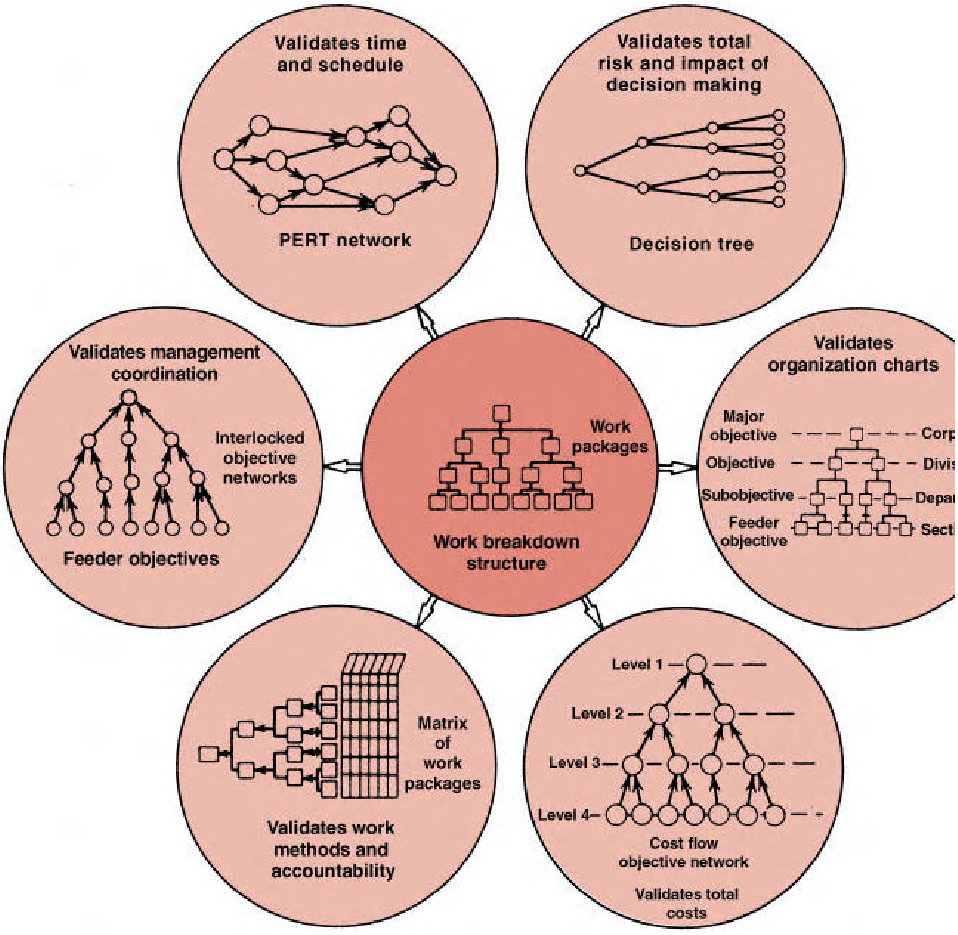


Figure (2.1).
Work breakdown structure for objective control and evaluation.
Source: Paul Mali, *Managing by Objectives* (New York: Wiley, 1972) p. 163.

2.2 Defining the WBS

A work breakdown structure (WBS) is a process for defining the final and intermediate products of a project and their relationships. Generally, WBS uses a tree diagram/structure diagram to show the resolution of overall requirements into increasing levels of detail. WBS allows a team to accomplish its general requirements by partitioning a large task into smaller components and focusing on work that can be more easily accomplished.

A work breakdown structure is an essential element in project planning and project management. In the quality planning process, WBS begins with a generalized goal and then identifies progressively finer levels of actions needed to accomplish the goal. In the quality improvement process, the tool is especially useful for creating an implementation plan to remedy identified process problems. For WBS to accurately reflect the project, however, it is essential that the team using it have detailed understanding of the tasks required.

The upper levels of the WBS typically reflect the major deliverable work areas of the project, decomposed into logical groupings of work. The content of the upper levels can vary, depending on the type of project and industry involved. The lower WBS elements provide appropriate detail and focus for support of project management processes such as schedule development, cost estimating, resource allocation, and risk assessment. The lowest-level WBS components are called Work Packages and contain the definitions of work to be performed and tracked. These can be later used as input to the scheduling process to support the elaboration of tasks, activities, resources and milestones which can be cost estimated, monitored, and controlled.

Exhibits 2.1 through 2.3 below illustrate the very same WBS elements represented in Outline View format (Exhibit 2.1), Organization Chart format (Figure 2-2) and in the Tree or Centralized Tree Structure (Figure 2-3):

1.0 New Product Release
1.1 New Product Inventory
1.2 Product Documentation
1.3 Product Training Materials
1.4 Project Management

Exhibit 2.1 – Outline View.

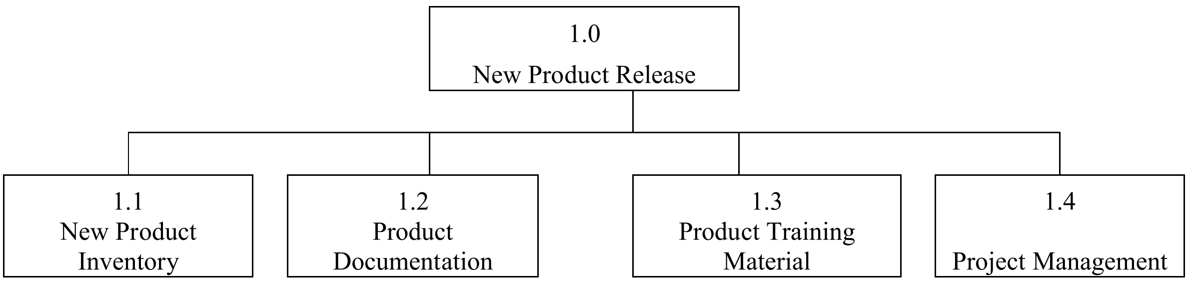


Figure (2-2): Tree Structure, or “Organizational Chart” Structure.

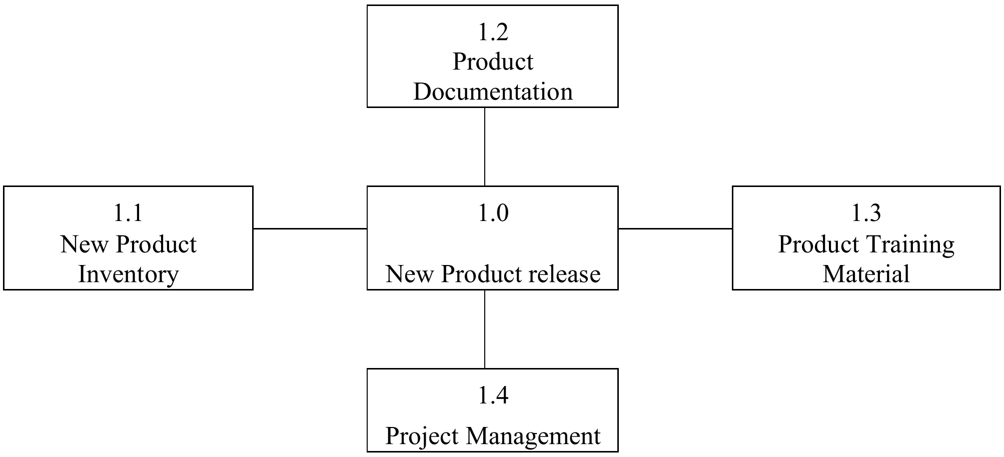


Figure (2-3): Centralized Tree Structure.

It is clear the WBS is the starting point in the planning process for many other essential project management processes such as Estimating, Scheduling and Monitoring/Controlling. However, applying the WBS effectively to these processes remains a difficult task for many project managers.

2.3 The Importance of the WBS

The purpose of a work breakdown structure (WBS) is to divide the project into manageable pieces of work to facilitate planning and control of cost, schedule and technical content. A WBS is written early in program/project development. It identifies the total work to be performed and divides the work into manageable elements, with increasing levels of detail.

The Work Breakdown Structure (WBS) is very important (even fundamental) in Project Management as it's a tool for defining and organizing the deliverables in an easy to view hierarchical structure. It is very helpful for both the Project Managers and the team members alike.

Experienced project managers know there are many things that can go wrong in projects regardless of how successfully they plan and execute their work. Component or full-project failures, when they do occur, can often be traced to a poorly developed or nonexistent WBS. A poorly constructed WBS can result in adverse project outcomes including ongoing, repeated project re-plans and extensions, unclear work assignments, scope creep or unmanageable, frequently changing scope, budget overrun, missed deadlines and unusable new products or delivered features.

The WBS is used as a starting point for scope management and is integral to other PMI processes, and as a result, the standards that define these processes explicitly or implicitly rely on the WBS. Standards that take advantage of the WBS either use the WBS as an input (e.g., PMI's Practice Standard for Earned Value Management (EVM) and the Practice Standard for Scheduling) or incorporate the WBS as the preferred tool to develop the scope definition.

2.4 Creating A Work-Breakdown Structure

The preparation of the work breakdown structure is not easy. The WBS is a communications tool, providing detailed information to different levels of management. If it does not contain enough levels, then the integration of activities may prove difficult. If too many levels exist, then unproductive time will be made to have the same number of levels for all projects, tasks, and so on. Each major work element should be considered by itself. The WBS establishes the number of required networks for cost control. For many programs, the work breakdown structure is established by the customer. If the contractor is required to develop a WBS, then certain guidelines must be considered. A partial list is as follows:

• The complexity and technical requirements of the program (i.e., the statement of work)
• The program cost
• The time span of the program
• The contractor's resource requirements
• The contractor's and customer's internal structure for management control and reporting.
• The number of subcontracts.

Applying these guidelines serves only to identify the complexity of the program. These data must then be subdivided and released, together with detailed information, to the different levels of the organization. The WBS should follow specified criteria because, although preparation of the WBS is performed by the program office, the actual work is performed by the doers, not the planners. Both the doers and the planners must be in agreement as to what is expected. A sample listing of criteria for developing a work breakdown structure is shown below:

• The WBS and work description should be easy to understand.
• All schedules should follow the WBS.
• No attempt should be made to subdivide work arbitrarily to the lowest possible level. The lowest level of work should not end up having a ridiculous cost in comparison to other efforts.
• Since scope of effort can change during a program, every effort should be made to maintain flexibility in the WBS.
• The WBS can act as a list of discrete and tangible milestones so that everyone will know when the milestones were achieved.
• The level of the WBS can reflect the "trust" you have in certain line groups.

• The WBS can be used to segregate recurring from nonrecurring costs.
• Most WBS elements (at the lowest control level) range from 0.5 to 2.5 percent of the total project budget.

2.4.1 Process of Work Breakdown Structure

To illustrate how the process would be put into practice, a simple example will be used. The WBS elements listed in the outline below are a few of the key scope components derived from an initial home building contract. Representing level 1, 2, 3 and 4, the high-level scope elements include the components of the primary structure, the foundation, exterior walls, roof, plumbing, electrical and interior walls. The component element list organizes as follow:

1. House Project
1.1 Primary Structure
1.1.1 Foundation Development
1.1.1.1 Layout – Topography
1.1.1.2 Excavation
1.1.1.3 Concrete Pour
1.1.2 Exterior Wall Development
1.1.3 Roof Development
1.2 Electrical Infrastructure
1.3 Plumbing Infrastructure
1.4 Inside Wall Development: Rough Finish

Exhibit 2.2 – House Project WBS Elements – An Illustration.

Here, in Exhibit 2.2, level 1 indicates the work called ―House Project, represents 100% of the work of the project. All other scope (WBS) elements associated with the project would be subordinate to the House Project element. At level 2, there are 4 major components that make up the House Project: Primary Structure, Electrical Infrastructure, Plumbing Infrastructure and Inside Wall Development. Level 3 shows the key components of the Primary Structure: Foundation Development, Exterior Wall Development and Roof Development. And finally the Foundation Development is decomposed into three work elements that become level 4: Layout-Topography, Excavation and Concrete Pour.

Granted, this is a highly simplified characterization of the work. It is used here, however, to help illustrate the WBS hierarchical concept, not necessarily the proper breakdown of all the work required to construct a home.

2.4.2 *Identifying Dependencies between WBS Elements*

Looking at this particular breakdown of the work, contractors, project managers and homeowners alike would likely recognize that if this were the work to be completed, it would occur in a prescribed order, with some elements coming before – and being completed - before others begin. For example, it would be very helpful to build the foundation and walls before constructing the roof. Though it isn't mandatory to do it in this way, building the foundation first and then the walls; establishing this order would allow the roof to be constructed on top of the walls – where it will ultimately be completed and integrated to secure the structure. Certainly this is not the only approach to home construction – and the order can surely be modified to accelerate the building process, but for this illustration, we will presume a traditional home construction project, and the order would be: foundation, exterior walls, then roof.

Once the foundation, walls and roof are completed (and assuming additional details such as windows, doors and exterior finish are part of the work), the construction can move to the interior of the home. Here, it would make sense to complete the electrical and plumbing work before putting the interior wall material in place. As before, this order is not mandatory, but common practice would indicate the simplest, quickest and easiest approach would be to first complete the work that would be hidden by the interior walls, then apply the interior wall material. Again, for this example, we will use that convention.

2.5 *Tricks for Creating the WBS*

- The best method to create a WBS is to use sticky notes with the team to break the project down (decompose the project) into smaller, more manageable pieces.
- The WBS is created with the team, but it may also be done with other stakeholders or the sponsor present. The is trick is especially helpful if the sponsor does not understand the work that needs to be done, or thinks it will take only a short amount of time. Having the sponsor present (but not contributing) during the WBS creation will help explain, in detail, why a project will take longer than the sponsor or stakeholders desire.
- Though the entire project team may not be identified at this stage, it is best to create a WBS with as close as possible to the final team, as a group. At a minimum, this improves buy-in and project quality, and decreases project risk.
- The project manager should create the top levels of the WBS before meeting with the team. It will give the team direction, let them see what a WBS is, and prevent wasted efforts.
- Add only work that is needed to complete the project deliverables. Do not include extra activities.
- To break each level down further, ask "What work do we need to do for this item in the WBS?"

Keep in mind that each level of the WBS is a smaller segment of the level above, and that the entire project is the aggregation of the highest levels of the WBS. All of the work should be included in the WBS. If it is not in the WBS, it is not part of the project. You will see that team members, managers, sponsors—everyone—gets really excited when they see a work breakdown structure or they help create one. From a project manager's point of view, you get a chance to double check: Are you on the right track? Do you understand what is expected of you? Does the team understand what it will take to accomplish the work of the project?

CH 3

Cost Estimation.

3.1 Introduction

Many People have referred to estimating as a “Black art.” This makes intuitive sense: at first glance, it might seem that estimation is a highly subjective process. One person might take a day to do a task that might only require a few hours of another’s time. As a result, when several people are asked to estimate how long it might take to perform a task, they will often give widely differing answers. But when the work is actually performed, it takes a real amount of time; any estimate that did not come close to that actual time is inaccurate. To someone who has never estimated a project in a structured way, estimation seems little more than attempting to predict the future. This view is reinforced when off-the-cuff estimates are inaccurate and projects come in late. But a good formal estimation process, one that allows the project team to reach a consensus on the estimates, can improve the accuracy of those estimates, making it much more likely that projects will come in on time. A project manager can help the team to create successful estimates for any software project by using sound techniques and understanding what makes estimates more accurate.

3.2 Costs Associated with Constructed Facilities

The costs of a constructed facility to the owner include both the initial capital cost and the subsequent operation and maintenance costs. Each of these major cost categories consists of a number of cost components.

The capital cost for a construction project includes the expenses related to the initial establishment of the facility:

- Land acquisition, including assembly, holding and improvement .
- Planning and feasibility studies.
- Architectural and engineering design.
- Construction, including materials, equipment and labor.
- Field supervision of construction.
- Construction financing.
- Insurance and taxes during construction.
- Owner's general office overhead.
- Equipment and furnishings not included in construction.
- Inspection and testing.

The operation and maintenance cost in subsequent years over the project life cycle includes the following expenses:

- Land rent, if applicable.
- Operating staff.
- Labor and material for maintenance and repairs.
- Periodic renovations.
- Insurance and taxes.

- Financing costs.
- Utilities.
- Owner's other expenses.

The magnitude of each of these cost components depends on the nature, size and location of the project as well as the management organization, among many considerations. The owner is interested in achieving the lowest possible overall project cost that is consistent with its investment objectives.

It is important for design professionals and construction managers to realize that while the construction cost may be the single largest component of the capital cost, other cost components are not insignificant. For example, land acquisition costs are a major expenditure for building construction in high-density urban areas, and construction financing costs can reach the same order of magnitude as the construction cost in large projects such as the construction of nuclear power plants.

From the owner's perspective, it is equally important to estimate the corresponding operation and maintenance cost of each alternative for a proposed facility in order to analyze the life cycle costs. The large expenditures needed for facility maintenance, especially for publicly owned infrastructure, are reminders of the neglect in the past to consider fully the implications of operation and maintenance cost in the design stage.

In most construction budgets, there is an allowance for contingencies or unexpected costs occurring during construction. This contingency amount may be included within each cost item or be included in a single category of construction contingency. The amount of contingency is based on historical experience and the expected difficulty of a particular construction project. For example, one construction firm makes estimates of the expected cost in five different areas:

- Design development changes.
- Schedule adjustments.
- General administration changes (such as wage rates).
- Differing site conditions for those expected.
- Third party requirements imposed during construction, such as new permits.

Contingent amounts not spent for construction can be released near the end of construction to the owner or to add additional project elements.

In this chapter, we shall focus on the estimation of construction cost, with only occasional reference to other cost components. We shall deal with the economic evaluation of a constructed facility on the basis of both the capital cost and the operation and maintenance cost in the life cycle of the facility. It is at this stage that tradeoffs between operating and capital costs can be analyzed.

3.3 Elements of a Successful Estimate

A sound estimate starts with a work breakdown structure (WBS). A WBS is a list of tasks that, if completed, will produce the final product. The way the work is broken down dictates how it will be done. There are many ways to decompose a project into tasks. The project can be broken down by feature, by project phase (requirements tasks, design tasks, programming tasks, QA tasks, etc.), or by some combination of the two. Ideally, the WBS should reflect the way previous projects have been developed.

A useful rule of thumb is that any project can be broken down into between 10 and 20 tasks. For large projects (for example, a space shuttle), those tasks will be very large ("Test the guidance system"); for small projects (like writing a simple calculator program), the tasks are small ("Build the arithmetic object that adds, multiplies, or divides two numbers"). The team must take care in generating the WBS—if the tasks are incorrect, they can waste time going down a wrong path.

Once the WBS is created, the team must create an estimate of the effort required to perform each task. The most accurate estimates are those that rely on prior experience. Team members should review previous project results and find how long similar tasks in previous projects took to complete. Sources of delays in the past should be taken into account when making current estimates. Postmortem reports (see Chapter 8) are a good source of this information.

No estimate is guaranteed to be accurate. People get sick or leave the organization; teams run into unforeseen technical problems; the needs of the organization change. The unexpected will almost certainly happen. Therefore, the goal of estimation is not to predict the future. Instead, it is to gauge an honest, well-informed opinion of the effort required to do a task from those people in the organization who have the most applicable training and knowledge.

If two people widely disagree on how long a task will take, it's likely that the source of that disagreement is that each person made different assumptions about details of the work product or the strategy for producing it. In other words, any disagreement is generally about what is required to perform the task itself, not about the effort required to complete it. For example, given the same vision and scope document for a tool that sets the computer clock, two different developers might come up with wildly different estimates. But it might turn out that one developer assumed that the implementation would have a simple command line interface, while the other assumed that there would be a complete user interface that had to integrate tightly with the operating system's control panel. By helping the programmers discuss these assumptions and come to a temporary resolution about their differences, the project manager can help them agree on a single estimate for the task.

A project manager can help the team create more accurate estimates by reducing the uncertainty about the project. The most effective way to do this is to do a thorough job creating a vision and scope document the more accurate and detailed it is, the more information the team has to work with when generating their estimate. The project manager can also ensure that the team has reached a consensus on the tasks that must be performed. Finally, the project manager can lead the team in a discussion of assumptions.

Example 3-1: Energy project resource demands [1]

The resources demands for three types of major energy projects investigated during the energy crisis in the 1970's are shown in Table 5-1. These projects are: (1) an oil shale project with a capacity of 50,000 barrels of oil product per day; (2) a coal gasification project that makes gas with a heating value of 320 billions of British thermal units per day, or equivalent to about 50,000 barrels of oil product per day; and (3) a tar sand project with a capacity of 150,000 barrels of oil product per day.

For each project, the cost in billions of dollars, the engineering manpower requirement for basic design in thousands of hours, the engineering manpower requirement for detailed engineering in millions of hours, the skilled labor requirement for construction in millions of hours and the material requirement in billions of dollars are shown in Table 5-1. To build several projects of such an order of magnitude concurrently could drive up the costs and strain the availability of all resources required to complete the projects. Consequently, cost estimation often represents an exercise in professional judgment instead of merely compiling a bill of quantities and collecting cost data to reach a total estimate mechanically.

TABLE 3-1 Resource Requirements of Some Major Energy Projects

	Oil shale (50,000 barrels/day)	Coal gasification (320 billions BTU/day)	Tar Sands (150,000 barrels/day)
Cost ($ billion)	2.5	4	8 to 10
Basic design (Thousands of hours)	80	200	100
Detailed engineering (Millions of hours)	3 to 4	4 to 5	6 to 8
Construction (Millions of hours)	20	30	40
Materials ($ billion)	1	2	2.5

Source: Exxon Research and Engineering Company, Florham Park, NJ.

3.4 Approaches to Cost Estimation

Cost estimating is one of the most important steps in project management. A cost estimate establishes the base line of the project cost at different stages of development of the project. A cost estimate at a given stage of project development represents a prediction provided by the cost engineer or estimator on the basis of available data. According to the American Association of Cost Engineers, cost engineering is defined as that area of engineering practice where engineering judgment and experience are utilized in the application of scientific principles and techniques to the problem of cost estimation, cost control and profitability.

Virtually all cost estimation is performed according to one or some combination of the following basic approaches:

- Production function: In microeconomics, the relationship between the output of a process and the necessary resources is referred to as the production function. In construction, the production function may be expressed by the relationship between the volume of construction and a factor of production such as labor or capital. A production function relates the amount or volume of output to the various inputs of labor, material and equipment. For example, the amount of output Q may be derived as a function of various input factors x_1, x_2, ..., x_n by means of mathematical and/or statistical methods. Thus, for a specified level of output, we may attempt to find a set of values for the input factors so as to minimize the production cost. The relationship between the size of a building project (expressed in square feet) to the input labor (expressed in labor hours per square foot) is an example of a production function for construction.
- Empirical cost inference: Empirical estimation of cost functions requires statistical techniques which relate the cost of constructing or operating a facility to a few important characteristics or attributes of the system. The role of statistical inference is to estimate the best parameter values or constants in an assumed cost function. Usually, this is accomplished by means of regression analysis techniques.
- Unit costs for bill of quantities: A unit cost is assigned to each of the facility components or tasks as represented by the bill of quantities. The total cost is the summation of the products of the quantities multiplied by the corresponding unit costs. The unit cost method is straightforward in principle but quite laborious in application. The initial step is to break down or disaggregate a process into a number of tasks. Collectively, these tasks must be completed for the construction of a facility. Once these tasks are defined and quantities representing these tasks are assessed, a unit cost is assigned to each and then the total cost is determined by summing the costs incurred in each task. The level of detail in decomposing into tasks will vary considerably from one estimate to another.
- Allocation of joint costs: Allocations of cost from existing accounts may be used to develop a cost function of an operation. The basic idea in this method is that each expenditure item can be assigned to particular characteristics of the operation. Ideally, the allocation of joint costs should be causally related to the category of basic costs in an allocation process. In many instances, however, a causal relationship between the allocation factor and the cost item cannot be identified or may not exist. For example, in construction projects, the accounts for basic costs may be classified according to (1) labor, (2) material, (3) construction equipment,

(4) construction supervision, and (5) general office overhead. These basic costs may then be allocated proportionally to various tasks which are subdivisions of a project.

3.5 Types of Construction Cost Estimates

Construction cost constitutes only a fraction, though a substantial fraction, of the total project cost. However, it is the part of the cost under the control of the construction project manager. The required levels of accuracy of construction cost estimates vary at different stages of project development, ranging from ball park figures in the early stage to fairly reliable figures for budget control prior to construction. Since design decisions made at the beginning stage of a project life cycle are more tentative than those made at a later stage, the cost estimates made at the earlier stage are expected to be less accurate. Generally, the accuracy of a cost estimate will reflect the information available at the time of estimation.

Construction cost estimates may be viewed from different perspectives because of different institutional requirements. In spite of the many types of cost estimates used at different stages of a project, cost estimates can best be classified into three major categories according to their functions. A construction cost estimate serves one of the three basic functions: design, bid and control. For establishing the financing of a project, either a design estimate or a bid estimate is used.

1. Design Estimates. For the owner or its designated design professionals, the types of cost estimates encountered run parallel with the planning and design as follows:
    - Screening estimates (or order of magnitude estimates)
    - Preliminary estimates (or conceptual estimates)
    - Detailed estimates (or definitive estimates)
    - Engineer's estimates based on plans and specifications

    For each of these different estimates, the amount of design information available typically increases.

2. Bid Estimates. For the contractor, a bid estimate submitted to the owner either for competitive bidding or negotiation consists of direct construction cost including field supervision, plus a markup to cover general overhead and profits. The direct cost of construction for bid estimates is usually derived from a combination of the following approaches.
    - Subcontractor quotations
    - Quantity takeoffs
    - Construction procedures.
3. Control Estimates. For monitoring the project during construction, a control estimate is derived from available information to establish:
    - Budget estimate for financing
    - Budgeted cost after contracting but prior to construction
    - Estimated cost to completion during the progress of construction.

- Design Estimates:

In the planning and design stages of a project, various design estimates reflect the progress of the design. At the very early stage, the screening estimate or order of magnitude estimate is usually made before the facility is designed, and must therefore rely on the cost data of similar facilities built in the past. A preliminary estimate or conceptual estimate is based on the conceptual design of the facility at the state when the basic technologies for the design are known. The detailed estimate or definitive estimate is made when the scope of work is clearly defined and the detailed design is in progress so that the essential features of the facility are identifiable. The engineer's estimate is based on the completed plans and specifications when they are ready for the owner to solicit bids from construction contractors. In preparing these estimates, the design professional will include expected amounts for contractors' overhead and profits.

The costs associated with a facility may be decomposed into a hierarchy of levels that are appropriate for the purpose of cost estimation. The level of detail in decomposing the facility into tasks depends on the type of cost estimate to be prepared. For conceptual estimates, for example, the level of detail in defining tasks is quite coarse; for detailed estimates, the level of detail can be quite fine.

As an example, consider the cost estimates for a proposed bridge across a river. A screening estimate is made for each of the potential alternatives, such as a tied arch bridge or a cantilever truss bridge. As the bridge type is selected, e.g. the technology is chosen to be a tied arch bridge instead of some new bridge form, a preliminary estimate is made on the basis of the layout of the selected bridge form on the basis of the preliminary or conceptual design. When the detailed design has progressed to a point when the essential details are known, a detailed estimate is made on the basis of the well defined scope of the project. When the detailed plans and specifications are completed, an engineer's estimate can be made on the basis of items and quantities of work.

- Bid Estimates:

The contractor's bid estimates often reflect the desire of the contractor to secure the job as well as the estimating tools at its disposal. Some contractors have well established cost estimating procedures while others do not. Since only the lowest bidder will be the winner of the contract in most bidding contests, any effort devoted to cost estimating is a loss to the contractor who is not a successful bidder. Consequently, the contractor may put in the least amount of possible effort for making a cost estimate if it believes that its chance of success is not high.

If a general contractor intends to use subcontractors in the construction of a facility, it may solicit price quotations for various tasks to be subcontracted to specialty subcontractors. Thus, the general subcontractor will shift the burden of cost estimating to subcontractors. If all or part of the construction is to be undertaken by the general contractor, a bid estimate may be prepared on the basis of the quantity takeoffs from the plans provided by the owner or on the basis of the construction procedures devised by the contractor for implementing the project. For example, the cost of a footing of a certain type and size may be found in commercial publications on cost data which can be used to facilitate cost estimates from quantity takeoffs. However, the contractor may want to assess the actual cost of construction by considering the actual construction procedures to be used and the associated costs if the project is deemed to be different from typical designs. Hence, items such as labor, material and equipment needed to perform various tasks may be used as parameters for the cost estimates.

- Control Estimates

Both the owner and the contractor must adopt some base line for cost control during the construction. For the owner, a budget estimate must be adopted early enough for planning long term financing of the facility. Consequently, the detailed estimate is often used as the budget estimate since it is sufficient definitive to reflect the project scope and is available long before the engineer's estimate. As the work progresses, the budgeted cost must be revised periodically to reflect the estimated cost to completion. A revised estimated cost is necessary either because of change orders initiated by the owner or due to unexpected cost overruns or savings.

For the contractor, the bid estimate is usually regarded as the budget estimate, which will be used for control purposes as well as for planning construction financing. The budgeted cost should also be updated periodically to reflect the estimated cost to completion as well as to insure adequate cash flows for the completion of the project.

Example 3-2: Screening estimate of a grouting seal beneath a landfill [2]

One of the methods of isolating a landfill from groundwater is to create a bowl-shaped bottom seal beneath the site as shown in Figure (3.1). The seal is constructed by pumping or pressure-injecting grout under the existing landfill. Holes are bored at regular intervals throughout the landfill for this purpose and the grout tubes are extended from the surface to the bottom of the landfill. A layer of soil at a minimum of 5 ft. thick is left between the grouted material and the landfill contents to allow for irregularities in the bottom of the landfill. The grout liner can be between 4 and 6 feet thick. A typical material would be Portland cement grout pumped under pressure through tubes to fill voids in the soil. This grout would then harden into a permanent, impermeable liner.

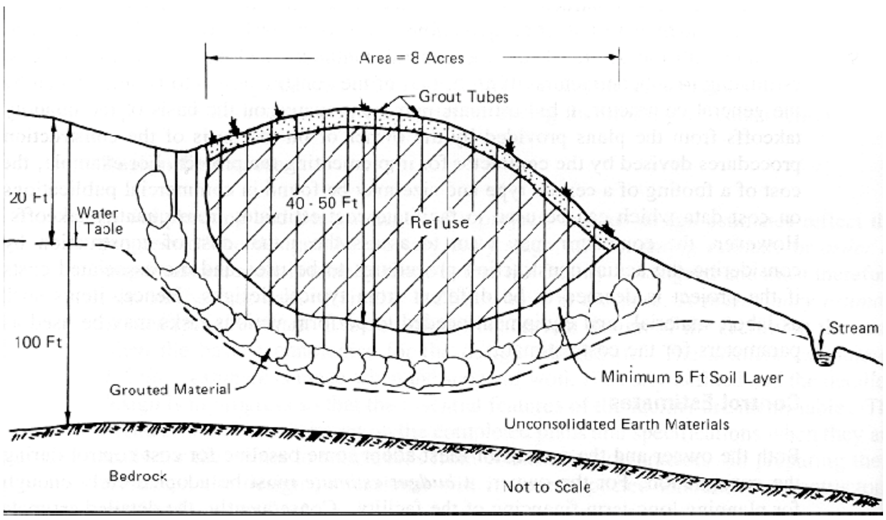


Figure (3.1): Grout Bottom Seal Liner at a Landfill

The work items in this project include (1) drilling exploratory bore holes at 50 ft intervals for grout tubes, and (2) pumping grout into the voids of a soil layer between 4 and 6 ft thick. The quantities for these two items are estimated on the basis of the landfill area:

8 acres = (8)(43,560 ft^2/acre) = 348,480 ft^2

(As an approximation, use 360,000 ft2 to account for the bowl shape)

The number of bore holes in a 50 ft by 50 ft grid pattern covering 360,000 ft^2 is given by:

$$\frac{3600{,}000 ft^2}{(50 ft)(50 ft)} = 144$$

The average depth of the bore holes is estimated to be 20 ft. Hence, the total amount of drilling is (144)(20) = 2,880 ft.

The volume of the soil layer for grouting is estimated to be:

for a 4 ft layer, volume = (4 ft)(360,000 ft^2) = 1,440,000 ft^3
for a 6 ft layer, volume = (6 ft)(360,000 ft^2) = 2,160,000 ft^3

It is estimated from soil tests that the voids in the soil layer are between 20% and 30% of the total volume. Thus, for a 4 ft soil layer:
grouting in 20% voids = (20%)(1,440,000) = 288,000 ft^3
grouting in 30 % voids = (30%)(1,440,000) = 432,000 ft^3
and for a 6 ft soil layer:
grouting in 20% voids = (20%)(2,160,000) = 432,000 ft^3
grouting in 30% voids = (30%)(2,160,000) = 648,000 ft^3

The unit cost for drilling exploratory bore holes is estimated to be between \$3 and \$10 per foot (in 1978 dollars) including all expenses. Thus, the total cost of boring will be between (2,880)(3) = \$ 8,640 and (2,880)(10) = \$28,800. The unit cost of Portland cement grout pumped into place is between \$4 and \$10 per cubic foot including overhead and profit. In addition to the variation in the unit cost, the total cost of the bottom seal will depend upon the thickness of the soil layer grouted and the proportion of voids in the soil. That is:
for a 4 ft layer with 20% voids, grouting cost = \$1,152,000 to \$2,880,000
for a 4 ft layer with 30% voids, grouting cost = \$1,728,000 to \$4,320,000
for a 6 ft layer with 20% voids, grouting cost = \$1,728,000 to \$4,320,000
for a 6 ft layer with 30% voids, grouting cost = \$2,592,000 to \$6,480,000

The total cost of drilling bore holes is so small in comparison with the cost of grouting that the former can be omitted in the screening estimate. Furthermore, the range of unit cost varies greatly with soil characteristics, and the engineer must exercise judgment in narrowing the range of the total cost. Alternatively, additional soil tests can be used to better estimate the unit cost of pumping grout and the proportion of voids in the soil. Suppose that, in addition to ignoring the cost of bore holes, an average value of a 5 ft soil layer with 25% voids is used together with a unit cost of \$ 7 per cubic foot of Portland cement grouting. In this case, the total project cost is estimated to be:
(5 ft)(360,000 ft^2)(25%)(\$7/ft^3) = \$3,150,000

An important point to note is that this screening estimate is based to a large degree on engineering judgment of the soil characteristics, and the range of the actual cost may vary from $ 1,152,000 to $ 6,480,000 even though the probabilities of having actual costs at the extremes are not very high.

3.6 Allocation of Construction Costs Over Time

Since construction costs are incurred over the entire construction phase of a project, it is often necessary to determine the amounts to be spent in various periods to derive the cash flow profile, especially for large projects with long durations. Consequently, it is important to examine the percentage of work expected to be completed at various time periods to which the costs would be charged. More accurate estimates may be accomplished once the project is scheduled as described in Chapter 10, but some rough estimate of the cash flow may be required prior to this time.

Consider the basic problem in determining the percentage of work completed during construction. One common method of estimating percentage of completion is based on the amount of money spent relative to the total amount budgeted for the entire project. This method has the obvious drawback in assuming that the amount of money spent has been used efficiently for production. A more reliable method is based on the concept of value of work completed which is defined as the product of the budgeted labor hours per unit of production and the actual number of production units completed, and is expressed in budgeted labor hours for the work completed. Then, the percentage of completion at any stage is the ratio of the value of work completed to date and the value of work to be completed for the entire project. Regardless of the method of measurement, it is informative to understand the trend of work progress during construction for evaluation and control.

In general, the work on a construction project progresses gradually from the time of mobilization until it reaches a plateau; then the work slows down gradually and finally stops at the time of completion. The rate of work done during various time periods (expressed in the percentage of project cost per unit time) is shown schematically in Figure 5-10 in which ten time periods have been assumed. The solid line A represents the case in which the rate of work is zero at time $t = 0$ and increases linearly to 12.5% of project cost at $t = 2$, while the rate begins to decrease from 12.5% at $t = 8$ to 0% at $t = 10$. The dotted line B represents the case of rapid mobilization by reaching 12.5% of project cost at $t = 1$ while beginning to decrease from 12.5% at $t = 7$ to 0% at $t = 10$. The dash line C represents the case of slow mobilization by reaching 12.5% of project cost at $t = 3$ while beginning to decrease from 12.5% at $t = 9$ to 0% at $t = 10$.

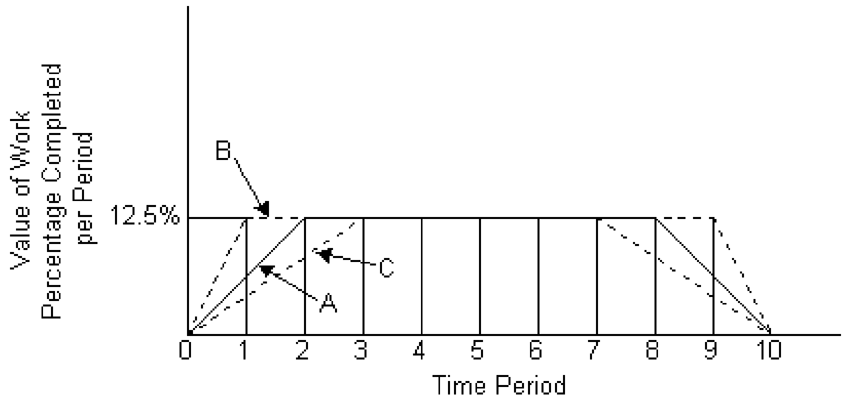


Figure (3.2): Rate of Work Progress over Project Time.

The value of work completed at a given time (expressed as a cumulative percentage of project cost) is shown schematically in Figure 5-11. In each case (A, B or C), the value of work completed can be represented by an "S-shaped" curve. The effects of rapid mobilization and slow mobilization are indicated by the positions of curves B and C relative to curve A, respectively.

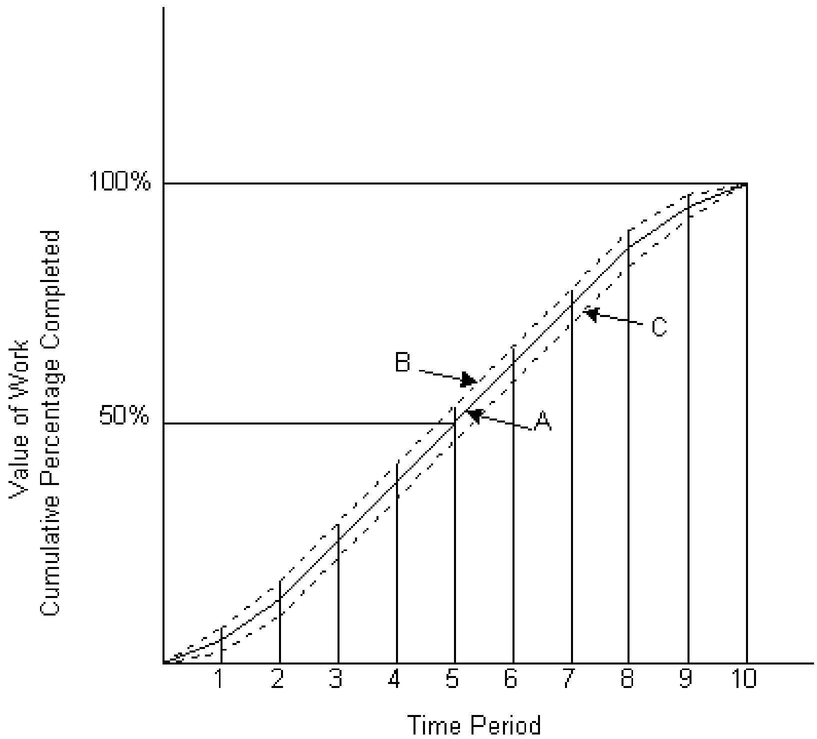


Figure 3.3: Value of Work Completed over Project Time

While the curves shown in Figures 3,2 and 3.3 represent highly idealized cases, they do suggest the latitude for adjusting the schedules for various activities in a project. While the rate of work progress may be changed quite drastically within a single period, such as the change from rapid mobilization to a slow mobilization in periods 1, 2 and 3 in Figure 3.2, the effect on the value of work completed over time will diminish in significance as indicated by the cumulative percentages for later periods in Figure 3.3. Thus, adjustment of the scheduling of some activities may improve the utilization of labor, material and equipment, and any delay caused by such adjustments for individual activities is not likely to cause problems for the eventual progress toward the completion of a project.

In addition to the speed of resource mobilization, another important consideration is the overall duration of a project and the amount of resources applied. Various strategies may be applied to shorten the overall duration of a project such as overlapping design and construction activities (as described in Chapter 2) or increasing the peak amounts of labor and equipment working on a site. However, spatial, managerial and technical factors will typically place a minimum limit on the project duration or cause costs to escalate with shorter durations.

Example 3.3: Calculation of Value of Work Completed

From the area of work progress in Figure 3.2, the value of work completed at any point in Figure 3.3 can be derived by noting the area under the curve up to that point in Figure 3.2. The result for t = 0 through t = 10 is shown in Table 3.2 and plotted in Figure 3.3.

TABLE 3.2 Calculation of Value of Work Completed

Time	Case A	Case B	Case C
0	0	0	0
1	3.1%	6.2%	2.1%
2	12.5	18.7	8.3
3	25.0	31.2	18.8
4	37.5	43.7	31.3
5	50.0	56.2	43.8
6	62.5	68.7	56.3
7	75.0	81.2	68.8
8	87.5	91.7	81.9
9	96.9	97.9	93.8
10	100.0	100.0	100.0

3.7 Assumptions Make Estimates More Accurate

Once the team has agreed upon a WBS, they can begin to discuss each task so they can come up with an estimate. At the outset of the project, the team members do not have all of the information they need in order to produce estimates; nevertheless, they need to come up with numbers. To deal with incomplete information, they must make assumptions about the work to be done. By making assumptions, team members can leave placeholders for information that can be corrected later, in order to make the estimate more accurate.

For the estimates to be most effective, the assumptions must be written down. Important information is discovered during the discussion that the team will need to refer back to during the development process, and if that information is not written down, the team will have to have the discussion all over again. If an assumption turns out to be incorrect, the schedule will need to be adjusted; they will be able to point to the exact cause of the delay by showing that a documented assumption turned out to be incorrect. This will help the project manager explain any resulting schedule delay to others in the organization and avoid that source of delays in the future. The assumptions also provide a way to keep a record of team decisions, share those decisions with others, and find errors in their decisions.

The team should hold a brainstorming session to try to identify as many assumptions as possible. The bigger the list of assumptions, the lower the overall risk for the project. A project manager may get better results from this session by helping the team see how these assumptions can work to their benefit. Any software engineer who has had a bad experience with an estimate that has turned out to be inaccurate will appreciate the value of assumptions: they serve as a warning to the rest of the organization that the estimate is contingent on the assumptions being true. If even one of these assumptions turns out to be incorrect, the team cannot be "blamed" for the incorrect estimate that resulted.

While identifying assumptions is a skill that improves with experience, there are a set of questions that can help a novice team member figure out what assumptions he or she needs to make in order to properly estimate the software. The project manager can use these questions to help lead the discussion to identify the assumptions:

- Are there project goals that are known to the team but not written in any documentation?
- Are there any concepts, terms, or definitions that need to be clarified?
- Are there standards that must be met but will be expensive to comply with?
- How will the development of this project differ from that of previous projects? Will there be new tasks added that were not performed previously?
- Are there technology and architecture decisions that have already been made?
- What changes are likely to occur elsewhere in the organization that could cause this estimate to be inaccurate?
- Are there any issues that the team is known to disagree on that will affect the project?

The last bullet point is especially important. If one team member believes that the project will go down one path while another team member believes the project will go down a different path, the estimates could vary significantly, depending on which team member is correct. For example, one team member may think that a certain off-the-shelf component should be used because that is cheaper than building it, while another team member may believe that they must build that component themselves because they cannot locate one for sale which suits their particular needs. Instead of reaching an impasse, the team can make an assumption—either assume that they will buy the component, or assume that they will build it—which will enable them to move forward with the estimate. It should be easier to reach an agreement at this point because it is not the final decision. By writing down the assumption, the team keeps a record of the disagreement and leaves open the possibility that this will change in the future. The written assumption will be especially useful later while doing a risk assessment for the project plan because there is a risk that the assumption is incorrect.

In other words, assumptions can help find a compromise to resolve disagreements. If two team members disagree, the team can agree to write down an assumption to temporarily resolve the issue for the purposes of the estimate. It's much easier to get people to agree on one answer temporarily by agreeing to revisit the issue later.

Discussing and writing down the assumptions in a team setting helps the team to identify potential roadblocks. For example, the team may have a genuine disagreement about whether or not to develop a user interface for their clock-setting application. The assumption allows the team to reach a temporary decision, knowing that the final decision is still open. Writing down the assumption allows the team to go back and revise the estimate later if it turns out the assumption is wrong—which means that it is vital that everyone understands that the assumptions are allowed to be incorrect. That way, if the team estimated that they would build a command-line program but later the decision was made to go with a full user interface, everyone will be able to explain why the schedule is delayed.

Another benefit of discussing assumptions is that it brings the team together very early on in the project to make progress on important decisions that will affect development. It's all too common for a developer to make estimates after reading the vision and scope document but before ever talking to anyone about the details of the project. Even if she writes down her assumptions, she has almost certainly missed many others. A moderated discussion of assumptions gives the project team a very effective forum to discuss the unknowns of the project. Identifying unknowns eliminates the source of many inaccuracies in the estimates.

One side effect of writing down the assumptions is that it puts pressure on the senior managers to allow the project to be estimated again if any of the assumptions prove to be incorrect. This is why the project manager should plan on having the vision and scope document updated to include any new assumptions that were identified during the estimation session. This gives the stakeholders and management a chance to review those assumptions and accept or reject them very early on, before they have had a chance to interfere with the development of the software. By having the senior managers review the assumptions, a project manager can reduce a source of future project delays.

3.8 Distrust Can Undermine Estimates

Estimates can either be a source of trust or distrust between the project team and their managers. If the team knows that they are given the opportunity to fully justify their estimates, and that they will be allowed to estimate if the scope of the project changes, that they won't be punished for making an honest mistake in estimation, then each team member will work very hard to produce accurate estimates. In this case, estimation can be an effective tool for team motivation. Estimates are most accurate when everyone on the project team feels that he was actively part of the estimation process. Every team member feels a personal stake in the estimates, and will work very hard to meet any schedule based on those estimates.

Estimation is, by its nature, a politically charged activity in most organizations. When a team is asked to create estimates for work, they are essentially being asked to define their own schedule. Stakeholders need the project completed but usually do not have software engineering experience, so they may not be equipped to understand why a project will take, say, six months instead of three. For this reason, project managers must take care to make the estimation process as open and honest as possible so that the stakeholders can understand what's going on.

It is common for nontechnical people to assume that programmers pad their estimates. They often have a "rule" by which they cut off a third or half of any estimate that they hear, and expect that to be the "real" deadline. They often feel, fairly or not, that the engineering team is "putting one over" on them, mostly because the entire engineering process is, to them, a mystery. This lack of trust causes engineers to automatically pad their estimates, because they know they won't be given enough time otherwise. And even when the situation is not this bad (although it often is), some environment of distrust still exists to a lesser extent in many organizations.

In many of these organizations, there are some kinds of estimates—especially those for quality and requirements tasks—that are particularly likely to not be taken seriously. Senior managers are often willing to take the programmers' estimates at face value, even when those estimates are clearly padded. This is because, to them, programming is opaque: managers and stakeholders don't understand how code is written, so they assume that all programming tasks are difficult. They are more likely to trust programmers' estimates, even when those estimates are highly padded. Requirements analysts, on the other hand, often produce specifications using nothing more than a word processor. A manager or stakeholder is much more likely to trivialize that work and distrust the estimate because he (incorrectly) feels that he has an intuitive grasp on the work being done. Even worse, in some organizations there is a "rule" that testing should always take exactly one-third (or some other fixed ratio) of the programming time, which causes the testing effort to be shortchanged by only allowing exactly that much time for it instead of the actual amount of time testing would require.

Distrust in a software organization can be a serious, endemic problem. It starts with a kernel of distrust between management and the engineering team; the distrust grows until management simply won't accept the team's estimates. For example, a senior manager may decide that the team plans to spend too much time testing the software, even though the team reached consensus and all team members stand behind the estimates. A project manager must be especially careful to explain this and support that consensus when senior managers start to pick apart the team's estimates. If deadlines are handed down that do not allow enough time for the team to complete the work, it can lead to serious morale problems—and the project manager will be blamed for the delay, often by the same people who caused it in the first place.

An important part of running successful software projects is reaching a common understanding between the engineers, managers, and stakeholders. One way to do that is with a consistent set of practices. This allows the engineers' work to be transparent to the rest of the organization. Similarly, the managers' and stakeholders' needs and expectations must be transparent to the engineers. By having key managers attend the estimation session, a project manager can show them that the estimates are made systematically, using an orderly and sensible process, and that they are not just made up on a whim. When the team is having trouble reaching convergence on a task, team members should bring up examples of past results for tasks of similar size and complexity. This transparency helps everyone present (especially the observers) understand why these estimates come out as they do.

CH 4

Scheduling

4.1 Introduction

The central question for most projects is "when will it be done?" One of the primary features that distinguish project management from general management is the special attention to scheduling. the purpose of the develop the schedule step is to embark on a systematic process for creating the project schedule, since schedules developed using a systematic process are more likely to be predictable and credible, Unfortunately, some people think that project management is nothing but scheduling. This viewpoint is incorrect. Scheduling is just one of the tools used to manage jobs and should not be considered the primary one. Scheduling is the determination of the timing and sequence of operations in the project and their assembly to give the overall completion time. as mentioned previously , Scheduling is just one part of the planning effort. One common tendency is for people to acquire scheduling software, of which there is abundance, and think that it will make them instant project managers. They soon find that that idea is wrong. In fact, it is nearly impossible to use the software effectively unless you understand project management (and scheduling methodology in particular).

4.2 Important of project scheduling

Schedule may be important for many reasons, such as the following:

1- To calculate the project completion date. Many contractor and there team, is obligated to finish the project at certain date.
2- To calculate the start or end of a specific activity.
3- To expose and adjust conflicts between trades or subcontractors.
4- To predict and calculate the cash flow.
5- To evaluate the effect of changes. Change orders are almost inevitable but well-planned project may have few or minor change orders.
6- To improve work efficiency.
7- To resolve delay claims.
8- To serve as an effective project control tool.

4.3 The scheduler

The scheduler may be a Civil Engineer, a Computer Whiz, a Mathematician, a Project Manager, an Artist, or a communicator?

The knowledge that a scheduler must have:

1- Knowledge of computer software and hardware.
2- Knowledge of the principles of scheduling and project control (as part of project management).
3- Knowledge of the specific technical field, such as commercial building, industrial, transportation.

4.4 A Brief History of Scheduling

Until around 1958, the only tool for scheduling projects was the bar chart. Because Henry Gantt developed a complete notational system for showing progress with bar charts, they are often called Gantt charts. They are simple to construct and to read, and they remain the best tool for communicating to team members what they need to do in given time frames. Although arrow diagrams tend to be too complicated for some teams, it is often helpful to show such a diagram to the people doing the work so that they understand interdependencies among tasks and why it is important that they complete certain tasks on time. Gantt charts have one serious drawback determining the impact of a slip of one task on the rest of the project is very difficult.

That is, if Collect Data in Figure 5-1 gets behind, it is hard to tell how it will affect the rest of the work, because the bar chart does not show the interdependencies of the work. To overcome this problem, two methods of scheduling were developed in the late 1950s and early 1960s that used arrow diagrams to capture the sequential and parallel relationships among project activities. One method was called Critical Path Method (CPM), developed by du Pont; the other, Performance Evaluation and Review Technique (PERT), was developed by the Navy and the Booze, Allen and Hamilton consulting group. Although it has become customary to call all arrow diagrams PERT networks, strictly speaking, the PERT method makes use of probability techniques, whereas CPM does not. In other words, using PERT allows you to calculate the probability that an activity will be completed by a certain time, whereas CPM does not.

4.5 Time scheduling techniques

There are many techniques to scheduling project like:

4.5.1 Bar (Gantt) chart

A bar chart is "a graphic representation of project activities shown in a time-scaled bar line with no links shown between activities ". The bar chart was originally developed by Henry L. Gantt in 1917 and is alternatively called a Gantt chart. On bar chart, the bar may not indicate continuous work from the start of the activity until its end.

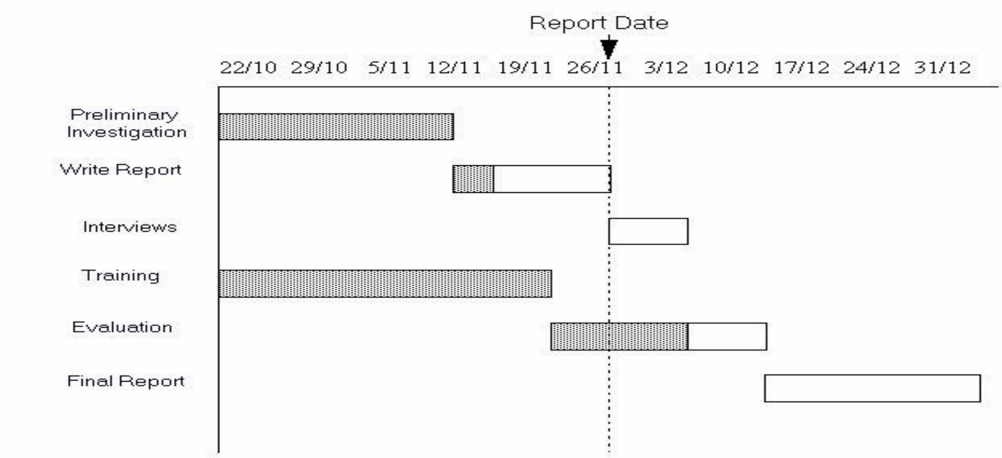


Figure 1: Gantt Chart

Fig. 4.1 (Gantt chart)

Advantage of bar chart

1- Easy to prepare.

2- Easily understood by all parties.
3- It shows the total plan in impact form.
4- Good communication tool.
5- They can be prepared anywhere with just a pencil and paper.

Disadvantages of bar charts

1- The main disadvantage of bar chart is lake of logical representation

2- Does not show interrelationships between activities.
3- Managing projects becomes difficult without those relationships between activities.
4- It is difficult to judge the impact of an unexpected event on the rest of the construction process.
5-Bar chart may not be practical for projects with large numbers of activities.

4.5.2 The critical path method (CPM)

The Critical Path Method (CPM) or Critical Path Analysis is an important technique for effectively managing the complex list of activities of a project. It uses a mathematically based algorithm to calculate a network model known as the "critical path" to help a project manager determine the following:

- How much time a project will require taking into account all the dependencies of the activities.
- Which activities are "critical" or "on the critical path" that need to be completed on time to avoid delaying the whole project.
- The slack time of the activities. An activity with slack time can be delayed without delaying the entire project. Activities not "critical" usually have slack time. One of the motivations of postponing an activity is the savings of labor and warehouse costs until it is necessary.

It is the best-known technique to support project scheduling is the *Critical Path Method* (*CPM*).

The critical path is the longest path in a network and every plan represented by a network diagram must have at least one critical path running through it. Activities (tasks) which are not one the critical path have more leeway, and may slip without affecting the end date of the project. This called slack or float. Activities on the critical path have no slack and this feature may use to actual identify the critical path. It is also quite common to have more than one critical path.

Activities relationship

- Finish to start: The predecessor activity must finish before the successor activity can start .

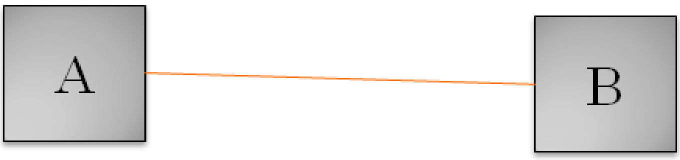


Fig. 4.2 (Finish to start relationship)

- Finish to finish: The predecessor activity must finish before the successor activity can start.

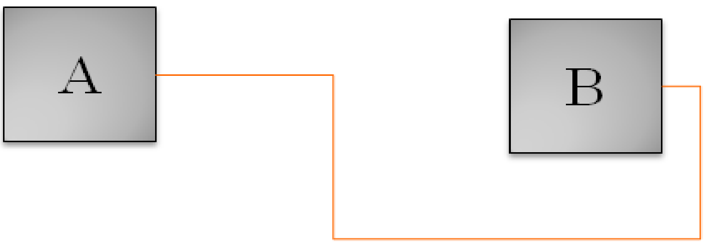


Fig. 4.3 (Finish to finish relationship)

- Start to start: The predecessor activity must start before the successor activity can start .

Fig. 4.4 (Start to start relationship)

- Start to finish: The predecessor activity must start before the successor activity can finish .

Fig. 4.5 (Start to finish relationship)

- Activity or task: A basic unit of work as part of the total project that is easily measured and controlled. It is time and resource consuming.
- Early Start (ES): Earliest possible point in time on which a task can start.
- Early Finish (EF): Earliest possible point in time on which a task can finish.
- Late Start (LS): Latest possible point in time on which a task can start.
- Late Finish (LF): Latest possible point in time on which a task can finish.

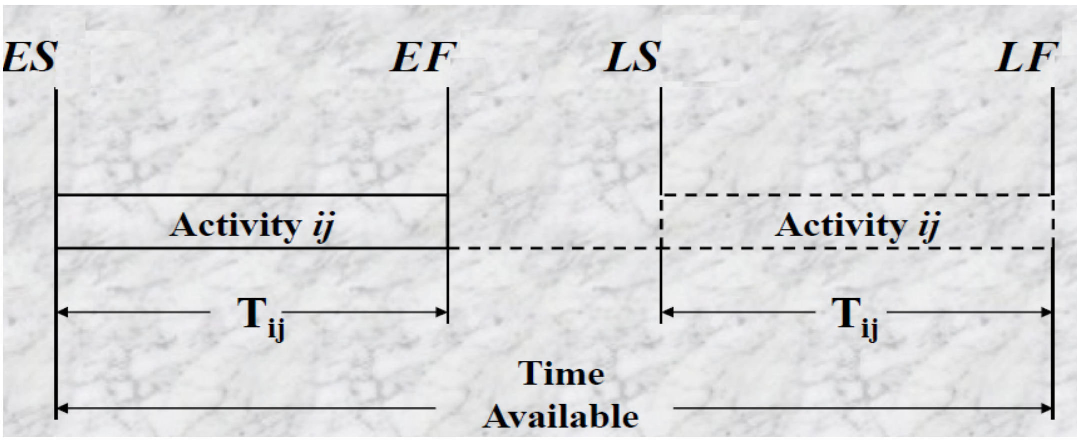


Fig. 4.6 (activity relationship)

- Backward pass: The process of navigating through a network from end to start and calculating the late dates for each activity. The late dates (along with the early dates) determine the critical activities, the critical path, and the amount of float each activity has.
- Forward pass: The process of navigating through a network from start to end and calculating the finish date for the entire project and the early dates for each activity.

• Critical path has zero or negative Total Float. The project can have several critical paths.

The CPM approach is very simple and provides very useful and fundamental information about a project and its activities' schedule. However, because of its' single point estimate assumption it is too simplistic to be used in real complex projects.

Steps for solving with CPM

Step 1:

Build an activity diagram, including estimating the time required (or duration) for all tasks. Include a space on each task card for early and late start and finish dates or times. The early start and early finish are simply the earliest times that a task can start or finish. The late start and late finish are the latest times that a task can start or finish.

Step 2:

Starting with the tasks at the beginning of the diagram, compute the early start and early finish for each task in turn. The early start of a task is the same as the early finish of the preceding task. If there is more than one predecessor task, then there are several possible early start figures Select the largest these. The early finish for each task equal to the early start plus the duration of the task. The final calculation is for the earliest completion time for the project. This calculation in the same way as the early start date.

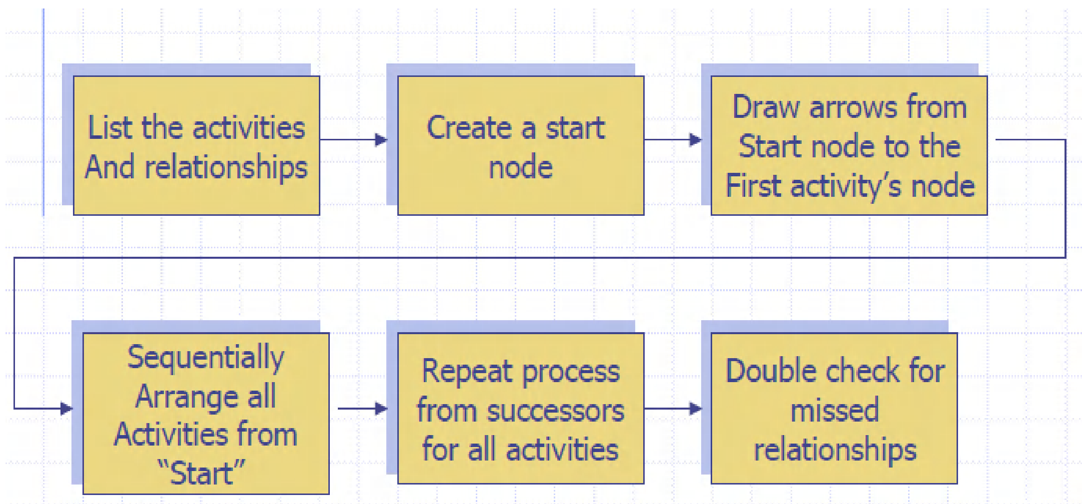


Fig. 4.7 (How to solution CPM)

Step 3:

Starting with the tasks at the end of the diagram, calculate the late start and late finish for each task in turn, following the arrows in the reverse direction to the previous task, as in the diagram below. The late finish is the same as the late start of the succeeding task (for the final tasks in the project, this is equal to the earliest completion date). If there is more than one successor task, then there are several possible late figures. Select the smallest of these. The late start for each task is the late finish minus the duration of the task. The final calculation is for the earliest completion time for the project. This calculated in the same way as the early start date.

Step 4:

You now have, for each task, the earliest and latest times that it can start and finish. Now find the(Total Float and the Lag and the Free Float and the critical path).

Free Float (FF): Amount of time a single task can be delayed without delaying the early start of any successor task.

FF = min LAG

Total Float: Amount of time a single task can be delayed without delaying project completion.

TF = LS – ES or TF = LF - EF.

LAG: A modification of a logical relationship that directs a delay in the successor task.

LAG (AB) = ES(B) – EF(A)

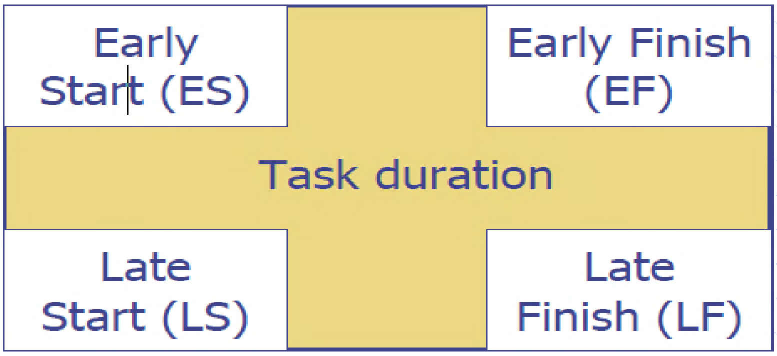


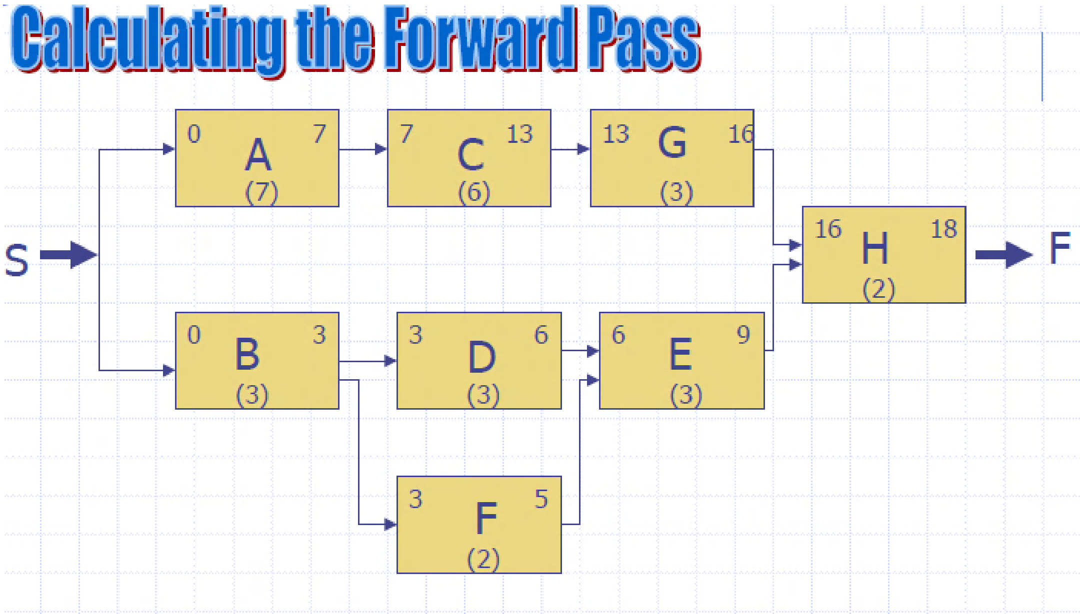
Fig. 4.8 (Activity in CPM method)

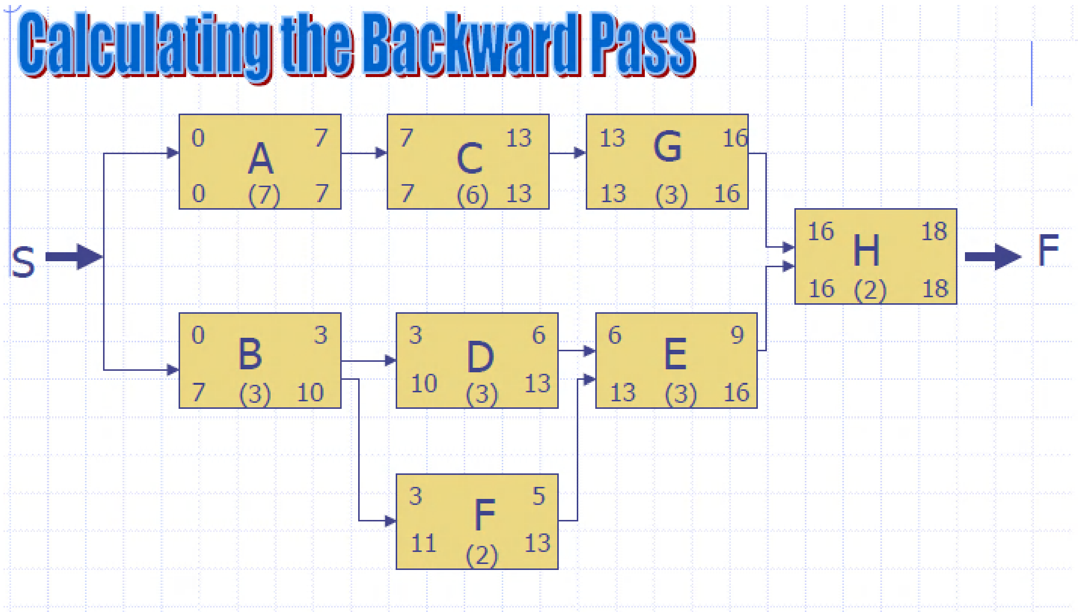
Example:

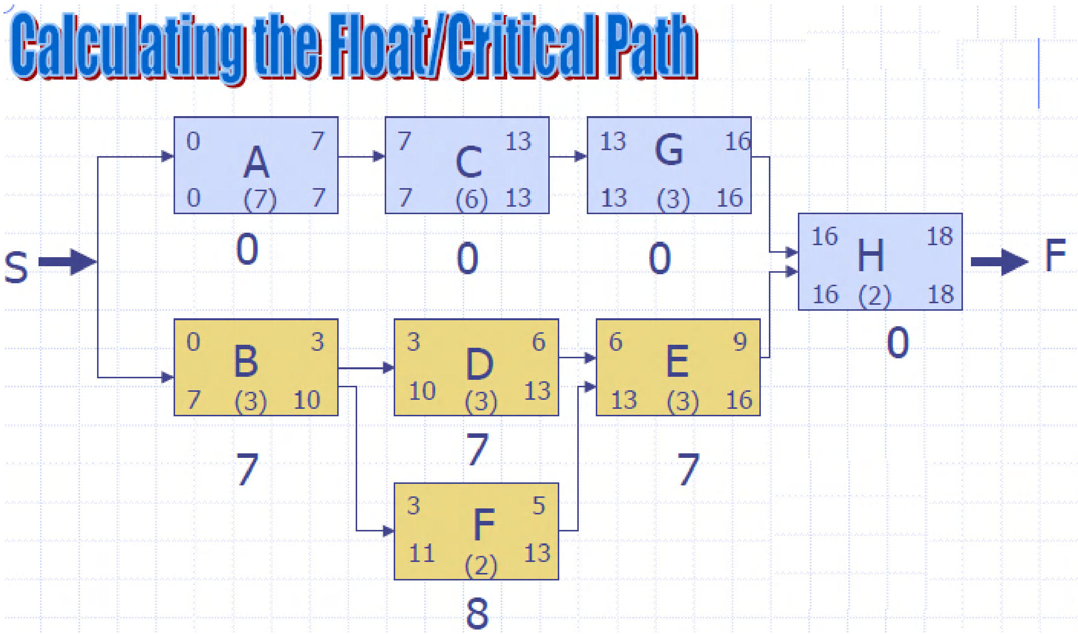
Finding the critical path method

Task ID	Duration	Dependency
A	7	
B	3	
C	6	A
D	3	B
E	3	D,F
F	2	B
G	3	C
H	2	E,G

Solution:







The critical path is (S – A – C – G – H – F).

4.5.3 Arrow Diagram Method (ADM)

A network is a logical and chronological graphic representation of the activities composing a project. Also called activity-on-arrow (AOA) network diagram or (I-J) method (because activities are defined by the form node, I, and to the node, J).Can only show finish-to-start dependencies.

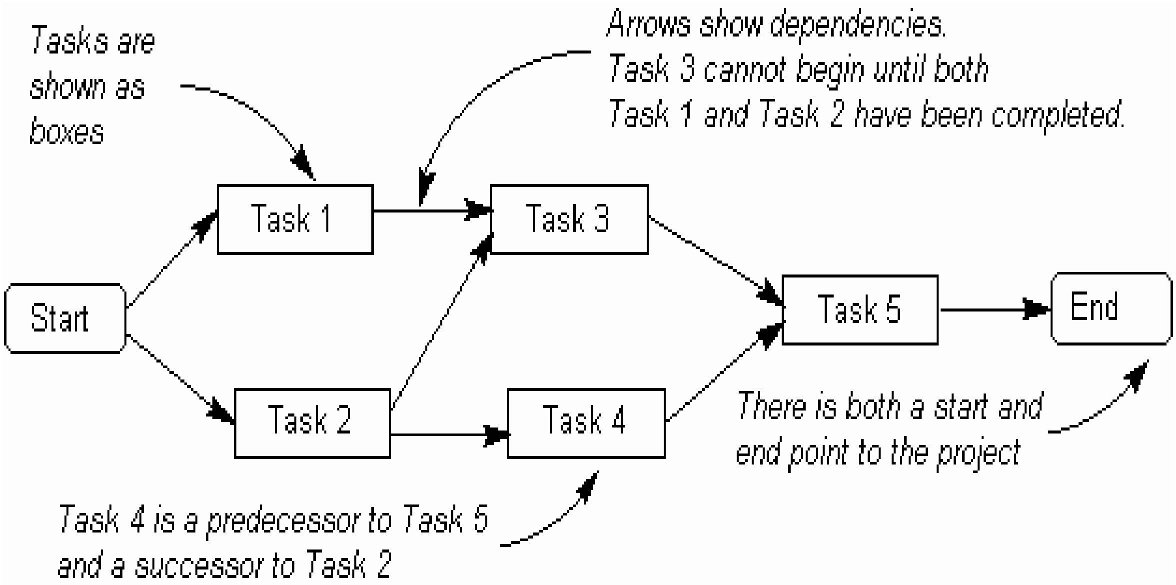


Fig. 4.9 (Arrow Diagram Method)

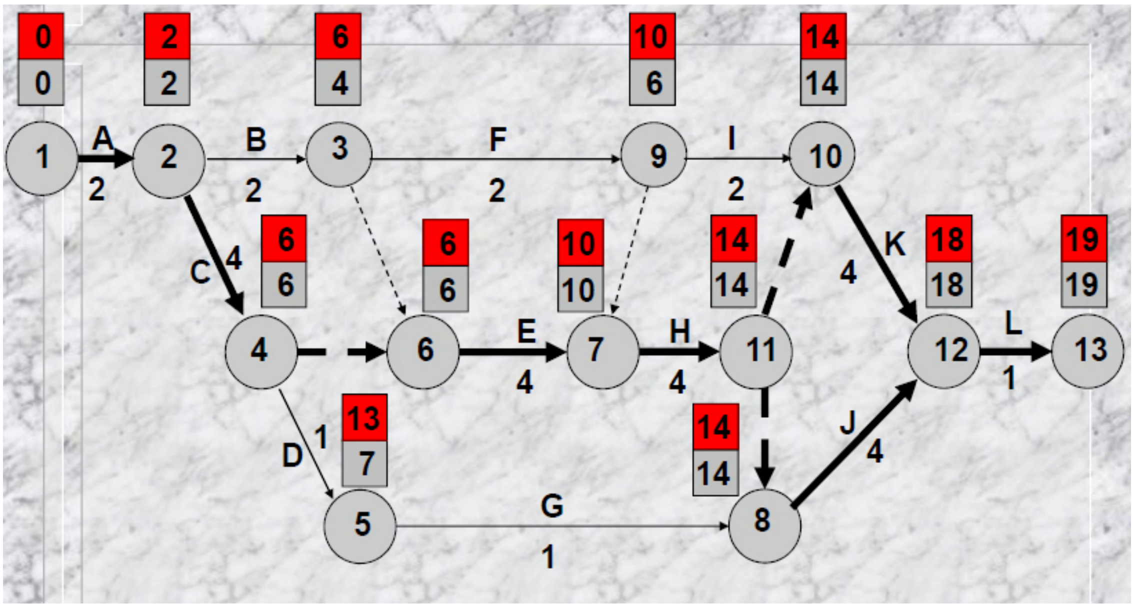


Fig. 4.10 (Arrow Diagram Method)

Advantages

- Show precedence well
- Reveal interdependencies not shown in other techniques
- Ability to calculate critical path
- Ability to perform "what if" exercises

Disadvantages

- Default model assumes resources are unlimited
- You need to incorporate this yourself (Resource Dependencies) when determining the "real" Critical Path
- Difficult to follow on large projects.

4.5.4 Precedence Diagram Method (PDM)

A network diagramming technique in which activities represented by nodes, activities linked by precedence relationships to show the sequence in which the activities are to perform.

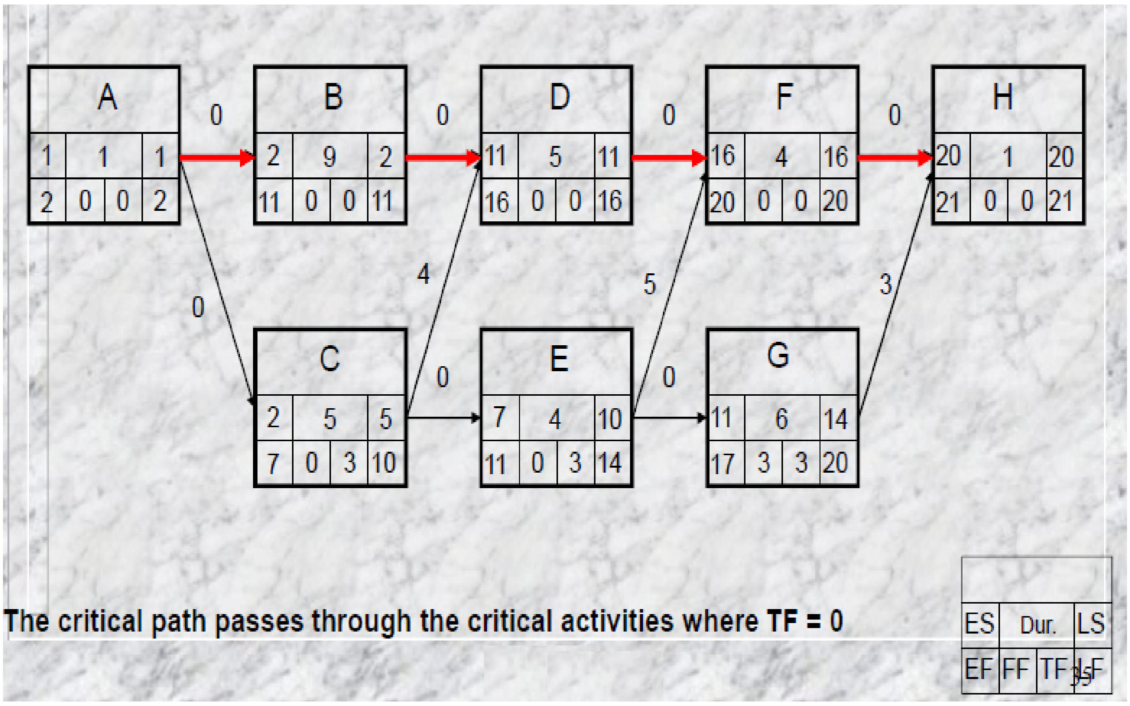


Fig.4.11 (Precedence Diagram Method)

4.5.5 Program evaluation and review technique (PERT)

Program (Project) Evaluation and Review Technique (PERT) is a project management tool used to schedule, organize, and coordinate tasks within a project. It is basically a method to analyze the tasks involved in completing a given project, especially the time needed to complete each task, and to identify the minimum time needed to complete the total project. PERT planning involves the following steps:

- Identify the specific activities and milestones.
- Determine the proper sequence of the activities.
- Construct a network diagram.
- Estimate the time required for each activity.
- Determine the critical path.
- Update the PERT chart as the project progresses.

The major difference between the approaches is that PERT assumes that an activity's duration cannot be precisely predetermined. It requires the planner to specify three separate duration for each activity:

1- The most likely.
2- The optimistic.
3- The pessimistic duration estimates.

CH 5

Resource Management

5.1 Resource Plan

A Resource plan indentifies the physical resource s required to complete the project . Atypical Resource plan includes:

* A list of types of resource (labor, equipment and materials) required.
* A schedule out lining when each of the resource is required to be utilized.
*An assignment of each resource to a set of activities to be completed.

TO create a Resource plan, the following steps are taken :
*list the general types of resource to be utilized on the project.
*Indentify the number of resource and purpose of each type of resource .
*Indentify when the resources are required by completing a(resource schedule)table.
*Allocate the resources to project activities by completing a(resource usage)table.

5.2 Resource Definition

The first step in resource management is to decide exactly what resource are considered important enough to be managed .while the most resource used is people or workers ,it may also include other resources such as machines(excavator) , space on a project where space is restricted and where this restriction limits the amount of other resources which can be deployed at any one time ,financial resources money that are needed to perform the required work ,or materials (needed to accomplish different activities).Generally , a resource can be defined as anything (labor ,equipment .material , money ,etc) that is needed to have the work done .

Resources may be considered as consumable ,such as materials that may be used once and once only ,or non –consumable ,such as people ,which may be used again and again .The way in which consumable resources are used is not critical as long as they are used can have a significant impact on project .

Resource management is therefore mainly concerned with non-consumable resources. Also, resources may be classified according to their importance to key resources, secondary resources and general resources. Key resources are the most important ,expensive and available resources in the project such as skilled labors, or equipment .These types of resource s will have a great attention in the resource scheduling process .Secondary resources are those resources which have no constraints on their availability ,such as normal labor. General resources are defined as those resources that are used by all or most of the activities on the project such as site over heads. General resources will not be included in the resource management described later.

5.3 Resource Allocation

Resource allocation, also called resource loading, is concerned with assigning the required number of those resources identified in the previous step to each activity identified in the plan. More than one type of resource may be attributed to a specific activity. For example, fixing the plates on a ship's hull may require 10 fitters, 20 welders, 15 laborers and a certain type of welding machine. From a practical standpoint, resource allocation does not have to follow a constant pattern; some activities may initially require fewer resources but may require more of the same resources during the later stages of the project. At this stage, the impact of any resource allocation decision is not known and we cannot yet answer questions such as:

- Is lack of resources on this particular activity having an adverse effect on the duration of the whole project? Such an activity is more likely to be on the critical path.
- By excessive use of resources are we completing this activity more quickly than necessary in terms of the overall project duration? Such an activity is not likely to be on the critical path.

These questions will be answered later in the resource modeling process, specifically during the resource leveling and smoothing stage.

5.4 Resource Aggregation

Resource aggregation, or resource loading, is simply the summation, on a period-by-period basis, of the resources required to complete all activities based on the resource allocation carried out in the previous stage. The results are usually shown graphically as a histogram. Such aggregation may be done on an hourly, daily, or weekly basis, depending on the time unit used to allocate resources. When a bar chart is used as the planning tool, the resource aggregation is fairly simple and straightforward. For a given bar chart, there is a unique resource unit aggregation chart which can be drawn underneath the bar chart. However, a separate graph will be required for each resource unit. An example is shown in Figure 5.1 below, where, for a particular resource, the required resource units for each time period are annotated on the bar chart. The total number of resource units for each time period can then be summed and a resource aggregation or load chart can be produced.

Week / Activity	1	2	3	4	5	6	7	8	9
A	10	10							
B		8	8	6					
C				2	6				
D				2	6	10	10	8	
E								6	6
Total resource units requirement	10	18	8	10	12	10	10	14	6

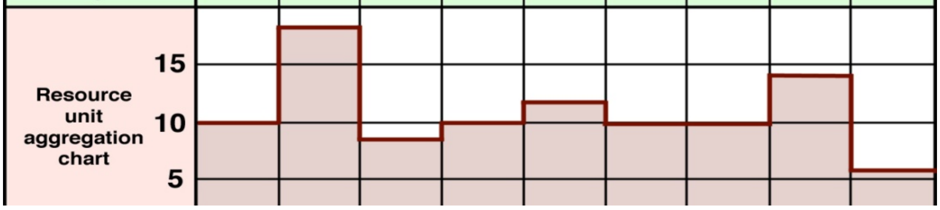


Figure 5.1 Resource Unit Aggregation Chart Derived from a Bar

However, when a network is used for planning, the resource aggregation procedure is not so simple or straightforward. As the network is not drawn to a time-scale, there is not a direct link between the network and the demand for resources. Therefore, a schedule must be prepared which tabulates activities in terms of time. However, this highlights another difficulty, namely that those activities which are not on the critical path do not have fixed starting and finishing times but are constrained by the earliest and latest starting and finishing times. However, this seeming difficulty offers the planner considerable scope for adjusting the demand for resources. This will be discussed in more detail later, but the limits within which resources can be adjusted, without extending the overall project duration, are the resource requirements between the earliest starting times and the latest starting times. This is illustrated in Figure 3.2, which shows the differing resource requirements that arise when both earliest and latest start times are considered and also highlights the resource requirements for those activities which are on the critical path.

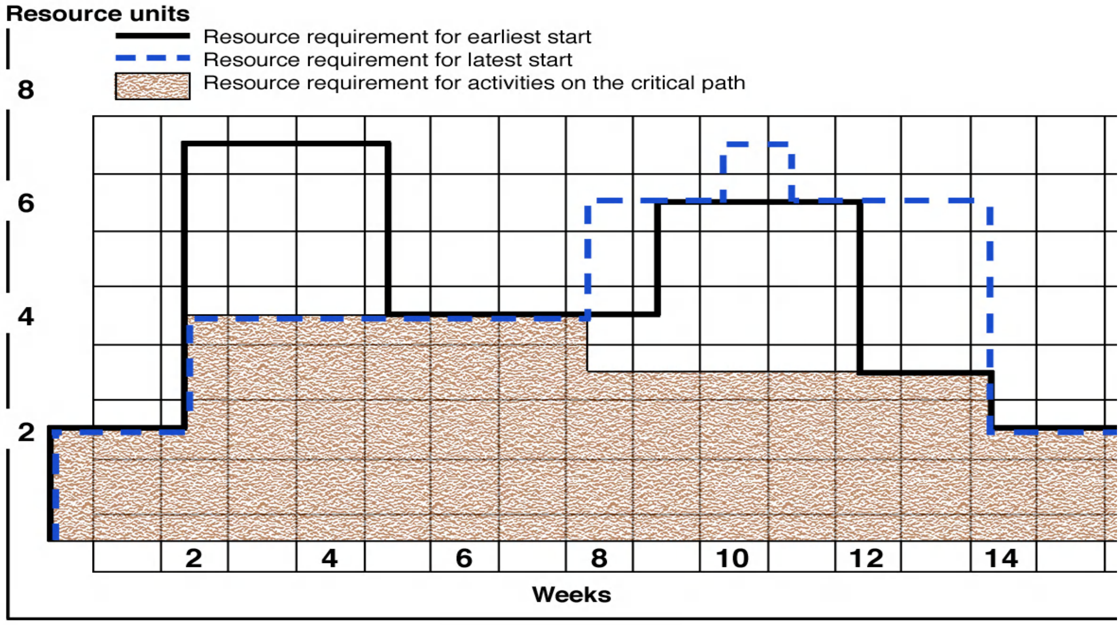


Figure 5.2 (Resource Unit Aggregation Chart Showing Resource Requirements Associated with Earliest and Latest Start Along with Highlighted Resource Unit Requirements for Critical Path Activities)

5.5 Resource Leveling

Having established the resource requirements through resource allocation and aggregation, we will now examine the next phase of the planning and resource management process--resource leveling. We will now compare those requirements with resource availability by developing resource profiles. Disregarding factors such as economic considerations, if sufficient resources are available so that supply always exceeds demand then, we should have no problem. However, the most likely scenario is that, at some point, demand will exceed supply. Such a scenario is illustrated in Figure 5.3.

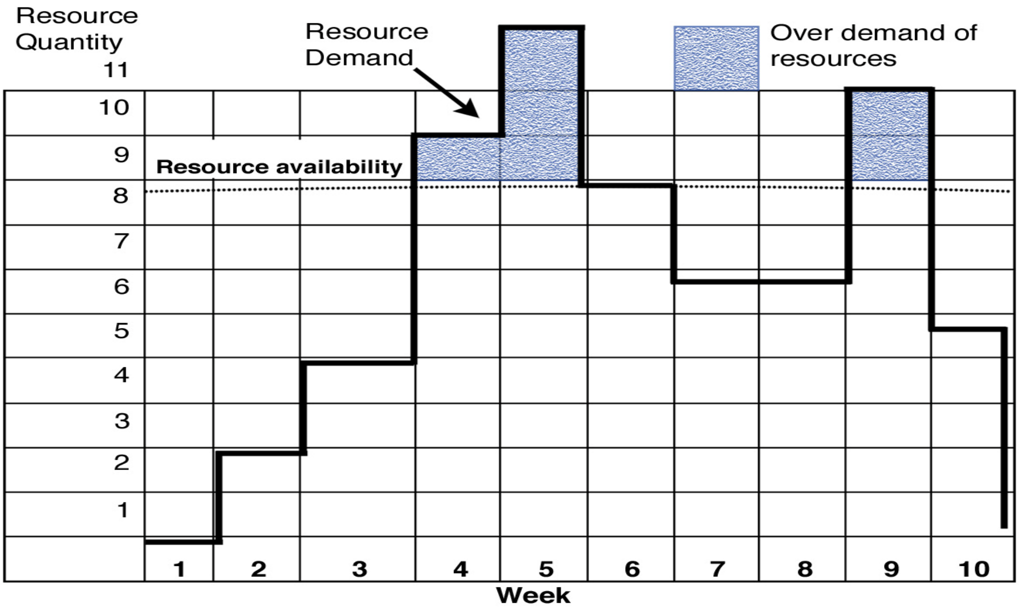


Figure 5.3 Resource Demand Compared to Resource Availability

Resource leveling is the process that ensures resource demand does not exceed resource availability. The ideal scenario would be a build up of resource usage at the beginning of the project and a reduction at the end of the project. However, the approach to resource leveling will also depend on whether resources are dedicated to a particular project or shared across several projects and whether there is a need to keep all resources fully utilized.

We will begin by analyzing the issues involved in resource leveling for a situation where a bar chart has been used as the primary planning technique for a simple project. The reason for this is that resource leveling must be considered within a time framework and bar charts are drawn to a time scale while networks are not. Examine Figure 5.1. In this figure, the time-scale for the activities comprising the project are shown in a bar chart, which also shows resource requirements for one particular resource unit. An examination of the bar chart and its associated resource chart in Figure 5.1 shows that improvements can be made to the level of resource requirements by:

- Delaying or bringing forward the start of certain activities
- Extending the duration of certain activities and so reducing the demand for resources over the duration of the activity or by a combination of both of these adjustments

However, there are problems with using the simple bar chart as a tool for resource leveling. For example, we do not have any information about the interdependency of tasks. Therefore, if we delay a task by starting later than originally planned or by extending the duration of the task, we cannot evaluate the exact impact this will have on the overall project. Referring to Figure 5.1 again, if we assume that the maximum amount of resource availability is 14 units, then we have a problem in week 2 because 18 units of resources are required in that week. In order to reduce the resource demand in week 2, we may have to extend Activity A into week 3 (if this is possible) and spread the resource demand over three weeks, or delay the commencement of Activity B. However, the exact impact of these changes on the overall project duration cannot be easily determined.

Another issue is that the critical path(s) cannot be easily determined, although we may be able to deduce which activities are critical by inspection. Clearly, if we do not wish to extend the overall duration of the project we must avoid extending or delaying activities which are on the critical path. Finally, the availability of slack or float is not clear. Knowing this is important because it is this attribute that can be utilized to adjust our resource requirements.

Resource leveling can be accomplished more easily if resource requirements to complete an activity are expressed in terms of hours or days required. The definition of resource requirements using such units of measure can help us determine if an activity should be completed in a short time through the use of many resources or over a longer period of time through the use of fewer resources. In practice, however, there is a limit to the number of resources that can be deployed and, therefore, a limit to the amount by which any activity duration can be shortened.

We will now examine situations where networks are used as the primary planning method. Generally, there are two approaches to leveling and smoothing the resources required:

- Time-limited resource considerations
  In this case emphasis will be placed on completing the project within a specified time. This time will usually have been determined by network analysis. Adjustments in the timing of any activity, and the resources required at a given time, must be undertaken within the float (slack) available. Obviously there can be no adjustment of activities which are on the critical path.
- Resource-limited resource considerations
  In this case the project must be completed with the resources available even if this means extending the project duration. If the total resource demand exceeds the resource availability at any time then some of the activities must be delayed until there is sufficient resource availability.

For both of the above approaches, information concerning the earliest and the latest start times and slack will be used to level resources.

5.6 Project Manager Roles and Responsibilities

It is a long-standing joke in the project management community that if anyone ever asks you who is responsible for anything in the project, the answer will always be the project manager. Truly it is easier to specify what the project manager does not do than to discuss what he or she actually does and is responsible for.

The nature and scope of the project should dictate the individual roles and responsibilities of the project team. When all of the team assignments and responsibilities have been decided, all of the functions and responsibilities of the project will have been assigned. The responsibility-accountability matrix is useful for determining and tracking the relationship between a given responsibility and who is responsible for it.

5.7 Human Resources Management

Human resources management is required to make the most efficient use of the project human resources. This includes all of the people involved in the project—the stakeholders, sponsors, customers, other departments, the project team, subcontractors, and all others .Organizational planning involves the organizing of the human resources.

These are the roles, responsibilities, and relationships of the people that are on the project team. As in all things in project management, human resources management takes place throughout the project. If at any time the project organization needs to be revised, the human resources plan will assist in carrying this out.

CH 6:

Risk management.

6.1 Introduction

In the early days of project management on many commercial programs, the majority of project decisions heavily favored cost and schedule. This favoritism occurred because we knew more about cost and scheduling than we did about technical risks. Technology forecasting was very rarely performed other than by extrapolating past technical knowledge into the present.

Today, the state of the art of technology forecasting is being pushed to the limits. For projects with a time duration of less than one year, we normally assume that the environment is known and stable, particularly the technological environment. For projects over a year or so in length, technology forecasting must be considered. Computer technology doubles in performance about every two years. Engineering technology is said to double every three or so years. How can a project manager accurately define and plan the scope of a three- or four-year project without expecting engineering changes resulting from technology improvements? What are the risks?

A Midwest manufacturing company embarked on an eight-year project to design the manufacturing factory of the future. The plant is scheduled to go into the construction phase in the year 2000. How do we design the factory of the future without forecasting the technology? What computer technology will exist? What types of materials will exist and what types of components will our customers require? What production rate will we need and will technology exist to support this production level?

Economists and financial institutions forecast interest rates. The forecasts appear in public newspapers and journals. Yet, every company involved in high tech does some form of technology forecasting, but appears very reluctant to publish the data. Technology forecasting is regarded as company proprietary information and may be part of the company's strategic planning process.

The risk management process, however, should be designed to do more than just identify the risk. The process must also include: a formal planning activity, analysis to quantify the likelihood and predict the impact on the project, a handling strategy for selected risks, and the ability to monitor the progress in reducing these selected risks to the desired level.

A project, by definition, is something that we have not done previously and will not do again in the future. Because of this uniqueness, we have developed a "live with it" attitude on risk and attribute it as part of doing business. If risk management is set up as a continuous, disciplined process of planning, assessment (identification and analysis), handling, and monitoring, then the system will easily supplement other systems as organization, planning and budgeting, and cost control. Surprises that become problems will be diminished because emphasis will now be on proactive rather than reactive management.

Risk management can be justified on almost all projects. The level of implementation can vary from project to project, depending on such factors as size, type of project, who the customer is, relationship to the corporate strategic plan, and corporate culture. Risk management is particularly important when the overall stakes are high and a great deal of uncertainty exists. In the past, we treated risk as a "let's live with it." Today, risk management is a key part of overall project management. It forces us to focus on the future where uncertainty exists and develop suitable plans of action to prevent potential issues from adversely impacting the project.

6.2 Definition of Risk

Risk is a measure of the probability and consequence of not achieving a defined project goal. Most people agree that risk involves the notion of uncertainty. Can the specified aircraft range be achieved? Can the computer be produced within budgeted cost? Can the new product launch date be met? A probability measure can be used for such questions; for example, the probability of not meeting the new product launch date is 0.15. However, when risk is considered, the consequences or damage associated with occurrence must also be considered.

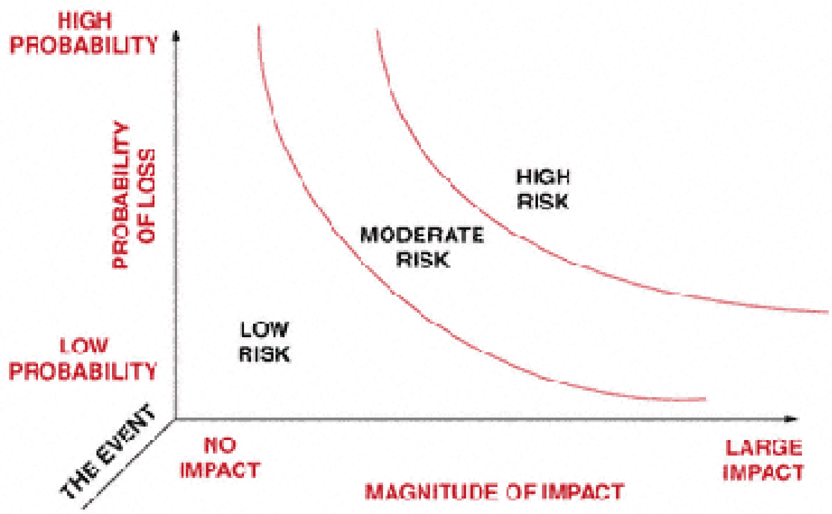


Figure (6.1).
Overall risk is a function of its components.

Risk has two primary components for a given event:

• A probability of occurrence of that event.
• Impact of the event occurring (amount at stake).

Conceptually, risk for each event can be defined as a function of likelihood and impact; that is,

$$Risk = f\text{(likelihood, impact)}.$$

In general, as either the likelihood or impact increases, so does the risk. Both the likelihood and impact must be considered in risk management.

Risk constitutes a lack of knowledge of future events. Typically, future events (or outcomes) that are favorable are called opportunities, whereas unfavorable events are called risks.

Another element of risk is the cause of risk. Something, or the lack of something, can induce a risky situation. We denote this source of danger as the hazard. Certain hazards can be overcome to a great extent by knowing them and taking action to overcome them. For example, a large hole in a road is a much greater danger to a driver who is unaware of it than to one who travels the road frequently and knows enough to slow down and go around the hole. This leads to the second representation of risk:

$$\text{Risk} = f(\text{Hazard, Safeguard}).$$

Risk increases with hazard but decreases with safeguard. The implication of this equation is that good project management should be structured to identify hazards and to allow safeguards to be developed to overcome them. If enough safeguards are available, then the risk can be reduced to an acceptable level.

6.3 Definition of Risk Management

Risk management is the act or practice of dealing with risk. It includes planning for risk, assessing (identifying and analyzing) risk issues, developing risk handling options, and monitoring risks to determine how risks have changed.

Risk management is not a separate project office activity assigned to a risk management department, but rather is one aspect of sound project management. Risk management should be closely coupled with key project processes, including but not limited to: overall project management, systems engineering, cost, scope, quality, and schedule.

Risk management covers all the processes involved in identifying, assessing and judging risks, assigning ownership, taking actions to mitigate or anticipate them, and monitoring and reviewing progress. Risk is a major factor to be considered during the management of a project. Project management must control and contain risks if a project is to stand a chance of being successful. The management of risk is not a linear process; rather it is the balancing of a number of interwoven elements which interact with each other and which have to be in balance with each other.

Proper risk management is proactive rather than reactive. As an example, an activity in a network requires that a new technology be developed. The schedule indicates six months for this activity, but project engineers think that nine months is closer to the truth. If the project manager is proactive, he might develop a Risk Handling Plan right now. If the project manager is reactive (e.g., a "problem solver"), then he will do nothing until the problem actually occurs. At that time the project manager must react rapidly to the crisis, and may have lost valuable time when contingencies could have been developed. Hence, proper risk management will attempt to reduce the likelihood of an event occurring and/or the magnitude of its impact.

Risk management at the project level focuses on keeping unwanted outcomes to an acceptable minimum. Decisions about risk management at this level form an important part of the Business Case.

Where suppliers and/or partners are involved, it is important to gain a shared view of the risks and how they will be managed.

The aim is to manage that exposure by taking action to keep exposure to an acceptable level in a cost-effective way. Risk management involves having:

- Access to reliable, up-to-date information about risks.
- Decision-making processes supported by a framework of risk analysis and evaluation.

- Processes in place to monitor risks.
- The right balance of control in place to deal with those risks.

Risk is the chance, great or small, that damage or an adverse outcome will occur from a particular hazard.

There are some essential elements that need to be in place in a project if risk management is to be effective and innovation encouraged, i.e. that:

- The Project Board supports and promotes risk management, understands and accepts the time and resource implications of any countermeasures.
- Risk management policies and the benefits of effective risk management are clearly communicated to all staff.
- A consistent approach to risk management is fully embedded in the project management processes.
- Management of risks is an essential contribution to the achievement of business objectives.
- Risks through working with programmers and other projects are assessed and managed.
- There is a clear structure to the risk process so that each element or level of risk identification fits into an overall structure.
- Where the project is part of a programmed, changes in the state of any project risks that are also identified as programmer risks must be flagged to programmer management or the designated risk management function in the programmer.

6.4 Risk Management Process

It is important that a risk management strategy is established early in a project and that risk is continually addressed throughout the project life cycle. Risk management includes several related actions involving risk: planning, assessment (identification and analysis), handling, and monitoring, Risk planning: This is the process of developing and documenting an organized, comprehensive, and interactive strategy and methods for identifying and tracking risk issues, developing risk handling plans, performing continuous risk assessments to determine how risks have changed, and assigning adequate resources.

- Risk assessment: This process involves identifying and analyzing program areas and critical technical process risks to increase the likelihood of meeting cost, performance, and schedule objectives. Risk identification is the process of examining the program areas and each critical technical process to identify and document the associated risk. Risk analysis is the process of examining each identified risk issue or process to refine the description of the risk, isolate the cause, and determine the effects.
- Risk handling: This is the process that identifies, evaluates, selects, and implements options in order to set risk at acceptable levels given program constraints and objectives. This includes the specifics on what should be done, when it should be accomplished, who is responsible, and associated cost and schedule. Risk handling options include

assumption, avoidance, control (also known as mitigation), and transfer. The most desirable handling option is selected, and a specific approach is then developed for this option.

• Risk monitoring: This is the process that systematically tracks and evaluates the performance of risk handling actions against established metrics throughout the acquisition process and provides inputs to updating risk handling strategies, as appropriate.

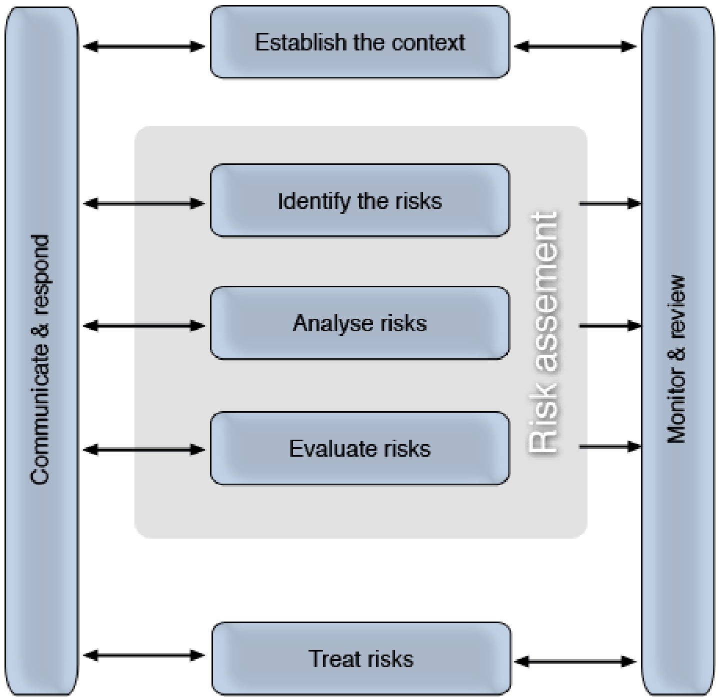


Figure (6.2)
Risk management process.

6.5 Risk Planning

Risk Planning is developing and documenting organized, comprehensive, and interactive strategies and methods for identifying risks. It is also used for performing risk assessments to establish risk handling priorities, developing risk handling plans, monitoring the status of risk handling actions, determining and obtaining the resources to implement the risk management strategies. Risk planning is used in the development and implementation of required training and communicating risk information up and down the project stakeholder organization. At the start of this step, it is important to clearly understand and articulate the fundamental objectives of the project. Once the project goals and constraints are clearly articulated and agreed on, the next step is to determine and document project risk management goals and objectives. Alignment with overall organizational strategies, objectives and performance goals is required. To accomplish this there must be a common risk language, effective organizational structure, and appropriate enablement through systems, tools, and skills. There are several key elements in successfully implementing an effective risk management process and each is necessary for risk management planning.

Risk planning is the detailed formulation of a program of action for the management of risk. It is the process to:

- Develop and document an organized, comprehensive, and interactive risk management strategy.
- Determine the methods to be used to execute a program's risk management strategy.
- Plan for adequate resources.

Risk planning is iterative and includes the entire risk management process, with activities to assess (identify and analyze), handle, monitor (and document) the risk associated with a program. The result is often the risk management plan (RMP).

Planning begins by developing and documenting a risk management strategy. Early efforts establish the purpose and objective, assign responsibilities for specific areas, identify additional technical expertise needed, describe the assessment process and areas to consider, define a risk rating approach, delineate procedures for consideration of handling options, establish monitoring metrics (where possible), and define the reporting, documentation, and communication needs.

The risk management plan is the roadmap that tells the project team how to get from where the program is today to where the program manager wants it to be in the future. The key to writing a good RMP is to provide the necessary information so the program team knows the objectives, goals, and the risk management process. Since it is a roadmap, it may be specific in some areas, such as the assignment of responsibilities for project personnel and definitions, and general in other areas to allow users to choose the most efficient way to proceed. For example, a description of techniques that suggests several methods for evaluators to use to assess risk is appropriate, since every technique has advantages and disadvantages depending on the situation.

6.6 Risk Assessment

Risk assessment is the problem definition stage of risk management, the stage that identifies, analyzes, and quantifies program issues in terms of probability and consequences, and possibly other considerations (e.g., the time to impact). The results are a key input to many subsequent risk management actions. It is often a difficult and time-consuming part of the risk management process. There are no quick answers or shortcuts. Tools are available to assist evaluators in assessing risk, but none are totally suitable for any program and are often highly misleading if the user does not understand how to apply them or interpret the results. Despite its complexity, risk assessment is one of the most important phases of the risk management process because the caliber and quality of assessments can have a large impact on program outcomes.

The components of assessment— identification and analysis— are performed sequentially with identification being the first step. Risk identification begins by compiling the program's risk issues. Project issues should be examined and identified by reducing them to a level of detail that permits an evaluator to understand the significance of any risk and its causes (e.g., risk issues). This is a practical way of addressing the large

and diverse number of potential risks that often occur in moderate- to large-scale programs.
For example, a WBS level 4 or 5 element may be made up of several risk issues associated with a specification or function.

Risk analysis is a technical and systematic process to examine identified risks, isolate causes, determine the relationship to other risks, and express the impact in terms of probability and consequence of occurrence.

6.7 Risk Response

Risk Response Planning is the process of developing options, and determining actions to enhance opportunities and reduce threats to the project's objectives. It follows the Qualitative Risk Analysis and Quantitative Risk Analysis processes. It includes the identification and assignment of one or more persons (the "risk response owner") to take responsibility for each agreed-to and funded risk response. Risk Response Planning addresses the risks by their priority, inserting resources and activities into the budget, schedule, and project management plan, as needed.

Risk response strategies are the approaches we can make to dealing with the risks we have identified and quantified. In the section on risk quantification we discussed evaluating the risk in terms of its impact and probability in such a way that we would be able to rank risks in their order of importance. This is what we called severity, the combination of impact and probability.

Risk response strategy is really based on risk tolerance, which has been discussed. Risk tolerance in terms of severity is the point above which a risk is not acceptable and below which the risk is acceptable.

Several strategies are available for dealing with risks. These are avoidance, acceptance, transfer, and mitigation.

There are many reasons for selecting one risk strategy over another, and all of these factors must be considered. Cost and schedule are the most likely reasons for a given risk to have a high severity. Other factors may affect our choice of risk strategy. For example, if a schedule risk is identified for a task in the project, and if this task has many other tasks depending on it, its severity may be calculated as being lower than is apparent, and the severity should be adjusted even though the schedule impact due to the disruption may be difficult to judge. The strategy should be appropriate for the risk it is intended for.

- ***Negative Risk Response Strategies:***

- Avoidance - The project plan is altered to avoid the identified risk.
- Mitigation - Effort is made to reduce the probability, impact, or both of an identified risk in the project before the risk event occurs.
- Transference - The risk is assigned to a third party, usually for a fee. The risk still exists, but the responsibility is deflected to the third party.

- ***Positive Risk Response Strategies:***

Tools and Techniques for Risk Response Planning; it's important to know how to handle both positive and negative risk.

- Exploit - Used in conjunction with positive impacts where the host organization wants to ensure the positive risk definitely happens.
- Share - 3rd party partnerships that include forming risk-sharing partnerships, teams, special-purpose companies, or joint ventures, which can be established with the express purpose of managing opportunities.
- Enhance - Seeks to facilitate or strengthen the cause of the opportunity, and proactively targeting and reinforcing its trigger conditions, to potentially increase probability.

[http://pmtips.net/defining-risk-management-part-6-risk-response/].

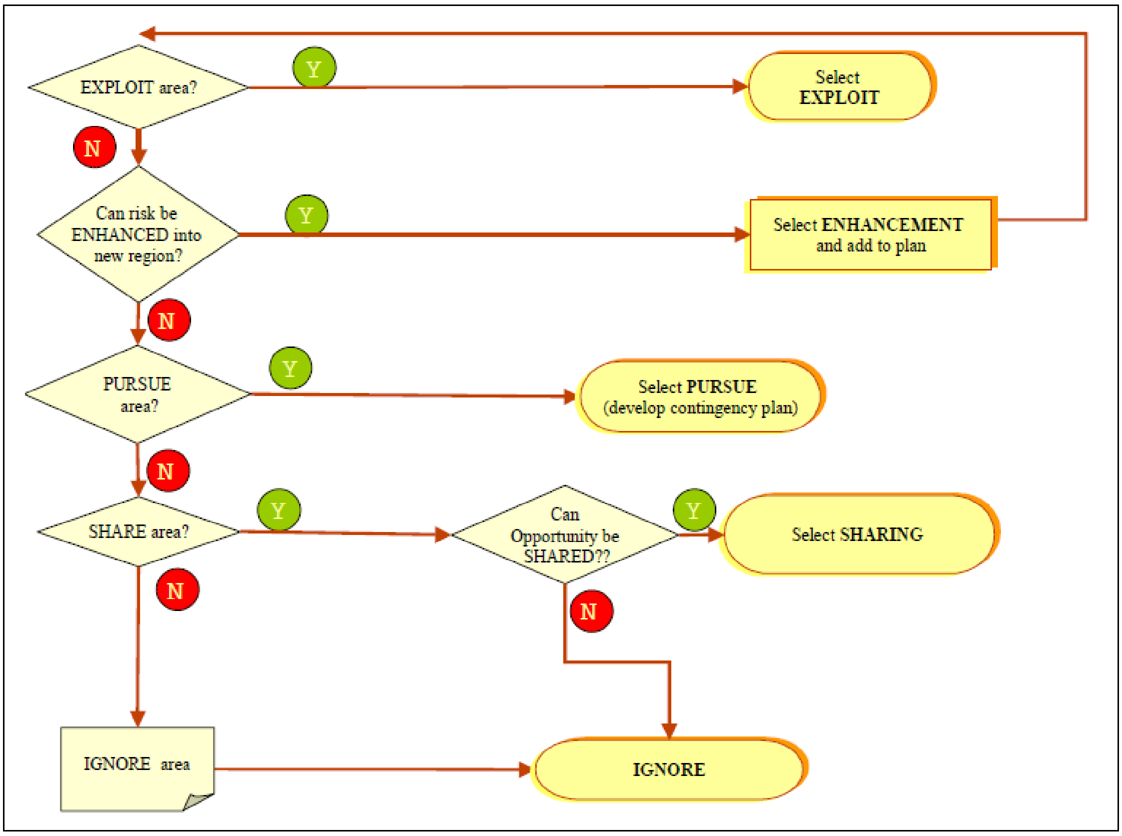


Figure 6.2: Flow chart of risk response planning of opportunities.

Section Three

CH 7

Project Quality management

7.1 Introduction

Project Quality Management includes the process required to ensure that the project will satisfy the needs for which it was undertaken. It includes ‘‘all activities of the overall management function that determine the quality policy, objectives, and responsibilities and implements them by means such as quality planning, quality control, quality assurance, and quality improvement, within the quality system ’’.

The improvements have occurred not only in product quality, but also in quality leadership and quality high-tech engineering companies never fully recognized the need for shortening product development time and the relationship between project management, and concurrent engineering. The push for higher levels of quality appears to be customer driven.

7.2 Definition of Quality

The ISO 9000 definition is the totality of feature and characteristics of a product or service that bears on its ability to satisfy stated or implied needs. Terms such as fitness for use, customer satisfaction, and zero defects are goals rather than definitions. Most organizations today view quality more as a process than a product.

TO be more specific, it is a continuously improving process where lessons learned are used to enhance future products and services in order to:

- Retain existing customers.
- Win back lost customers.
- Win new customers.

7.3 Definition of Quality Management

Quality management is a method for ensuring that all the activities necessary to design, develop and implement a product or service are efficient with respect to the system and its performance. Quality management is focused not only on product quality, but also achieves it.

7.4 Quality Management activities

From a project manager's perspective, there are three quality management activities that should exist to support each and every project. They include:

- Quality planning.
- Quality assurance.
- Quality control.

7.4.2 Quality planning

Quality planning involves identifying which quality standards are relevant to the project and determining how to satisfy them. It is one of the key facilitating processes during project planning and should be performed regularly and in parallel with the other project planning processes.

* **Inputs of quality planning:**

1. Quality policy: Quality policy is the overall intentions and direction of an organization with regard to quality, as formally expressed by top management.
2. Scope statement: The scope statement is a key input to quality planning since it documents major project deliverable, as well as the project objective that serve to define important stakeholder requirements.
3. Product description: Although elements of the product description may be embodied in the scope statement, the product description will often contain details of technical issues and other concerns that may affect quality planning.
4. Standards and regulations: The project management team must consider any application area-specific standards or regulations that may affect the project.

* **Tools & Techniques of quality planning:**

1. Benefit/cost analysis: The quality planning process must consider benefit/cost tradeoffs, the primary benefit or meeting Quality requirements is less rework, which means higher productivity, lower cost, and increased stakeholder satisfaction.
2. Benchmarking: Benchmarking involves comparing actual or planned project practices to those of other projects to generate ideas for improvement and to provide a standard by which to measure performance.
3. Flowcharting: A flow chart is any diagram that shows how various elements of a system relate.
4. Design of experiments: Design of experiments is a statistical method that helps identify which factor might influence specific variables.
5. Cost of quality: Cost of quality refers to the total cost of all efforts to achieve product/service quality, and includes all work to ensure conformance to requirements, as well as all work resulting from nonconformance to requirements.

* **Outputs of quality planning:**

1. Quality management plan: The Quality management plan should describe how the project management team will implement its quality policy.
2. Operational definitions: An operational definition describes, in very specific terms, what something is and how it is measured by the quality control process.
3. Checklists: A Checklist is a structural tool, usually item specific, used to verify that a set of required steps has been performed.
4. Input to other processes: The quality planning process may identify a need for further activity in another area.

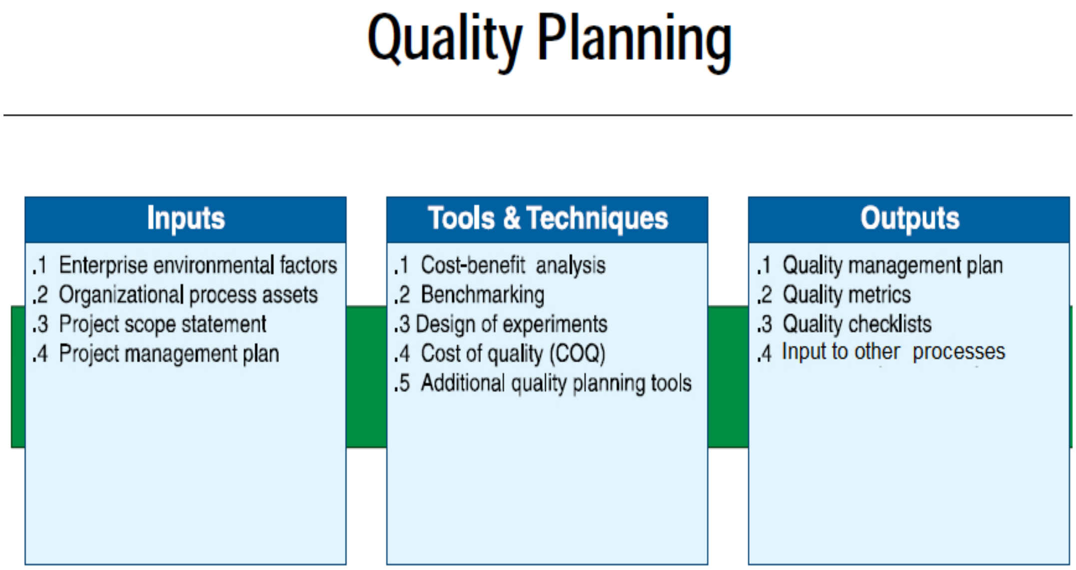


Figure 7.1 (Quality Planning)

7.4.3 Quality assurance

Quality assurance is the All of the activities that make it possible to define standards, to measure and improve the performance of services and health providers so that care is as effective as possible. It should be performed throughout the project. Prior to development of the ISO 9000 series, the activities described under quality planning were widely included as a part of quality assurance.

Quality assurance is often provided by a Quality Assurance department or similarly titled organizational unit, but it does not have to be.

* **Input to Quality Assurance:**

1. Quality management plan.
2. Results of quality control measurements: Quality control measurements are records of quality control testing and measurement in a format for comparison and analysis.
3. Operational definitions.

* **Tools & Techniques of quality Assurance**:

1. Quality planning tools and techniques.
2. Quality audits: A quality audits is a structured review of other quality management activities. The objective of a quality audit is to identify lessons learned that can improve performance of this project or of other project within the performing organization.

* **Output from quality planning:**

1. Quality improvement: Quality improvement includes taking action to increase the effectiveness and efficiency of the project to provide added benefits to the project stakeholders.

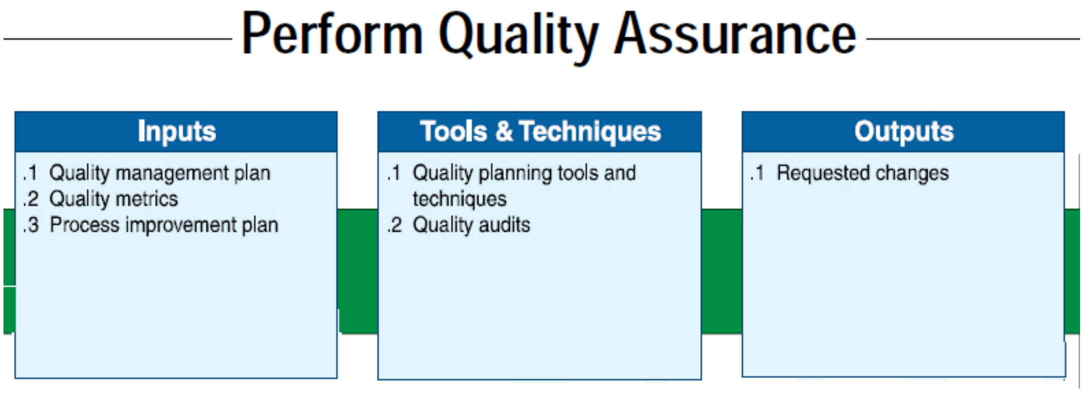


Figure 7.2 (Quality Assurance)

7.4.3 Quality control:

Quality control involves monitoring specific project results to determine if they comply with relevant quality standards, and identifying ways to eliminate causes of unsatisfactory results. It should be performed throughout the project. Project results include both product results, such as deliverables, and project management results, such as cost and schedule performance.

* **Input to quality control:**
  1. Work results.
  2. Quality management plan.
  3. Operational definitions.
  4. Checklists.

* **Tool and techniques for quality planning:**
  1. Inspection: Inspection includes activities such as measuring, examining, and testing undertaken to determine whether results conform to requirements.
  2. Control charts: control charts are a graphic display of the results, over time, of a process.
  3. Pareto diagrams: A Pareto diagram is a histogram, ordered by frequency of occurrence that shows how many results were generated by type or category of identified cause.
  4. Statistical sampling: Statistical sampling involves choosing part of the a population of interest for inspection.
  5. Flowcharting: Flowcharting is used in quality control to help analyze how problems occur.
  6. Trend analysis: Trend analysis involves using mathematical techniques to forecast future outcomes based on historical results.

* **Output to quality control**:
  1. Quality improvement.
  2. Acceptance decisions.
  3. Rework: Rework is action taken to bring a defective or nonconforming item into compliance with requirements or specifications.
  4. Completed checklists.
  5. Process adjustments: Process adjustments involve immediate corrective or preventive action as a result of quality control measurements.

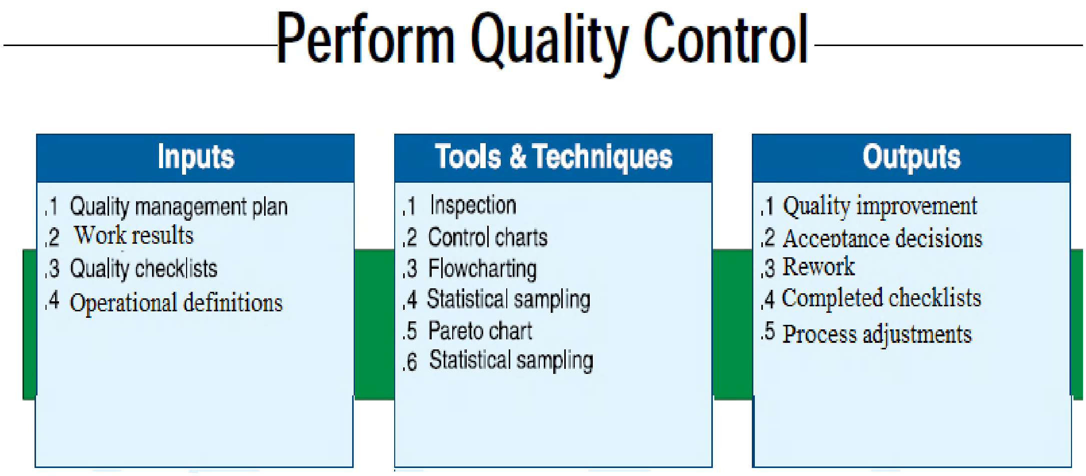


Figure 7.3 (Quality Control)

7.4.4 ISO 9000.

The International Organization for standardization (ISO).
The American National Standard Institute (ANSI) represents the United States.
ISO 9000 is not a set of standards for products or services, nor is it specific to any one industry. Instead, it is a quality system standard applicable to any product, service, or process anywhere in the world. The information included in the ISO 9000 series included:

1. ISO 9000: this defines the key terms and act as a road map for the other standards within the series.

2. ISO 9001: This defines the model for a quality system when a contractor demonstrates the capability to design, products or services.

3. ISO 9002: This is a quality system model for quality assurance in production and installation.

4. ISO 9003: This is a quality system model for quality assurance in final inspection and testing.

5. ISO 9004: This provides quality management guidelines for any organization wishing to develop and Implement a quality system. Guidelines are also available to determine the extent to which each quality system model is applicable.

Figure 7.4 (ISO 9001)

ISO 9000 is actually a three-part, never-ending cycle including planning, controlling, and documentation. Planning is required to ensure that the objectives, goals, authority, and responsibility relationships of each activity are properly defined and understood. Controlling is required to ensure that the goals and objectives are met, and that problems are anticipated or averted through proper corrective actions. Documentation is used predominantly for feedback on how well the quality management system is performing to satisfy customer's needs and what changes may necessary.

CH 8

Communication Resources

8.1 Introduction:

Probably the single most important thing in project management is communications. It is said that if good communications exist in a project, the team will be motivated and the project will succeed in spite of problems that might kill another project. It is essential that project managers have a good understanding of communications. It is generally agreed among project managers that communications skills are the most important skills that a project manager can have. These skills are considered to be more building skills, and leadership skills, and they are certainly considered more important for project managers than technical skills (figure 8-1). It is often said that if a project manager has good communications skills and no other skills at all, the project team will get the project completed successfully in spite of the project manager. According to the Guide to the Project Management Body of Knowledge, communications management in projects is the process required to ensure timely and appropriate generation, collection, dissemination, storage, and ultimately disposition of project information.

8.2 General Model of Communications:

Communicating is the process of delivering a message to another with understanding.

Communication skills	84%
Organization skills	75%
Team Building skills	72%
Leadership skills	68%
Technological skills	48%

Figure 8-1. The importance of communications management(survey of project mans).

Which of the following do you consider important project management skills? Refer to figure 8-2, the communications model. We should first review the terms to make sure we are communicating properly.

Thinking

The sender frames the ideas and creates the message that he or she wants to send.

Encoding

The encoding process consists of formatting the message into some transmittable form. This makes the communication possible. The language, written and spoken words, facial expressions, body language, and other means of transmitting an idea can be used. Some of the time a communication we do not wish to send is sent anyway. We can communicate by physically touching someone. We can communicate by making some sort of a physical gesture such as pointing a finger.

Symbols

All sorts of symbols can be used to communicate. Symbols stand in the place of something we have experienced initially. A picture of a person is a symbol of that person. A uniform is a symbol for a policeman. Words are symbols for the objects or ideas they represent.

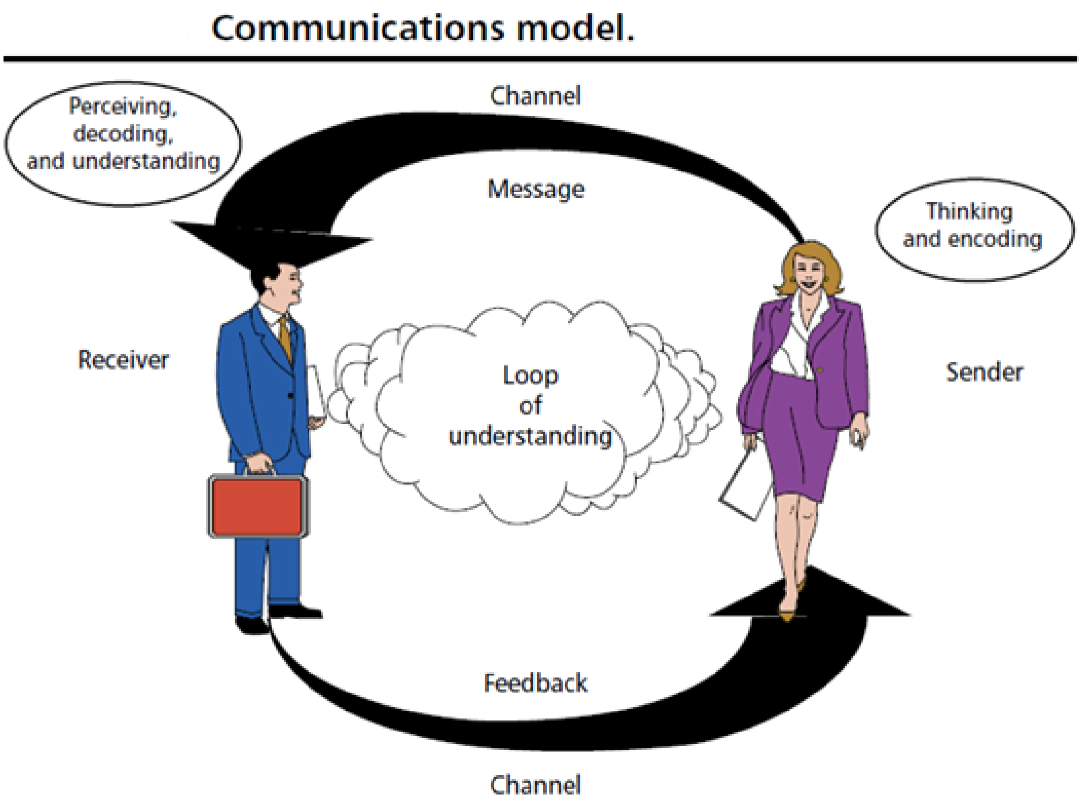


Figure 8.2 communication model

Transmitting

This is the process of moving the message from the sender to the receiver. The medium used might be air waves, as in the use of the spoken word; electronically, as in e-mail, telephone, and fax; visual signals; or combinations of these.

Perceiving

The receiver must have recognition that the message is coming. If there is no perception of the message, then the message is never received. Ultimately, the message must enter the receiver by means of one of a person's five senses: sight, sound, smell, taste, or touch.

Decoding

The receiver must now take the message and convert it into some form that can be understood.

Understanding

If there is no understanding, there is no message. The message must have some understandable meaning for the receiver.

8.3 Barriers to Communications:

There can be many barriers to communications. Messages can be blocked or distorted, and as a result, their meaning can be cahanged considerably.

Distorted Perceptions

Many times the receiver is not in the proper frame of mind to receive the message. This may be due to many factors, such as the environment, the mood of the receiver, or the subject matter being delivered. The status of the person sending the message may have an effect as well. When something is being said by the person working in the next cubicle, the effectiveness of the communication will be different than if the person is the CEO of the company. So we can say that motivation and needs and even experience affect a person's perception.

The receiver's perception is also affected by the need to connect the new message to already received information that is stored in the receiver's memory. We try to connect new information to old information in order to make it meaningful.

Distrusted Sources

The source of a communication may be wrong about what he or she is communicating. It can be that the source is really wrong or it may be that we are just convinced that the source is wrong. When this condition exists in an extreme way, it makes no difference what is really said. The perception of the message will be similar to what is expected.

Transmission Errors

There are a number of reasons why a message is not properly received, and language is one of the most common problems. Not only are the different words of different languages a problem, but the cultural differences between people who speak

different languages result in errors in communication even if the words and meanings are the same.
Receiving and sending messages can only be done within the framework of common experience and understanding. When the experience and understanding are different, communication is difficult.

When you deal with people from different cultural backgrounds, care must be taken with the choice of words that you use. This is not only necessary when dealing with those who are from a different country than yours. There are significant cultural differences between people from different parts of the same country and even from different neighborhoods within the same city.

8.4 Improving Communications:

The following guidelines will help you improve your communications.

Make the Message Relevant for the Receiver

Good communications come when the receiver is interested and has some thing at stake in the message. If the message is relevant, then the receiver is more likely to get a more complete meaning. We have all been in the situation where someone is telling us about something that is not relevant to us.
Our attention wanders off to some other area, and we actually do not hear anything that is said for a period of time.

Reduce the Message to Its Simplest Terms

When you communicate with someone, keep the message as simple as possible.
Many times the message is complicated with unnecessary details about the rationale and the justification of a project when the listener is already convinced and just wants to know what to do.

Organize the Message into a Series of Stages

One of the reasons that verbal communication succeeds over written communications is the opportunity to keep things simple. The sender can send a simple part of the message and receive feedback immediately. The sender can send another part of the message and receive feedback on that too.
In this way, the message is kept simple, and the receiver is brought to the complete understanding of the full message, one piece at a time. You may have heard this question: ‘‘How do you eat an elephant?’’ The answer is, ‘‘One bite at a time.’’ Of course, if it takes too long, the elephant may spoil, and the message may be lost.

Repeat the Key Points

Because listening takes place a very small percentage of the time, it is important to repeat the important points of the message. As communication takes place, it is a good idea to go back a few steps and summarize what has gone before. This allows repetition of some of the major points and ensures that the receiver is getting all of the important points in the message.

8.5 *Type of communications:*

Formal and Informal Communications

8.5.1 *Formal Communications*

Project managers and members of their project teams are frequently required to make formal presentations to their managers, their customers, and various other stakeholders in the project. In order to accomplish this, it is necessary for them to have good presentation skills.

Today we are fortunate that there is much in the way of computer software for presentations that makes this formerly expensive chore easy and inexpensive to accomplish. One of the most popular software packages is Microsoft PowerPoint. This software package makes formal presentations easy. Digital photography is now widely available, so that photographs can be easily inserted into the presentation to make it more meaningful. Video projection is also widely available, so that the tedious process of making presentation graphics on transparencies is no longer necessary. Distance conferencing is now widely used. Video and audio connections between conference rooms eliminate the need to have people travel to distant locations to attend meetings. This not only reduces the cost of travel but significantly saves time that could be devoted to more direct project work.

The Internet has proven to be a great communication tool for project management. Project data from various parts of a project located in remote parts of the world can be easily shared and combined with other project data through the Internet. E-mail has already changed the way we communicate. For most of us, the use of e-mail has changed the way we do business. Unlike telephone calls, which are almost always an interruption in what we are doing, the email we receive is looked at when want to. This allows us to pay close attention to what is being communicated and carefully respond to inquiries. Many times the decisions made quickly during a telephone call are soon regretted.

8.5.2 *Informal Communications*

I have a good friend who is now retired from the U.S. Navy. He was a captain and had a large command of some twelve hundred people that he was responsible for. We often have discussions about the Navy way of doing things. One of the problems in any military organization is the structure of the military chain of command. The strict chain of command is required be- 202 Preparing for the Project Management Professional Certification Exam cause, when fighting a war, it is critical that legitimate orders be carried out. There is usually no time for discussion, and commanders do not usually have time to explain things to the subordinates who are to carry out the orders. It is important that each subordinate communicates to his or her superior officer and not deviate from that order. It would lead to confusion if an officer would go directly to a subordinate three levels below the officer. The problem is that the military are not always engaged in war and fighting.

Most of the time they are engaged in the business of keeping the forces ready to fight. This part of the military function is more like an everyday business. As we have seen, in a company, free and open communications are better ways to communicate than by having a strict chain of command. It is not possible to have an organization work two different ways. The problem is solved by having parties. The U.S. Navy has frequent cocktail parties. When I attended these parties, I noticed that very few people were drinking. I also observed that very few people were sitting. This was because the party allowed people to circulate regardless of rank and order in the chain of command. If one person needed to get information from another, he or she could do it this way without going through the formality of the chain of command. Often in project management there is a need for formal communications. The normal method of communications between the project team and the stakeholders should be open and free, but there are times when formal communications are necessary. When major milestones in the project are being passed and agreement must be had from all the stakeholders, formal communications are necessary. When authorized project changes are made, it is necessary to have formal communications. As the number of persons involved in a decision is increased, the need for formal communication increases.

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PART TWO

Application Of Construction Management ..
Palestinian Monetary Authority New Building.

After studying the principles of construction management in the theoretical part of the project, it’s very important to apply these theories at a real project to see the correct way of applying these principles, which gives a better understanding of many issues and to get some experience in construction management which make you familiar with any project in the real life.

Here, you start to built up a project step by step from the start to finish, by asking people whom have experience at construction management, like contractors, and project managers, to get the knowledge about collecting data, making activity lists, putting the WBS to the project, quantity surveying, estimating (cost & time), scheduling, controlling and managing resources of the projects using the principles of construction management, and using computer software’s, which make the estimating, and management more easy and smoothly, and save the time and effort.

The project that chosen to study is Palestinian Monetary Authority Building, this building is not a normal building, because of the design of each storey is different from another, which is not commonly in a lot of projects, this make the study hard and took a lot of time.

At this part, managing is done using computer software’s programs which are; Primavera software; this program is used for schedule and the durations of the project. WBS Chart Pro, And Microsoft Excel.

Next, the steps of managing this project, will be discussed at this part, and discuss the notes and the problems, that may happen at the similar projects, which will give an idea about this type of projects.

1. Project Description:

Palestinian Monetary Authority began the implementation of a new special and big building, to achieve their service and structural needs, and to have a special and important building, as it seeks to be a Central Bank of Palestine.

The Project is located at the end of AL- Ersal Street in Ramallah city, and consists of 9 floors, equipped with all modern and necessary supplies for the operation of central banks advanced, the 4^{th}, and 3^{rd} basement floors are used for parking, main electric power, the other floors contain; stores, safes, offices, hall meetings, conference rooms, central office, training rooms, and the building is surrounded by green areas.

The areas of the floors are different, and it's summarized as follow:

Areas Summary	
Basement Four	3261.77 m^2
Basement Three	3261.77 m^2
Basement Two	3261.77 m^2
Basement One	3073.51 m^2
Ground Floor	1696.18 m^2
First Floor	1696.18 m^2
Second Floor	1696.18 m^2
Third Floor	1696.18 m^2
Fourth Floor	901.77 m^2
Stairs & Elevators	100.83 m^2
Outside Stair	56.14 m^2
SUM	**20702.28 m^2**

Table 1 : Areas Summary.

The following Picture shows the site plan:

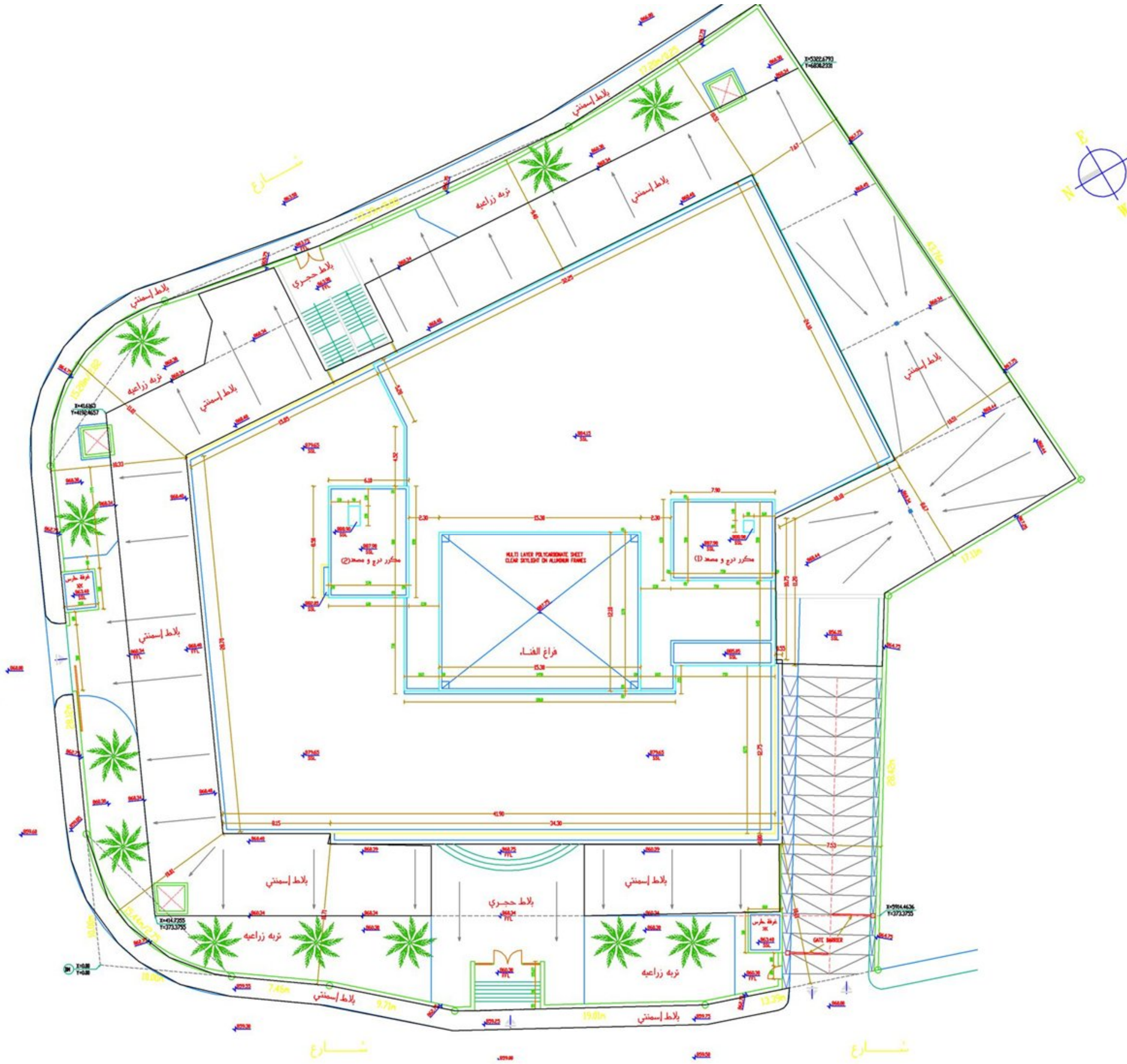


Figure 1 : Site Plan.

According to the drawings, plans, specifications, the management operation starting using the methods of engineering construction management in projects, a specific method is used in managing by applying the major processes of construction management at this project, by following these steps:

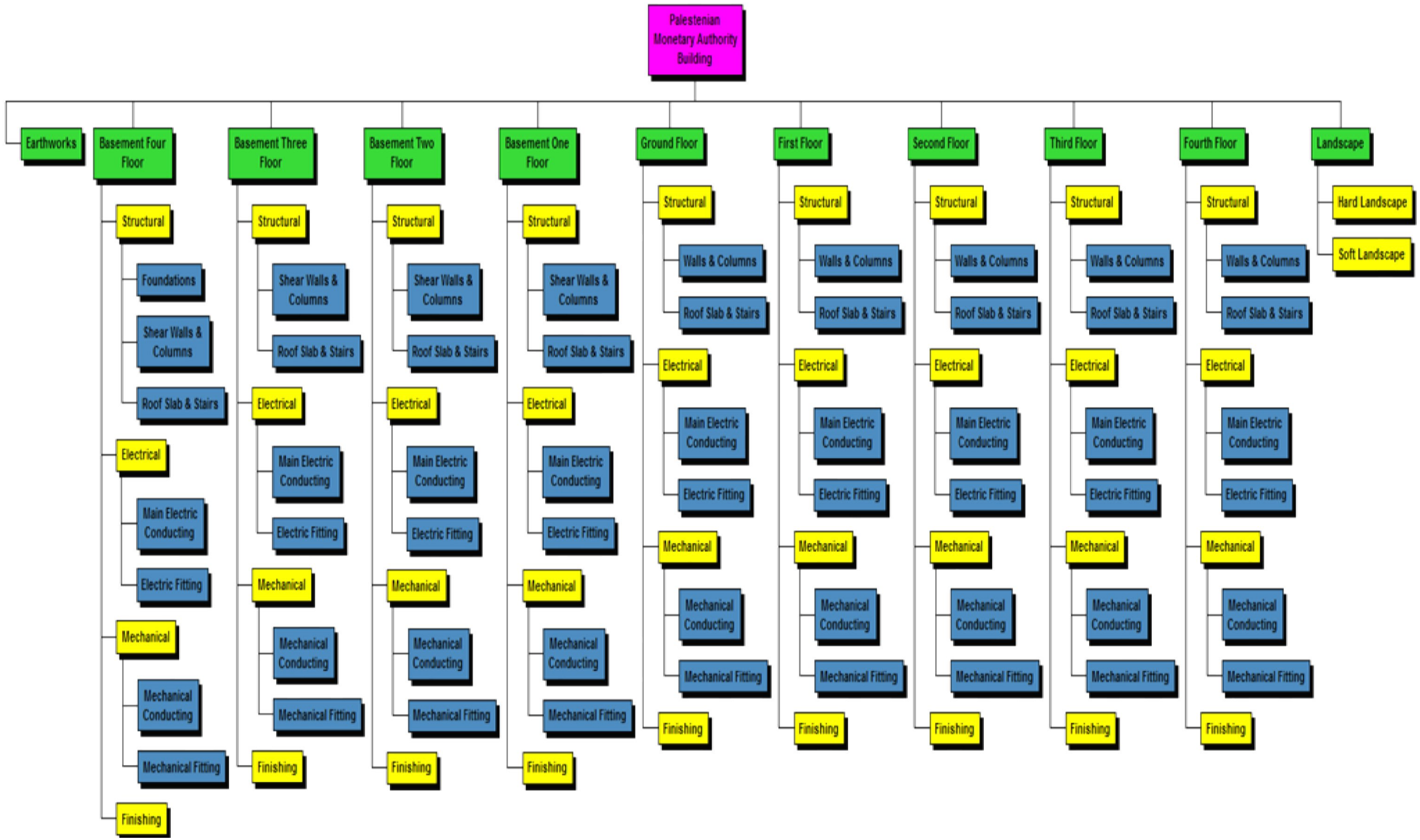
- WBS Preparation.
- Quantity Surveying.
- Activity list & activity coding.
- Bill of quantity (BOQ) preparation; quantities, cost, resources, and man hours.
- Activity durations & productivity.
- Project network.
- Project budgeting.
- Project duration & CPM analysis.

2. Work Breakdown Structure (WBS):

The suitable WBS selected according to the drawings and specifications, to divide the project into packages (as shown in figure 2), which makes managing the project easy and controlled well, WBS allows limiting the price of each package in the project, the WBS of the project is divided into these levels:

1. Level One: The whole of the project.
2. Level Two: The earth works, the floors, and landscape of the project
3. Level Three: The types of work (structural, electrical, mechanical, finishing).
4. Level Four: The work packages of types in level three.
5. Level Five: The Activities.

As shown in **figure 2**, next page:


Palestenian Monetary Authority Building
Earthworks
Basement Four Floor
Structural
Foundations
Shear Walls & Columns
Roof Slab & Stairs
Electrical
Main Electric Conducting
Electric Fitting
Mechanical
Mechanical Conducting
Mechanical Fitting
Finishing
Basement Three Floor
Structural
Shear Walls & Columns
Roof Slab & Stairs
Electrical
Main Electric Conducting
Electric Fitting
Mechanical
Mechanical Conducting
Mechanical Fitting
Finishing
Basement Two Floor
Structural
Shear Walls & Columns
Roof Slab & Stairs
Electrical
Main Electric Conducting
Electric Fitting
Mechanical
Mechanical Conducting
Mechanical Fitting
Finishing
Basement One Floor
Structural
Shear Walls & Columns
Roof Slab & Stairs
Electrical
Main Electric Conducting
Electric Fitting
Mechanical
Mechanical Conducting
Mechanical Fitting
Finishing
Ground Floor
Structural
Walls & Columns
Roof Slab & Stairs
Electrical
Main Electric Conducting
Electric Fitting
Mechanical
Mechanical Conducting
Mechanical Fitting
Finishing
First Floor
Structural
Walls & Columns
Roof Slab & Stairs
Electrical
Main Electric Conducting
Electric Fitting
Mechanical
Mechanical Conducting
Mechanical Fitting
Finishing
Second Floor
Structural
Walls & Columns
Roof Slab & Stairs
Electrical
Main Electric Conducting
Electric Fitting
Mechanical
Mechanical Conducting
Mechanical Fitting
Finishing
Third Floor
Structural
Walls & Columns
Roof Slab & Stairs
Electrical
Main Electric Conducting
Electric Fitting
Mechanical
Mechanical Conducting
Mechanical Fitting
Finishing
Fourth Floor
Structural
Walls & Columns
Roof Slab & Stairs
Electrical
Main Electric Conducting
Electric Fitting
Mechanical
Mechanical Conducting
Mechanical Fitting
Finishing
Landscape
Hard Landscape
Soft Landscape

3. Activity List & Coding:

The lowest level of the WBS is composed of work packages, and these are broken down into the specific activities that are included on the activity list.

The Activity List is the complete list of the scheduled activities for a project. As it is used to help develop the project schedule and estimate needed resources, it serves as an input to the following processes: sequence activities, estimate activity resources, estimate activity durations, and develop schedule.

Activities are prepared according to the method of work, and through the work breakdown structure, and a particular encoding used to represent each activity; this makes easy access for each activity in the network of the project.

The activity code used at this project can be illustrated as follows:

- The first letter: represents the 1st letter at level two in the WBS, like;
  E: earth work.
  B4: basement four.
  GF: ground floor.
  L: Landscape.
- The second letter: represents the 1st letter at level three in the WBS, like;
  S: structural.
  E: electrical.
  M: mechanical.
  H: hard landscape.
  SO: soft landscape.
- The third letter: represents the 1st letter at level four in the WBS, like;
  W: walls & columns.
  RS: roof slab &stairs.
  C: conducting.
  F: fitting.
  And so…

For example; activity (F2SW20) is located at 2nd floor, structural works, walls & columns.

Activity List

WBS

Activity ID	Activity Name

1 Palestinian Monetary Authority Building

1.1 Earthworks

E10	Site preparation and mobilization
E20	Excavation of agricaltural soil

1.2 Basement four floor

1.2.1 Structural

1.2.1.1 Foundations

B4SF10	Excavation for foundation
B4SF20	Blind Concrete-15cm-(B180)
B4SF30	Foundation(steel,formwork&Casting)
B4SF40	Foundation(Bitumen)

1.2.1.2 Shear Walls & Columns

B4SW10	Exterior Walls (steel, formwork,casting) of B4
B4SW20	Interior Walls & columns of B4(steel, formwork,casting)

1.2.1.3 Roof Slab & Stairs

B4SRS10	Slab & Stairs Formwork of B4
B4SRS20	Slab(block, steel, casting) of B4

1.2.2 Electrical

1.2.2.1 Main Electric Conducting

B4EC10	Earthing Systems (B4)
B4EC20	Electric Conduit of B4

1.2.2.2 Electric Fitting

B4EF10	Electric finishing (all units) of B4

1.2.3 Mechnical

1.2.3.1 Mechanical Conducting

B4MC10	Mechanic conduit of B4

1.2.3.2 Mechanical Fitting

B4MF10	Mechanic fitting of B4

1.2.4 Finishing

B4F10	Plastering of B4
B4F20	Tiling ground of B4
B4F30	Doors Frames of B4
B4F40	Doors installation of B4
B4F50	Painting of B4
B4F60	False ceiling of B4
B4F70	Stairs finishing of B4

1.3 Basement three floor

1.3.1 Structural

1.3.1.1 Shear Walls & Columns

B3SW10	Exterior Walls (steel, formwork,casting) of B3
B3SW20	Interior Walls & columns of B3(steel, formwork,casting)

Activity List

WBS

Activity ID	Activity Name
1.3.1.2 Roof Slab & Stairs	
B3SRS10	Slab & Stairs formworks of B3
B3SRS20	Slab(block, steel, concrete casting) of B3
1.3.2 Electrical	
1.3.2.1 Main Electric Conducting	
B3EC10	Electric Conduit of B3
1.3.2.2 Electric Fitting	
B3EF10	Electric finishing (all units) of B3
1.3.3 Mechnical	
1.3.3.1 Mechanical Conducting	
B3MC10	Mechanic conduit of B3
1.3.3.2 Mechanical Fitting	
B3MF10	Mechanic fitting of B3
1.3.4 Finishing	
B3F10	Plastering of B3
B3F20	Tiling of B3
B3F30	Doors Frames of B3
B3F40	Doors installation of B3
B3F50	Painting of B3
B3F60	False ceiling of B3
B3F70	Stairs finishing of B3
1.4 Basement two floor	
1.4.1 Structural	
1.4.1.1 Shear Walls & Columns	
B2SW10	Exterior Walls (steel, formwork,casting) of B2
B2SW20	Interior Walls & columns of B2(steel, formwork,casting)
1.4.1.2 Roof Slab & Stairs	
B2SRS10	Slab & Stair Forming of B2
B2SRS20	Slab(block, steel, concrete casting) of B2
1.4.2 Electrical	
1.4.2.1 Main Elecrtic Conducting	
B2EC10	Electric Conduit of B2
1.4.2.2 Electric Fitting	
B2EF10	Electric finishing (all units) of B2
1.4.3 Mechnical	
1.4.3.1 Mechanical Conducting	
B2MC10	Mechanic conduit of B2
1.4.3.2 Mechanical Fitting	
B2MF10	Mechanic fitting of B2
1.4.4 Finishing	
B2F10	Block partitions of B2

Activity List

WBS Activity ID	Activity Name
B2F20	Plastering of B2
B2F30	Tiling ground of B2
B2F40	Wall tiling of B2
B2F50	Doors Frames of B2
B2F60	Doors installation of B2
B2F70	Painting of B2
B2F80	False ceiling of B2
B2F90	Stairs finishing of B2

1.5 Basement one floor

1.5.1 Structural

1.5.1.1 Shear Walls & Columns

Activity ID	Activity Name
B1SW10	Exterior Walls & columns of B1(steel, forming,casting)
B1SW20	Interior Walls & columns of B1(steel, formwork,casting)

1.5.1.2 Roof Slab & Stairs

Activity ID	Activity Name
B1SRS10	Slab & Stair Forming of B1
B1SRS20	Slab(block, steel, concrete casting) of B1

1.5.2 Electrical

1.5.2.1 Main Electric Conducting

Activity ID	Activity Name
B1EC10	Electric Conduit of B1

1.5.2.2 Electric Fitting

Activity ID	Activity Name
B1EF10	Electric finishing (all units) of B1

1.5.3 Mechnical

1.5.3.1 Mechanical Conducting

Activity ID	Activity Name
B1MC10	Mechanic conduit of B1

1.5.3.2 Mechanical Fitting

Activity ID	Activity Name
B1MF10	Mechanic fitting of B1

1.5.4 Finishing

Activity ID	Activity Name
B1F10	Block partitions of B1
B1F20	Plastering of B1
B1F30	Tiling ground of B1
B1F40	Wall tiling of B1
B1F50	Doors Frames of B1
B1F60	Doors installation of B1
B1F70	Painting of B1
B1F80	False ceiling of B1
B1F90	Stairs finishing of B1

1.6 Ground floor

1.6.1 Structural

1.6.1.1 Shear Walls & Columns

Activity ID	Activity Name
GFSW20	Exterior Walls & Columns of GF (steel, formwork,casting)
GFSW30	Interior Walls & columns of GF(steel, formwork,casting)

Activity List

WBS	
Activity ID	**Activity Name**

1.6.1.2 Roof Slab & Stairs

GFSRS10	Slab & Stair Forming of GF
GFSRS20	Slab(block, steel, concrete casting) of GF

1.6.2 Electrical

1.6.2.1 Main Elecrtic Conducting

GFEC10	Electric Conduit of GF

1.6.2.2 Electric Fitting

GFEF10	Electric finishing (all units) of GF

1.6.3 Mechnical

1.6.3.1 Mechanical Conducting

GFMC10	Earth drianage & manholes
GFMC20	Mechanic conduit of GF

1.6.3.2 Mechanical Fitting

GFMF10	Mechanic fitting of GF

1.6.4 Finishing

GFF10	Block partitions of GF
GFF100	Stone work of GF
GFF110	Stairs finishing of GF
GFF20	Plastering of GF
GFF30	Tiling ground of GF
GFF40	Wall tiling of GF
GFF50	Doors frames of GF
GFF60	Windows of GF
GFF70	Doors installation of GF
GFF80	Painting of GF
GFF90	False ceiling of GF

1.7 1st Floor

1.7.1 Structural

1.7.1.1 Walls & Columns

F1SW20	Exterior & columns of F1(steel, formwork,casting)
F1SW30	Interior Walls & columns of F1(steel, formwork,casting)

1.7.1.2 Roof Slab & Stairs

F1SRS10	Slab & Stair Forming of F1
F1SRS20	Slab(block, steel, concrete casting) of F1

1.7.2 Electrical

1.7.2.1 Main Electric Conducting

F1EC10	Electric Conduit of F1

1.7.2.2 Electric Fitting

F1EF10	Electric finishing (all units) of F1

1.7.3 Mechnical

1.7.3.1 Mechanical Conducting

Activity List

WBS	
Activity ID	**Activity Name**
F1MC10	Mechanic conduit of F1
1.7.3.2 Mechanical Fitting	
F1MF10	Mechanic fitting of F1
1.7.4 Finishing	
F1F10	Block partitions of F1
F1F100	Stone work of F1
F1F110	Stairs finishing of F1
F1F20	Plastering of F1
F1F30	Tiling ground of F1
F1F40	Wall tiling of F1
F1F50	Doors frames of F1
F1F60	windows of F1
F1F70	Doors installation of F1
F1F80	Painting of F1
F1F90	False ceiling of F1
1.8 2nd Floor	
1.8.1 Structural	
1.8.1.1 Walls & Columns	
F2SW20	Exterior Walls & columns of F2(steel, formwork,casting)
F2SW30	Interior Walls & columns of F2(steel, formwork,casting)
1.8.1.2 Roof Slab & Stairs	
F2SRS10	Slab & Stair Forming of F2
F2SRS20	Slab(block, steel, concrete casting) of F2
1.8.2 Electrical	
1.8.2.1 Main Electric Conducting	
F2EC10	Electric Conduit of F2
1.8.2.2 Electric Fitting	
F2EF10	Electric finishing (all units) of F2
1.8.3 Mechnical	
1.8.3.1 Mechanical Conducting	
F2MC10	Mechanic conduit of F2
1.8.3.2 Mechanical Fitting	
F2MF10	Mechanic fitting of F2
1.8.4 Finishing	
F2F10	Block Partitions of F2
F2F100	Stone work of F2
F2F110	Stairs finishing of F2
F2F20	Plastering of F2
F2F30	Tiling ground of F2
F2F40	Wall tiling of F2
F2F50	Doors frames of F2

Activity List

WBS Activity ID	Activity Name
F2F60	Windows of F2
F2F70	Doors installation of F2
F2F80	Painting of F2
F2F90	False ceiling of F2

1.9 3d Floor

1.9.1 Structural

1.9.1.1 Walls & Columns

F3SW20	Exterior Walls & columns of F3(steel, formwork,casting)
F3SW30	Interior Walls & columns of F3(steel, formwork,casting)

1.9.1.2 Roof Slab & Stairs

F3SRS10	Slab & Stair Forming of F3
F3SRS20	Slab(block, steel, concrete casting) of F3

1.9.2 Electrical

1.9.2.1 Main Electric Conducting

F3EC10	Electric Conduit of F3

1.9.2.2 Electric Fitting

F3EF10	Electric finishing (all units) of F3

1.9.3 Mechnical

1.9.3.1 Mechanical Conducting

F3MC10	Mechanic conduit of F3

1.9.3.2 Mechanical Fitting

F3MF10	Mechanic fitting of F3

1.9.4 Finishing

F3F10	Block partitions of F3
F3F100	Stone work of F3
F3F110	Stairs finishing of F3
F3F20	Plastering of F3
F3F30	Tiling ground of F3
F3F40	Wall tiling of F3
F3F50	Doors frames of F3
F3F60	Windows of F3
F3F70	Doors installation of F3
F3F80	Painting of F3
F3F90	False ceiling of F3

1.10 4th Floor

1.10.1 Structural

1.10.1.1 Walls & Columns

F4SW20	Exterior Walls & columns of F4(steel, formwork,casting)
F4SW30	Interior Walls & columns of F4(steel, formwork,casting)

1.10.1.2 Roof Slab & Stairs

F4SRS10	Slab & Stair Forming of F4

Activity List

WBS	
Activity ID	**Activity Name**
F4SRS20	Slab(block, steel, concrete casting) of F4
1.10.2 Electrical	
1.10.2.1 Main Electric Conducting	
F4EC10	Electric Conduit of F4
1.10.2.2 Electric Fitting	
F4EF10	Electric finishing (all units) of F4
1.10.3 Mechnical	
1.10.3.1 Mechanical Conducting	
F4MC10	Mechanic conduit of F4
1.10.3.2 Mechanical Fitting	
F4MF10	Mechanic fitting of F4
1.10.4 Finishing	
F4F10	Block Partitions of F4
F4F100	Roof finishing
F4F110	Stone work of F4
F4F120	Stairs finishing of F4
F4F20	Plastering of F4
F4F30	Tiling ground of F4
F4F40	Wall tiling of F4
F4F50	Doors frames of F4
F4F60	Windows of F4
F4F70	Doors installation of F4
F4F80	Painting of F4
F4F90	False ceiling of F4
1.11 landscape	
1.11.1 Hard landscape	
LH10	Agricultural soil of yards
LH20	Retaining Walls(forming,casting,steel)
1.11.2 Soft landscape	
LSO10	Tiling
LSO20	Outdoor Rooms & Gates

4. Activity durations & productivity.

After defining the activities, and finishing the activity list, and quantities of each activity; assigning activities duration started according to the productivity rates of the resources of the project.

The productivity rate a measure of output from a production process, per unit of input, and it's the work amount that the labor or the equipment can perform during certain time unit.

It essential to understand that nobody works a full eight hours. There is both lunch to deduct, as well as breaks in the morning and afternoon. Assuming it's a full hour for lunch, and two 15 minute breaks, a company is then left with 6 & ½ hours of available work time.

The duration of each activity is calculated as follow:

Duration = Total quantity/ crew productivity.

Assigning duration for activities comes parallel to resource allocation, so when assigning duration for an activity, it's assigned depending to the crew that available for this activity.

For example;

Activity: Block partition of a certain floor.
Quantity: 1400 m^2.
Crew Productivity: 20 m^2/day. For one crew (group).

So;

The duration= 1400/20 = 70 days.

You can decrease the duration by increasing your crew;
So you use five groups of partition mason, the productivity will increase.

The new duration = 1400/(5*20) = 14 days.

This means; you need five groups of partition mason to finish 1400 m^2 in 14 days.

5. *Project Network:*

The project network drawn according to the relationships between project activities, and depending on the construction logic.

The first step is how to specify predecessors and successors, while creating a list of project activities; you need to ask yourself the following questions:

- What project activities happen before the activity being examined?
- What project activities can happen at the same time with this activity?
- What project activities happen after this activity?

From the answers, we have determined the predecessors and successors of each activity. Similarly, you can examine each project activity and develop relationships between each one, then you will have table of project activities, which also contain information about predecessors and successors.

After creating a Network Diagram, you will need to use the Critical Path Method (CPM) to determine:

- The critical path diagram (project activities that can cause delay),
- The float for each activity, and
- Create a schedule.

The relations that used in this project are finish to start, and start to finish, the use of the second relation is due to the gap between the resource usages of some activities.

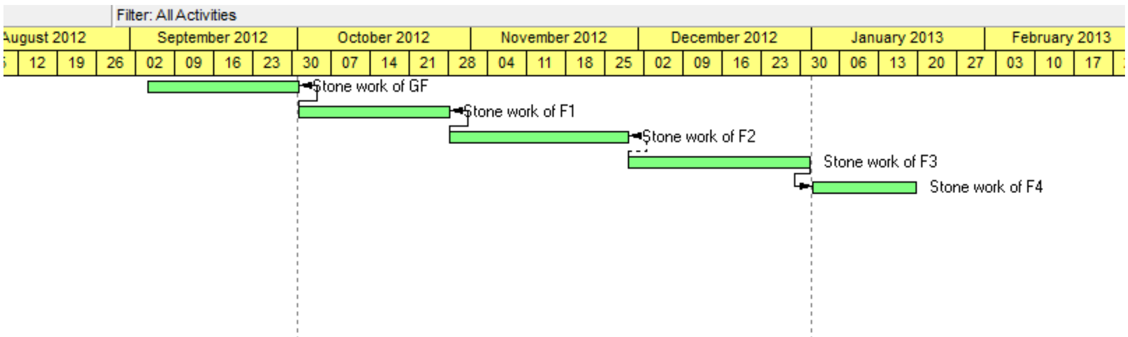


Figure (3): Start to finish relations.

The activities predecessors are shown in the next table:

Activity Predecessors

WBS Activity ID	Activity Name	Predecessors	Original Duration
1 Palestinian Monetary Authority Building			
1.1 Earthworks			
E10	Site preparation and mobilization		1d
E20	Excavation of agricaltural soil	E10	149d
Subtotal			**150d**
1.2 Basement four floor			
1.2.1 Structural			
1.2.1.1 Foundations			
B4SF10	Excavation for foundation	E20	25d
B4SF20	Blind Concrete-15cm-(B180)	B4SF10	6d
B4SF30	Foundation(steel,formwork&Casting)	B4SF20	30d
B4SF40	Foundation(Bitumen)	B4SF30	1d
Subtotal			**62d**
1.2.1.2 Shear Walls & Columns			
B4SW10	Exterior Walls (steel, formwork,casting) of B4	B4SF30, B4SF40, B4EC10	6d
B4SW20	Interior Walls & columns of B4(steel, formwork,casting)	B4SW10	8d
Subtotal			**14d**
1.2.1.3 Roof Slab & Stairs			
B4SRS10	Slab & Stairs Formwork of B4	B4SW20	15d
B4SRS20	Slab(block, steel, casting) of B4	B4SRS10	25d
Subtotal			**40d**
Subtotal			**118d**
1.2.2 Electrical			
1.2.2.1 Main Electric Conducting			
B4EC10	Earthing Systems (B4)	B4SF40	2d
B4EC20	Electric Conduit of B4	B4SRS20, B4EC10, B3EC10	14d
Subtotal			**255d**
1.2.2.2 Electric Fitting			
B4EF10	Electric finishing (all units) of B4	B4F50, B3EF10	7d
Subtotal			**7d**

Activity Predecessors

Activity ID	Activity Name	Predecessors	Original Duration
WBS			
	Subtotal		**489d**
	1.2.3 Mechnical		
	1.2.3.1 Mechanical Conducting		
B4MC10	Mechanic conduit of B4	B4SRS20, B3MC10	12d
	Subtotal		**12d**
	1.2.3.2 Mechanical Fitting		
B4MF10	Mechanic fitting of B4	B4F50, GFMC10, B3MF10	14d
	Subtotal		**14d**
	Subtotal		**234d**
	1.2.4 Finishing		
B4F10	Plastering of B4	B4MC10, B4EC20, B3F10	12d
B4F20	Tiling ground of B4	B4F10, B3F20	4d
B4F30	Doors Frames of B4	B4SRS20	1d
B4F40	Doors installation of B4	B4F20, B3F40	1d
B4F50	Painting of B4	B4F20, B3F50	6d
B4F60	False ceiling of B4	B4EC20, B4MC10, B4F50	1d
B4F70	Stairs finishing of B4	B4F50, B3F70	1d
	Subtotal		**528d**
	Subtotal		**646d**
	1.3 Basement three floor		
	1.3.1 Structural		
	1.3.1.1 Shear Walls & Columns		
B3SW10	Exterior Walls (steel, formwork,casting) of B3	B4SRS20	6d
B3SW20	Interior Walls & columns of B3(steel, formwork,casting)	B3SW10	8d
	Subtotal		**14d**
	1.3.1.2 Roof Slab & Stairs		
B3SRS10	Slab & Stairs formworks of B3	B3SW20	15d
B3SRS20	Slab(block, steel, concrete casting) of B3	B3SRS10	28d
	Subtotal		**43d**

Activity Predecessors

WBS Activity ID	Activity Name	Predecessors	Original Duration
	Subtotal		**57d**
	1.3.2 Electrical		
	1.3.2.1 Main Electric Conducting		
B3EC10	Electric Conduit of B3	B3SRS20, B2EC10	14d
	Subtotal		**14d**
	1.3.2.2 Electric Fitting		
B3EF10	Electric finishing (all units) of B3	B3F50, B2EF10	5d
	Subtotal		**5d**
	Subtotal		**239d**
	1.3.3 Mechnical		
	1.3.3.1 Mechanical Conducting		
B3MC10	Mechanic conduit of B3	B3SRS20, B2MC10	18d
	Subtotal		**18d**
	1.3.3.2 Mechanical Fitting		
B3MF10	Mechanic fitting of B3	B3F50, B2MF10	14d
	Subtotal		**14d**
	Subtotal		**236d**
	1.3.4 Finishing		
B3F10	Plastering of B3	B3EC10, B3MC10, B3F30, B2F20	12d
B3F20	Tiling of B3	B3F10, B2F40	4d
B3F30	Doors Frames of B3	B3SRS20	1d
B3F40	Doors installation of B3	B3F20, B2F60	1d
B3F50	Painting of B3	B3F20, B2F70	6d
B3F60	False ceiling of B3	B3EC10, B3MC10, B3F50	1d
B3F70	Stairs finishing of B3	B3F50, B2F90	1d
	Subtotal		**472d**
	Subtotal		**529d**

Activity Predecessors

WBS Activity ID	Activity Name	Predecessors	Original Duration
1.4 Basement two floor			
1.4.1 Structural			
1.4.1.1 Shear Walls & Columns			
B2SW10	Exterior Walls (steel, formwork,casting) of B2	B3SRS20	6d
B2SW20	Interior Walls & columns of B2(steel, formwork,casting)	B2SW10	9d
	Subtotal		**15d**
1.4.1.2 Roof Slab & Stairs			
B2SRS10	Slab & Stair Forming of B2	B2SW20	15d
B2SRS20	Slab(block, steel, concrete casting) of B2	B2SRS10	24d
	Subtotal		**39d**
Subtotal			**54d**
1.4.2 Electrical			
1.4.2.1 Main Elecrtic Conducting			
B2EC10	Electric Conduit of B2	B2F10, B1EC10	20d
	Subtotal		**20d**
1.4.2.2 Electric Fitting			
B2EF10	Electric finishing (all units) of B2	B2F70, B1EF10	10d
	Subtotal		**10d**
Subtotal			**235d**
1.4.3 Mechnical			
1.4.3.1 Mechanical Conducting			
B2MC10	Mechanic conduit of B2	B2F10, B1MC10	18d
	Subtotal		**18d**
1.4.3.2 Mechanical Fitting			
B2MF10	Mechanic fitting of B2	B2F70, B1MF10	15d
	Subtotal		**15d**
Subtotal			**233d**

Activity Predecessors

WBS

Activity ID	Activity Name	Predecessors	Original Duration
1.4.4 Finishing			
B2F10	Block partitions of B2	B2SRS20, B1F10	5d
B2F20	Plastering of B2	B2EC10, B2MC10, B2F50, B1F20	10d
B2F30	Tiling ground of B2	B1F40	14d
B2F40	Wall tiling of B2	B2F20, B2F30	3d
B2F50	Doors Frames of B2	B2F10, B1F50	1d
B2F60	Doors installation of B2	B2F30, B1F60	1d
B2F70	Painting of B2	B2F30, B1F70	19d
B2F80	False ceiling of B2	B2EC10, B2MC10, B2F70	3d
B2F90	Stairs finishing of B2	B2F70, B1F90	1d
Subtotal			**324d**
Subtotal			**473d**
1.5 Basement one floor			
1.5.1 Structural			
1.5.1.1 Shear Walls & Columns			
B1SW10	Exterior Walls & columns of B1(steel, forming,casting)	B2SRS20	6d
B1SW20	Interior Walls & columns of B1(steel, formwork,casting)	B1SW10	9d
Subtotal			**15d**
1.5.1.2 Roof Slab & Stairs			
B1SRS10	Slab & Stair Forming of B1	B1SW20	16d
B1SRS20	Slab(block, steel, concrete casting) of B1	B1SRS10	14d
Subtotal			**30d**
Subtotal			**45d**
1.5.2 Electrical			
1.5.2.1 Main Electric Conducting			
B1EC10	Electric Conduit of B1	B1F10	25d
Subtotal			**25d**
1.5.2.2 Electric Fitting			
B1EF10	Electric finishing (all units) of B1	B1F70	20d
Subtotal			**20d**

Activity Predecessors

WBS

Activity ID	Activity Name	Predecessors	Original Duration
	Subtotal		**235d**
	1.5.3 Mechnical		
	1.5.3.1 Mechanical Conducting		
B1MC10	Mechanic conduit of B1	B1F10	45d
	Subtotal		**45d**
	1.5.3.2 Mechanical Fitting		
B1MF10	Mechanic fitting of B1	B1F70	35d
	Subtotal		**35d**
	Subtotal		**250d**
	1.5.4 Finishing		
B1F10	Block partitions of B1	B1SRS20, GFF10	22d
B1F20	Plastering of B1	B1EC10, B1MC10, B1F50	44d
B1F30	Tiling ground of B1	GFF40	22d
B1F40	Wall tiling of B1	B1F20, B1F30	2d
B1F50	Doors Frames of B1	B1F10, GFF50	1d
B1F60	Doors installation of B1	B1F30, GFF70	1d
B1F70	Painting of B1	B1F30	22d
B1F80	False ceiling of B1	B1EC10, B1MC10, B1F70	5d
B1F90	Stairs finishing of B1	B1F70, GFF110	1d
	Subtotal		**320d**
	Subtotal		**420d**
	1.6 Ground floor		
	1.6.1 Structural		
	1.6.1.1 Shear Walls & Columns		
GFSW20	Exterior Walls & Columns of GF (steel, formwork,casting)	B1SRS20	3d
GFSW30	Interior Walls & columns of GF(steel, formwork,casting)	GFSW20	4d
	Subtotal		**7d**
	1.6.1.2 Roof Slab & Stairs		
GFSRS10	Slab & Stair Forming of GF	GFSW30	8d
GFSRS20	Slab(block, steel, concrete casting) of GF	GFSRS10	15d

Activity Predecessors

WBS Activity ID	Activity Name	Predecessors	Original Duration
	Subtotal		**23d**
	Subtotal		**30d**
	1.6.2 Electrical		
	1.6.2.1 Main Elecrtic Conducting		
GFEC10	Electric Conduit of GF	GFF10, B1EC10	28d
	Subtotal		**28d**
	1.6.2.2 Electric Fitting		
GFEF10	Electric finishing (all units) of GF	GFF80, B1EF10	14d
	Subtotal		**14d**
	Subtotal		**224d**
	1.6.3 Mechnical		
	1.6.3.1 Mechanical Conducting		
GFMC10	Earth drianage & manholes	B4SF30, B4MC10	25d
GFMC20	Mechanic conduit of GF	GFF10, B1MC10	35d
	Subtotal		**116d**
	1.6.3.2 Mechanical Fitting		
GFMF10	Mechanic fitting of GF	GFF80, B1MF10	25d
	Subtotal		**25d**
	Subtotal		**311d**
	1.6.4 Finishing		
GFF10	Block partitions of GF	GFSRS20, F1F10	15d
GFF100	Stone work of GF	GFSRS20, F1F100	23d
GFF110	Stairs finishing of GF	GFF80, F1F110	1d
GFF20	Plastering of GF	GFEC10, GFMC20, GFF50, B1F20	31d
GFF30	Tiling ground of GF	F1F40	15d
GFF40	Wall tiling of GF	GFF20, GFF30	3d
GFF50	Doors frames of GF	GFF10	1d
GFF60	Windows of GF	GFF30, GFF100, F1F60	2d
GFF70	Doors installation of GF	GFF30, F1F70	1d

Activity Predecessors

WBS

Activity ID	Activity Name	Predecessors	Original Duration
GFF80	Painting of GF	GFF30, B1F70	16d
GFF90	False ceiling of GF	GFEC10, GFMC20, GFF80	3d
	Subtotal		**333d**
	Subtotal		**376d**
	1.7 1st Floor		
	1.7.1 Structural		
	1.7.1.1 Walls & Columns		
F1SW20	Exterior & columns of F1(steel, formwork,casting)	GFSRS20	3d
F1SW30	Interior Walls & columns of F1(steel, formwork,casting)	F1SW20	4d
	Subtotal		**7d**
	1.7.1.2 Roof Slab & Stairs		
F1SRS10	Slab & Stair Forming of F1	F1SW30	7d
F1SRS20	Slab(block, steel, concrete casting) of F1	F1SRS10	15d
	Subtotal		**22d**
	Subtotal		**29d**
	1.7.2 Electrical		
	1.7.2.1 Main Electric Conducting		
F1EC10	Electric Conduit of F1	F1F10, GFEC10	30d
	Subtotal		**30d**
	1.7.2.2 Electric Fitting		
F1EF10	Electric finishing (all units) of F1	F1F80, GFEF10	20d
	Subtotal		**20d**
	Subtotal		**217d**
	1.7.3 Mechnical		
	1.7.3.1 Mechanical Conducting		
F1MC10	Mechanic conduit of F1	F1F10, GFMC20	40d
	Subtotal		**40d**

Activity Predecessors

WBS

Activity ID	Activity Name	Predecessors	Original Duration
	1.7.3.2 Mechanical Fitting		
F1MF10	Mechanic fitting of F1	F1F80, GFMF10	28d
	Subtotal		**28d**
	Subtotal		**223d**
	1.7.4 Finishing		
F1F10	Block partitions of F1	F1SRS20, F2F10	19d
F1F100	Stone work of F1	F1SRS20, F2F100	23d
F1F110	Stairs finishing of F1	F1F80, F2F110	1d
F1F20	Plastering of F1	F1EC10, F1MC10, F1F50, F2F20	37d
F1F30	Tiling ground of F1	F2F40	15d
F1F40	Wall tiling of F1	F1F20, F1F30	3d
F1F50	Doors frames of F1	F1F10	1d
F1F60	windows of F1	F1F30, F1F100, F2F60	1d
F1F70	Doors installation of F1	F1F30, F2F70	1d
F1F80	Painting of F1	F1F30, GFF80	19d
F1F90	False ceiling of F1	F1EC10, F1MC10, F2F90	4d
	Subtotal		**311d**
	Subtotal		**350d**
	1.8 2nd Floor		
	1.8.1 Structural		
	1.8.1.1 Walls & Columns		
F2SW20	Exterior Walls & columns of F2(steel, formwork,casting)	F1SRS20	3d
F2SW30	Interior Walls & columns of F2(steel, formwork,casting)	F2SW20	4d
	Subtotal		**7d**
	1.8.1.2 Roof Slab & Stairs		
F2SRS10	Slab & Stair Forming of F2	F2SW30	7d
F2SRS20	Slab(block, steel, concrete casting) of F2	F2SRS10	15d
	Subtotal		**22d**
	Subtotal		**29d**
	1.8.2 Electrical		

Activity Predecessors

WBS Activity ID	Activity Name	Predecessors	Original Duration
	1.8.2.1 Main Electric Conducting		
F2EC10	Electric Conduit of F2	F2F10, F1EC10	28d
	Subtotal		**28d**
	1.8.2.2 Electric Fitting		
F2EF10	Electric finishing (all units) of F2	F2F80, F1EF10	14d
	Subtotal		**14d**
	Subtotal		**203d**
	1.8.3 Mechnical		
	1.8.3.1 Mechanical Conducting		
F2MC10	Mechanic conduit of F2	F2F10, F1MC10	40d
	Subtotal		**40d**
	1.8.3.2 Mechanical Fitting		
F2MF10	Mechanic fitting of F2	F2F80, F1MF10	28d
	Subtotal		**28d**
	Subtotal		**211d**
	1.8.4 Finishing		
F2F10	Block Partitions of F2	F2SRS20, F3F10	23d
F2F100	Stone work of F2	F2SRS20, F3F100	28d
F2F110	Stairs finishing of F2	F2F80, F3F110	1d
F2F20	Plastering of F2	F2EC10, F2MC10, F2F50	43d
F2F30	Tiling ground of F2	F3F40	14d
F2F40	Wall tiling of F2	F2F20, F2F30	3d
F2F50	Doors frames of F2	F2F10	2d
F2F60	Windows of F2	F2F30, F2F100, F3F60	4d
F2F70	Doors installation of F2	F2F30, F3F70	2d
F2F80	Painting of F2	F2F30, F1F80	22d
F2F90	False ceiling of F2	F2EC10, F2MC10, F3F90	3d
	Subtotal		**289d**
	Subtotal		**349d**

Activity Predecessors

WBS

Activity ID	Activity Name	Predecessors	Original Duration
1.9 3d Floor			
1.9.1 Structural			
1.9.1.1 Walls & Columns			
F3SW20	Exterior Walls & columns of F3(steel, formwork,casting)	F2SRS20	3d
F3SW30	Interior Walls & columns of F3(steel, formwork,casting)	F3SW20	4d
	Subtotal		**7d**
1.9.1.2 Roof Slab & Stairs			
F3SRS10	Slab & Stair Forming of F3	F3SW30	7d
F3SRS20	Slab(block, steel, concrete casting) of F3	F3SRS10	15d
	Subtotal		**22d**
Subtotal			**29d**
1.9.2 Electrical			
1.9.2.1 Main Electric Conducting			
F3EC10	Electric Conduit of F3	F3F10, F2EC10	28d
	Subtotal		**28d**
1.9.2.2 Electric Fitting			
F3EF10	Electric finishing (all units) of F3	F3F80, F2EF10	14d
	Subtotal		**14d**
Subtotal			**197d**
1.9.3 Mechnical			
1.9.3.1 Mechanical Conducting			
F3MC10	Mechanic conduit of F3	F3F10, F2MC10	40d
	Subtotal		**40d**
1.9.3.2 Mechanical Fitting			
F3MF10	Mechanic fitting of F3	F3F80, F2MF10	28d
	Subtotal		**28d**
Subtotal			**199d**

Activity Predecessors

WBS

Activity ID	Activity Name	Predecessors	Original Duration
1.9.4 Finishing			
F3F10	Block partitions of F3	F3SRS20, F4F10	23d
F3F100	Stone work of F3	F3SRS20	28d
F3F110	Stairs finishing of F3	F3F80, F4F120	1d
F3F20	Plastering of F3	F3EC10, F3MC10, F3F50, F2F20	43d
F3F30	Tiling ground of F3	F3F40	15d
F3F40	Wall tiling of F3	F3F20	4d
F3F50	Doors frames of F3	F3F10	2d
F3F60	Windows of F3	F3F30, F3F100, F4F60	4d
F3F70	Doors installation of F3	F3F30, F4F70	2d
F3F80	Painting of F3	F3F30, F2F80	22d
F3F90	False ceiling of F3	F3EC10, F3MC10, F4F90	3d
Subtotal			**262d**
Subtotal			**348d**
1.10 4th Floor			
1.10.1 Structural			
1.10.1.1 Walls & Columns			
F4SW20	Exterior Walls & columns of F4(steel, formwork,casting)	F3SRS20	3d
F4SW30	Interior Walls & columns of F4(steel, formwork,casting)	F4SW20	4d
Subtotal			**7d**
1.10.1.2 Roof Slab & Stairs			
F4SRS10	Slab & Stair Forming of F4	F4SW30	6d
F4SRS20	Slab(block, steel, concrete casting) of F4	F4SRS10	13d
Subtotal			**19d**
Subtotal			**26d**
1.10.2 Electrical			
1.10.2.1 Main Electric Conducting			
F4EC10	Electric Conduit of F4	F4F10, F3EC10	20d
Subtotal			**20d**
1.10.2.2 Electric Fitting			
F4EF10	Electric finishing (all units) of F4	F4F80, F3EF10	14d

Activity Predecessors

WBS

Activity ID	Activity Name	Predecessors	Original Duration
	Subtotal		**14d**
	Subtotal		**183d**
	1.10.3 Mechnical		
	1.10.3.1 Mechanical Conducting		
F4MC10	Mechanic conduit of F4	F4F10, F3MC10	28d
	Subtotal		**28d**
	1.10.3.2 Mechanical Fitting		
F4MF10	Mechanic fitting of F4	F4F80, F3MF10	20d
	Subtotal		**20d**
	Subtotal		**179d**
	1.10.4 Finishing		
F4F10	Block Partitions of F4	F4SRS20	8d
F4F100	Roof finishing	F4SRS20	4d
F4F110	Stone work of F4	F4SRS20, F3F100	16d
F4F120	Stairs finishing of F4	F4F80	1d
F4F20	Plastering of F4	F4EC10, F4MC10, F4F50, F3F20	15d
F4F30	Tiling ground of F4	F4F40	8d
F4F40	Wall tiling of F4	F4F20, F3F30	2d
F4F50	Doors frames of F4	F4F10	1d
F4F60	Windows of F4	F4F30, F4F110	2d
F4F70	Doors installation of F4	F4F30	1d
F4F80	Painting of F4	F4F30, F3F80	8d
F4F90	False ceiling of F4	F4EC10, F4MC10	2d
	Subtotal		**237d**
	Subtotal		**339d**
	1.11 landscape		
	1.11.1 Hard landscape		
LH10	Agricultural soil of yards	LH20	1d
LH20	Retaining Walls(forming,casting,steel)	F4F100	8d
	Subtotal		**9d**

Activity Predecessors

WBS Activity ID	Activity Name	Predecessors	Original Duration
1.11.2 Soft landscape			
LSO10	Tiling	LH20, F4F110, F4F30, LH10	17d
LSO20	Outdoor Rooms & Gates	LH20	1d
Subtotal			**214d**
Subtotal			**222d**
Subtotal			**880d**
Total			**880d**

6. Project Budgeting:

It's the most important step, to estimate the cost of the material, equipment, and labor for each activity; it was very hard to collect the data from different contractors and companies.

But the creating of budget for a new project is a bit daunting- especially when you have a little information about costing and coordinating. Some expenses, such as salaries, utilities, rent, or equipment costs, material and labor cost.

The costs obtained from many sources; contractors, companies, and then the cost estimating process begin by estimating the cost of each activity, which include; labor, equipment, and material cost.

The cost of each activity shown in Fig. 1, at the appendix.

7. Labor Resource Usage:

Assigning labors to each activity is done according to productivity rates as shown in point section above; in addition to that the activity shouldn't be over loaded with labors, so assigning labors for the activities could be limited.

There is a difference in labor usage between some floors, and this is related to the nature of construction and design of each story, there is no similar story.

This project could be divided into three phases according to the usage of the structural labor as; carpenters, steel fixers, and helpers. And finishing labors as block partition masons, plastering masons, tiling masons, painting masons, stone work masons, and so.

These phases could be summarized as bellow;

- Phase (A): Foundations &Basement floors; which need a high number of structural labors, small number of finishing labors.
- Phase (B): Ground floor (GF) to the third floor (F3); which need less number of structural labor than that in phase (A), a high number of finishing labors.
- Phase(C): Fourth floor (F4); -At end of project- which needs the least number of structural labors, and less number of finishing labors than phase (B) floors.

The next two diagrams give an idea about the general usage of labor in the project at each phase;

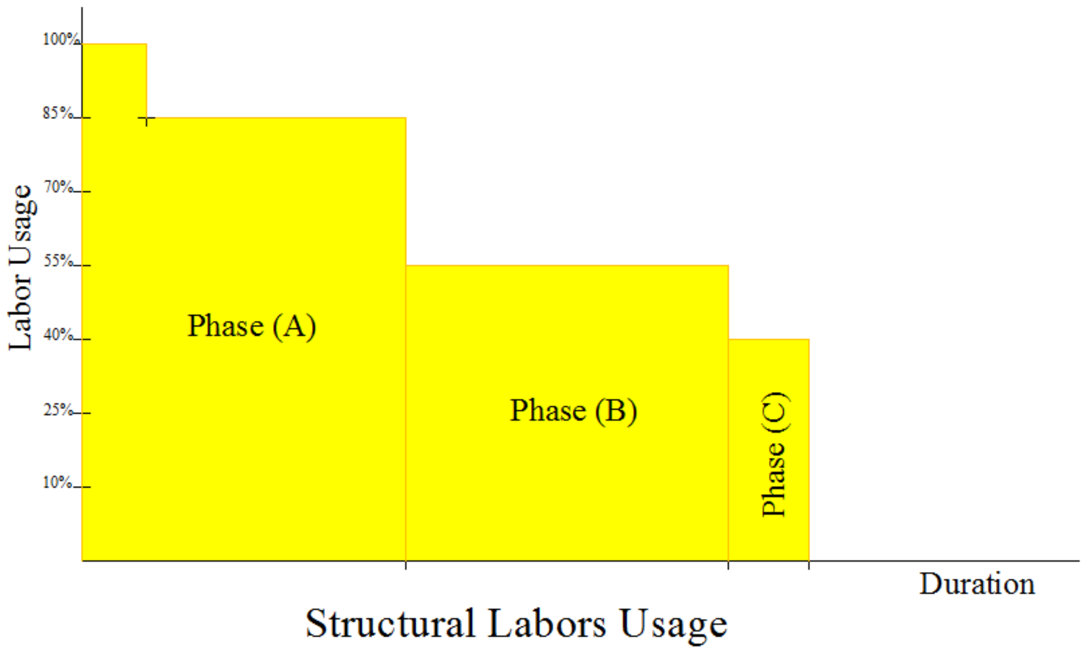


Figure (3)

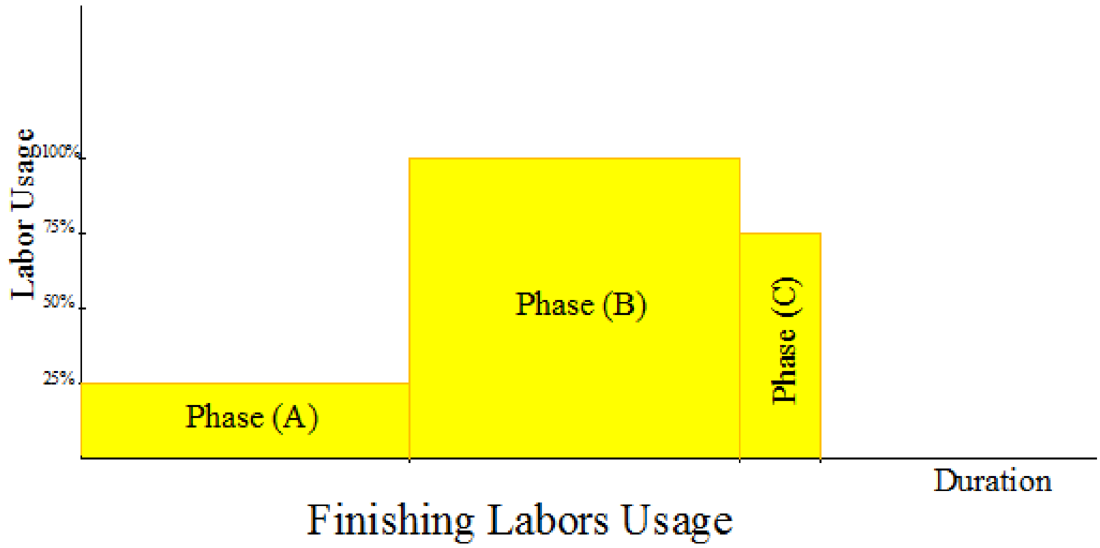


Figure (4)

8. Conclusion & Recommendations:

In part two of the graduation project, which applies the concepts of construction project management on a real project, and gives you a very good knowledge in this field, this real project was the new building of Palestinian Monetary Authority in Ramallah city.

The time schedule and project budgeted cost of this project is made using Primavera Project Planner (P6), and using Microsoft Excel, Firstly, using Microsoft Excel for estimating the material quantities according to the drawings and specifications done and summarized in excel sheets, then starts the most difficult step which is collecting data about the cost of material, labor, and labor productivity, from the many contractors and companies, which was very hard and take a lot of time, after this step, the durations and costs assigned to the related activities, to get finally the total cost and total price of the project.

Then; using Primavera Project Planner to apply the concepts of construction project management on this project to; do the schedule of the project, the total duration of the project, duration for each activity (ES, EF,LS,LF), flout of each activity, total direct cost, total indirect cost, total price, bar chart, cash flow, and resource usage.

Summary of the project:

1. The project planning start date was 1st Feb, 2011, & the latest early finish date is 1st Dec, 2013.
2. The number of activities is 172 activity, 70 activity are critical.
3. The Price Per meter square as total is approximately $500 ($=3.4NIS);
   - Basement Floors is approximately $400.
   - Ground Floor – the fourth floor is approximately $720.

4. The following table shows the cost & percentage;

Palestinian Monetary Authority Building				
Project Summary				
	(NIS)	Direct Cost %	Indirect Cost %	Price %
Total Material cost	24,280,997.00	83.73%	74.30%	67.54%
Total Labor Cost	4,036,030.00	13.92%	12.35%	11.23%
Total Non-Labor Cost	1,610,950.00	5.56%	4.93%	4.48%
Total Direct Cost	28,998,267.00	100.00%	88.73%	80.66%
Total Project Cost	32,681,046.91	-	100.00%	90.91%
Total Price	35,949,151.60	-	-	100.00%
Markup (Bid Factor)	1.24	-	-	-

Table (4): Project cost summary.

5. The project indirect cost estimated to be 12.7% of total cost.
6. The profit of the project is 10% of the indirect cost.
7. Summary of work packages:

Project Summary (of work packages)								
Backage	Labor Cost	Material Cost	Direct Cost	Indirect Cost	Price	Cost %	Total Mhr	Hr/m^2
Earth work	430.00	0.00	1,450,830.00	1,635,085.41	1,798,593.95	5.00	40.00	0.00
Structural work	2,134,750.00	13,245,904.80	14,839,664.80	16,724,302.23	18,396,732.45	51.17	109,344.00	5.47
Electrical work	228,900.00	1,948,636.00	2,061,406.00	2,323,204.56	2,555,525.02	7.11	2,616.00	0.13
Mechanical worl	468,850.00	3,784,385.00	4,457,845.00	5,023,991.32	5,526,390.45	15.37	3,864.00	0.19
Finishing work	1,151,500.00	5,048,518.00	6,011,058.00	6,774,462.37	7,451,908.60	20.73	23,680.00	1.18
Land Scape worl	50,080.00	141,873.20	177,463.20	200,001.03	220,001.13	0.61	2,376.00	0.12
SUM	4,034,510.00	24,169,317.00	28,998,267.00	32,681,046.91	35,949,151.60		141,920.00	7.10

8. Summary of concrete work:

	B4	B3	B2	B1	GF	F1	F2	F3	F4
m^3/m^2	1.71	0.44	0.53	0.59	0.59	0.58	0.58	0.58	0.67
Tot Mhr	28312	10768	10120	7800	4592	4816	4816	4592	3320
Hr/m^2	8.85	3.37	3.16	2.54	2.72	2.85	2.85	2.72	3.69
Hr/m^3	5.08	7.45	5.82	4.29	4.57	4.88	4.88	4.66	5.51

End of part two.

Appendices

Activity ID	Activity Name	Original Duration	Early Finish	Early Start	Late Start	Late Finish	Total Float	Budgeted Total Cost
Palestinian Monetary Authority Build		880d	01-Dec-13	01-Feb-11	01-Feb-11	01-Dec-13	0d	NIS35,949,149.16
Earthworks		150d	26-Jul-11	01-Feb-11	01-Feb-11	27-Jul-11	0d	NIS1,798,593.95
E10	Site preparation and mobilization	1d	01-Feb-11	01-Feb-11	01-Feb-11	02-Feb-11	0d	NIS25,327.07
E20	Excavation of agricaltural soil	149d	26-Jul-11	02-Feb-11	02-Feb-11	27-Jul-11	0d	NIS1,773,266.88
Basement four floor		646d	25-Aug-13	27-Jul-11	27-Jul-11	01-Dec-13	84d	NIS6,003,439.41
Structural		118d	14-Dec-11	27-Jul-11	27-Jul-11	15-Dec-11	0d	NIS5,536,515.08
Foundations		62d	08-Oct-11	27-Jul-11	27-Jul-11	09-Oct-11	0d	NIS3,662,611.34
B4SF10	Excavation for foundation	25d	24-Aug-11	27-Jul-11	27-Jul-11	25-Aug-11	0d	NIS216,327.65
B4SF20	Blind Concrete-15cm-(B180)	6d	01-Sep-11	25-Aug-11	25-Aug-11	03-Sep-11	0d	NIS131,631.35
B4SF30	Foundation(steel,formwork&Casting)	30d	06-Oct-11	03-Sep-11	03-Sep-11	08-Oct-11	0d	NIS3,133,804.90
B4SF40	Foundation(Bitumen)	1d	08-Oct-11	08-Oct-11	08-Oct-11	09-Oct-11	0d	NIS180,847.44
Shear Walls & Columns		14d	26-Oct-11	11-Oct-11	11-Oct-11	27-Oct-11	0d	NIS562,358.67
B4SW10	Exterior Walls (steel, formwork,casting	6d	17-Oct-11	11-Oct-11	11-Oct-11	18-Oct-11	0d	NIS221,988.62
B4SW20	Interior Walls & columns of B4(steel, fo	8d	26-Oct-11	18-Oct-11	18-Oct-11	27-Oct-11	0d	NIS340,370.05
Roof Slab & Stairs		40d	14-Dec-11	27-Oct-11	27-Oct-11	15-Dec-11	0d	NIS1,311,545.08
B4SRS10	Slab & Stairs Formwork of B4	15d	14-Nov-11	27-Oct-11	27-Oct-11	16-Nov-11	0d	NIS232,307.38
B4SRS20	Slab(block, steel, casting) of B4	25d	14-Dec-11	16-Nov-11	16-Nov-11	15-Dec-11	0d	NIS1,079,237.70
Electrical		489d	06-May-13	09-Oct-11	09-Oct-11	01-Dec-13	179d	NIS177,284.54
Main Electric Conducting		255d	05-Aug-12	09-Oct-11	09-Oct-11	20-Oct-13	377d	NIS62,612.29
B4EC10	Earthing Systems (B4)	2d	10-Oct-11	09-Oct-11	09-Oct-11	11-Oct-11	0d	NIS17,239.27
B4EC20	Electric Conduit of B4	14d	05-Aug-12	19-Jul-12	03-Oct-13	20-Oct-13	377d	NIS45,373.02
Electric Fitting		7d	06-May-13	27-Apr-13	23-Nov-13	01-Dec-13	179d	NIS114,672.25
B4EF10	Electric finishing (all units) of B4	7d	06-May-13	27-Apr-13	23-Nov-13	01-Dec-13	179d	NIS114,672.25
Mechnical		234d	18-Apr-13	19-Jul-12	02-Oct-13	01-Dec-13	193d	NIS236,286.82
Mechanical Conducting		12d	02-Aug-12	19-Jul-12	02-Oct-13	16-Oct-13	376d	NIS137,532.32
B4MC10	Mechanic conduit of B4	12d	02-Aug-12	19-Jul-12	02-Oct-13	16-Oct-13	376d	NIS137,532.32
Mechanical Fitting		14d	18-Apr-13	02-Apr-13	14-Nov-13	01-Dec-13	193d	NIS98,754.50
B4MF10	Mechanic fitting of B4	14d	18-Apr-13	02-Apr-13	14-Nov-13	01-Dec-13	193d	NIS98,754.50
Finishing		528d	25-Aug-13	15-Dec-11	20-Oct-13	01-Dec-13	84d	NIS53,352.97
B4F30	Doors Frames of B4	1d	15-Dec-11	15-Dec-11	30-Nov-13	01-Dec-13	611d	NIS3,843.07
B4F10	Plastering of B4	12d	14-Oct-12	30-Sep-12	20-Oct-13	03-Nov-13	329d	NIS12,466.42
B4F20	Tiling ground of B4	4d	05-Mar-13	28-Feb-13	03-Nov-13	07-Nov-13	211d	NIS11,256.48
B4F60	False ceiling of B4	1d	21-Mar-13	20-Mar-13	30-Nov-13	01-Dec-13	217d	NIS5,993.95
B4F50	Painting of B4	6d	28-Mar-13	21-Mar-13	07-Nov-13	14-Nov-13	197d	NIS9,639.91
B4F40	Doors installation of B4	1d	22-Jul-13	21-Jul-13	30-Nov-13	01-Dec-13	113d	NIS6,446.44
B4F70	Stairs finishing of B4	1d	25-Aug-13	24-Aug-13	30-Nov-13	01-Dec-13	84d	NIS3,706.70
Basement three floor		529d	26-Aug-13	15-Dec-11	15-Dec-11	01-Dec-13	83d	NIS2,461,219.39
Structural		57d	19-Feb-12	15-Dec-11	15-Dec-11	20-Feb-12	0d	NIS1,970,757.54
Shear Walls & Columns		14d	31-Dec-11	15-Dec-11	15-Dec-11	01-Jan-12	0d	NIS562,358.67
B3SW10	Exterior Walls (steel, formwork,casting	6d	21-Dec-11	15-Dec-11	15-Dec-11	22-Dec-11	0d	NIS221,988.62
B3SW20	Interior Walls & columns of B3(steel, fo	8d	31-Dec-11	22-Dec-11	22-Dec-11	01-Jan-12	0d	NIS340,370.05
Roof Slab & Stairs		43d	19-Feb-12	01-Jan-12	01-Jan-12	20-Feb-12	0d	NIS1,408,398.87
B3SRS10	Slab & Stairs formworks of B3	15d	17-Jan-12	01-Jan-12	01-Jan-12	18-Jan-12	0d	NIS234,489.25
B3SRS20	Slab(block, steel, concrete casting) of B	28d	19-Feb-12	18-Jan-12	18-Jan-12	20-Feb-12	0d	NIS1,173,909.62
Electrical		239d	12-May-13	05-Aug-12	03-Oct-13	01-Dec-13	174d	NIS158,734.25
Main Electric Conducting		14d	21-Aug-12	05-Aug-12	03-Oct-13	20-Oct-13	363d	NIS45,472.20
B3EC10	Electric Conduit of B3	14d	21-Aug-12	05-Aug-12	03-Oct-13	20-Oct-13	363d	NIS45,472.20
Electric Fitting		5d	12-May-13	06-May-13	25-Nov-13	01-Dec-13	174d	NIS113,262.05
B3EF10	Electric finishing (all units) of B3	5d	12-May-13	06-May-13	25-Nov-13	01-Dec-13	174d	NIS113,262.05
Mechnical		236d	06-May-13	02-Aug-12	29-Sep-13	01-Dec-13	179d	NIS277,630.81
Mechanical Conducting		18d	23-Aug-12	02-Aug-12	29-Sep-13	20-Oct-13	361d	NIS165,165.23
B3MC10	Mechanic conduit of B3	18d	23-Aug-12	02-Aug-12	29-Sep-13	20-Oct-13	361d	NIS165,165.23

Activity ID	Activity Name	Original Duration	Early Finish	Early Start	Late Start	Late Finish	Total Float	Budgeted Total Cost
Mechanical Fitting		14d	06-May-13	18-Apr-13	14-Nov-13	01-Dec-13	179d	NIS112,465.58
B3MF10	Mechanic fitting of B3	14d	06-May-13	18-Apr-13	14-Nov-13	01-Dec-13	179d	NIS112,465.58
Finishing		472d	26-Aug-13	20-Feb-12	19-Oct-13	01-Dec-13	83d	NIS54,096.79
B3F30	Doors Frames of B3	1d	20-Feb-12	20-Feb-12	19-Oct-13	20-Oct-13	518d	NIS4,214.98
B3F10	Plastering of B3	12d	28-Oct-12	14-Oct-12	20-Oct-13	03-Nov-13	317d	NIS12,466.42
B3F20	Tiling of B3	4d	10-Mar-13	05-Mar-13	03-Nov-13	07-Nov-13	207d	NIS11,256.48
B3F60	False ceiling of B3	1d	28-Mar-13	27-Mar-13	30-Nov-13	01-Dec-13	211d	NIS5,993.95
B3F50	Painting of B3	6d	04-Apr-13	28-Mar-13	07-Nov-13	14-Nov-13	191d	NIS9,639.91
B3F40	Doors installation of B3	1d	23-Jul-13	22-Jul-13	30-Nov-13	01-Dec-13	112d	NIS6,818.35
B3F70	Stairs finishing of B3	1d	26-Aug-13	25-Aug-13	30-Nov-13	01-Dec-13	83d	NIS3,706.70
Basement two floor		473d	27-Aug-13	20-Feb-12	20-Feb-12	01-Dec-13	82d	NIS3,463,430.09
Structural		54d	22-Apr-12	20-Feb-12	20-Feb-12	23-Apr-12	0d	NIS2,452,929.43
Shear Walls & Columns		15d	07-Mar-12	20-Feb-12	20-Feb-12	08-Mar-12	0d	NIS644,133.74
B2SW10	Exterior Walls (steel, formwork,casting	6d	26-Feb-12	20-Feb-12	20-Feb-12	27-Feb-12	0d	NIS227,944.14
B2SW20	Interior Walls & columns of B2(steel, fo	9d	07-Mar-12	27-Feb-12	27-Feb-12	08-Mar-12	0d	NIS416,189.61
Roof Slab & Stairs		39d	22-Apr-12	08-Mar-12	08-Mar-12	23-Apr-12	0d	NIS1,808,795.69
B2SRS10	Slab & Stair Forming of B2	15d	25-Mar-12	08-Mar-12	08-Mar-12	26-Mar-12	0d	NIS237,680.24
B2SRS20	Slab(block, steel, concrete casting) of E	24d	22-Apr-12	26-Mar-12	26-Mar-12	23-Apr-12	0d	NIS1,571,115.45
Electrical		235d	23-May-13	21-Aug-12	03-Oct-13	01-Dec-13	164d	NIS203,841.50
Main Elecrtic Conducting		20d	13-Sep-12	21-Aug-12	03-Oct-13	27-Oct-13	349d	NIS59,009.72
B2EC10	Electric Conduit of B2	20d	13-Sep-12	21-Aug-12	03-Oct-13	27-Oct-13	349d	NIS59,009.72
Electric Fitting		10d	23-May-13	12-May-13	19-Nov-13	01-Dec-13	164d	NIS144,831.78
B2EF10	Electric finishing (all units) of B2	10d	23-May-13	12-May-13	19-Nov-13	01-Dec-13	164d	NIS144,831.78
Mechnical		233d	23-May-13	23-Aug-12	06-Oct-13	01-Dec-13	164d	NIS621,585.58
Mechanical Conducting		18d	13-Sep-12	23-Aug-12	06-Oct-13	27-Oct-13	349d	NIS287,350.06
B2MC10	Mechanic conduit of B2	18d	13-Sep-12	23-Aug-12	06-Oct-13	27-Oct-13	349d	NIS287,350.06
Mechanical Fitting		15d	23-May-13	06-May-13	13-Nov-13	01-Dec-13	164d	NIS334,235.52
B2MF10	Mechanic fitting of B2	15d	23-May-13	06-May-13	13-Nov-13	01-Dec-13	164d	NIS334,235.52
Finishing		324d	27-Aug-13	13-Aug-12	28-Sep-13	01-Dec-13	82d	NIS185,073.57
B2F10	Block partitions of B2	5d	19-Aug-12	13-Aug-12	28-Sep-13	03-Oct-13	351d	NIS14,070.59
B2F50	Doors Frames of B2	1d	30-Sep-12	29-Sep-12	26-Oct-13	27-Oct-13	335d	NIS10,661.42
B2F20	Plastering of B2	10d	08-Nov-12	28-Oct-12	27-Oct-13	07-Nov-13	311d	NIS40,875.39
B2F40	Wall tiling of B2	3d	13-Mar-13	10-Mar-13	07-Nov-13	11-Nov-13	207d	NIS6,458.84
B2F30	Tiling ground of B2	14d	30-Mar-13	13-Mar-13	06-Oct-13	22-Oct-13	176d	NIS39,447.25
B2F80	False ceiling of B2	3d	04-Apr-13	01-Apr-13	27-Nov-13	01-Dec-13	205d	NIS20,771.17
B2F70	Painting of B2	19d	27-Apr-13	04-Apr-13	22-Oct-13	13-Nov-13	171d	NIS30,982.58
B2F60	Doors installation of B2	1d	24-Jul-13	23-Jul-13	30-Nov-13	01-Dec-13	111d	NIS18,099.62
B2F90	Stairs finishing of B2	1d	27-Aug-13	26-Aug-13	30-Nov-13	01-Dec-13	82d	NIS3,706.70
Basement one floor		420d	28-Aug-13	23-Apr-12	23-Apr-12	01-Dec-13	81d	NIS4,335,312.52
Structural		45d	14-Jun-12	23-Apr-12	23-Apr-12	16-Jun-12	0d	NIS1,849,652.73
Shear Walls & Columns		15d	10-May-12	23-Apr-12	23-Apr-12	12-May-12	0d	NIS713,569.83
B1SW10	Exterior Walls & columns of B1(steel, f	6d	29-Apr-12	23-Apr-12	23-Apr-12	30-Apr-12	0d	NIS297,380.23
B1SW20	Interior Walls & columns of B1(steel, fo	9d	10-May-12	30-Apr-12	30-Apr-12	12-May-12	0d	NIS416,189.61
Roof Slab & Stairs		30d	14-Jun-12	12-May-12	12-May-12	16-Jun-12	0d	NIS1,136,082.90
B1SRS10	Slab & Stair Forming of B1	16d	29-May-12	12-May-12	12-May-12	30-May-12	0d	NIS258,031.16
B1SRS20	Slab(block, steel, concrete casting) of E	14d	14-Jun-12	30-May-12	30-May-12	16-Jun-12	0d	NIS878,051.74
Electrical		235d	16-Jun-13	13-Sep-12	10-Nov-12	03-Sep-13	68d	NIS393,607.77
Main Electric Conducting		25d	13-Oct-12	13-Sep-12	10-Nov-12	09-Dec-12	49d	NIS104,754.65
B1EC10	Electric Conduit of B1	25d	13-Oct-12	13-Sep-12	10-Nov-12	09-Dec-12	49d	NIS104,754.65
Electric Fitting		20d	16-Jun-13	23-May-13	11-Aug-13	03-Sep-13	68d	NIS288,853.12
B1EF10	Electric finishing (all units) of B1	20d	16-Jun-13	23-May-13	11-Aug-13	03-Sep-13	68d	NIS288,853.12
Mechnical		250d	03-Jul-13	13-Sep-12	13-Sep-12	03-Jul-13	0d	NIS848,326.71
Mechanical Conducting		45d	05-Nov-12	13-Sep-12	13-Sep-12	05-Nov-12	0d	NIS354,640.98

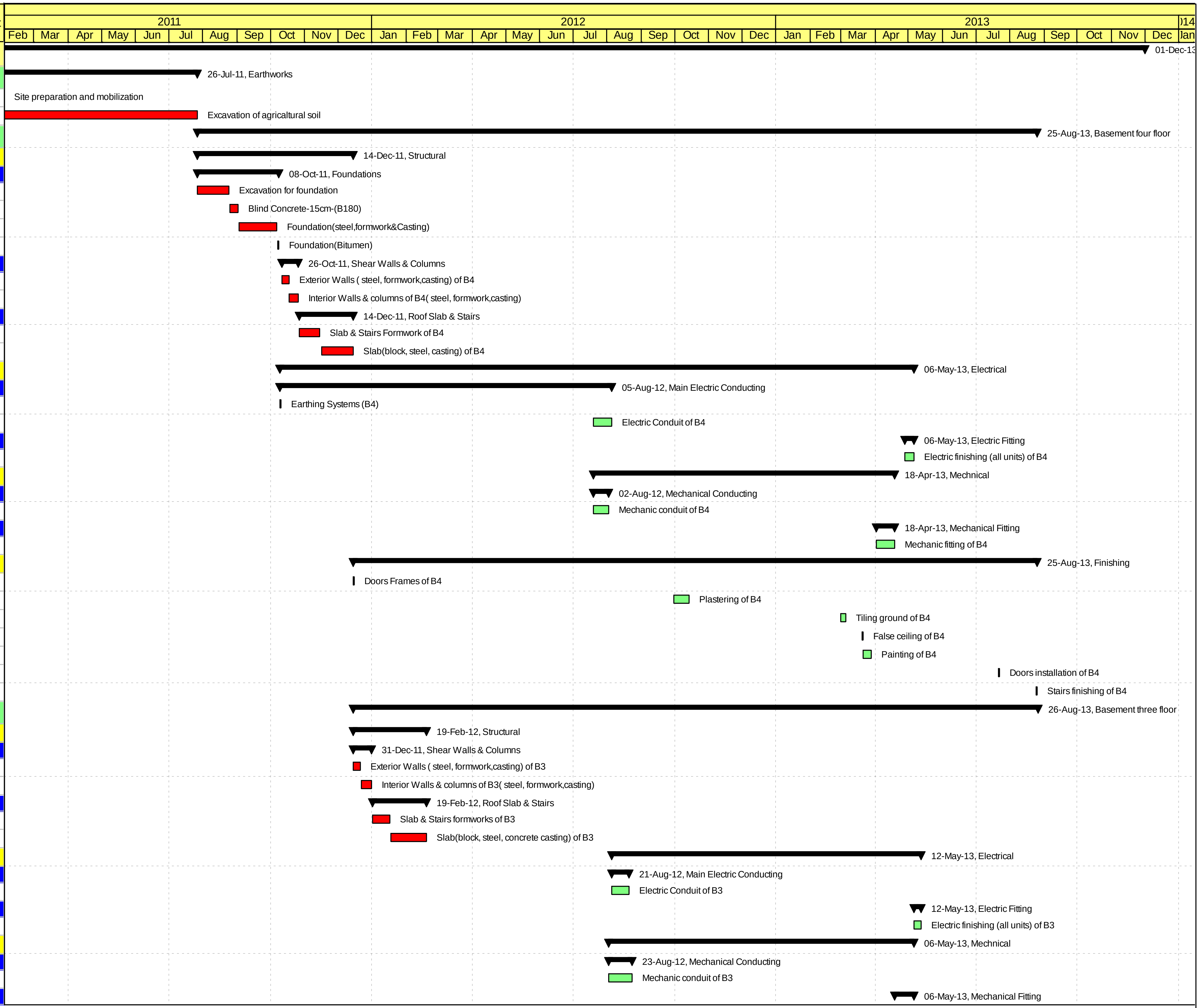
Activity ID	Activity Name	Original Duratior	Early Finish	Early Start	Late Start	Late Finish	Total Float	Budgeted Total Cost
B1MC10	Mechanic conduit of B1	45d	05-Nov-12	13-Sep-12	13-Sep-12	05-Nov-12	0d	NIS354,640.98
Mechanical Fitting		35d	03-Jul-13	23-May-13	23-May-13	03-Jul-13	0d	NIS493,685.73
B1MF10	Mechanic fitting of B1	35d	03-Jul-13	23-May-13	23-May-13	03-Jul-13	0d	NIS493,685.73
Finishing		320d	28-Aug-13	19-Aug-12	19-Aug-12	01-Dec-13	81d	NIS1,243,725.31
B1F10	Block partitions of B1	22d	13-Sep-12	19-Aug-12	19-Aug-12	13-Sep-12	0d	NIS432,258.60
B1F50	Doors Frames of B1	1d	01-Oct-12	30-Sep-12	31-Aug-13	01-Sep-13	286d	NIS33,967.78
B1F20	Plastering of B1	44d	30-Dec-12	08-Nov-12	01-Sep-13	22-Oct-13	253d	NIS186,421.13
B1F40	Wall tiling of B1	2d	01-Apr-13	30-Mar-13	22-Oct-13	24-Oct-13	176d	NIS16,326.85
B1F30	Tiling ground of B1	22d	27-Apr-13	01-Apr-13	01-Apr-13	27-Apr-13	0d	NIS240,204.27
B1F80	False ceiling of B1	5d	27-Apr-13	21-Apr-13	25-Nov-13	01-Dec-13	186d	NIS126,740.73
B1F70	Painting of B1	22d	23-May-13	27-Apr-13	27-Apr-13	23-May-13	0d	NIS144,965.56
B1F60	Doors installation of B1	1d	25-Jul-13	24-Jul-13	30-Nov-13	01-Dec-13	110d	NIS58,885.75
B1F90	Stairs finishing of B1	1d	28-Aug-13	27-Aug-13	30-Nov-13	01-Dec-13	81d	NIS3,954.64
Ground floor		376d	29-Aug-13	16-Jun-12	16-Jun-12	01-Dec-13	80d	NIS4,030,067.82
Structural		30d	19-Jul-12	16-Jun-12	16-Jun-12	21-Jul-12	0d	NIS955,663.41
Shear Walls & Columns		7d	23-Jun-12	16-Jun-12	16-Jun-12	24-Jun-12	0d	NIS247,670.24
GFSW20	Exterior Walls & Columns of GF (steel	3d	18-Jun-12	16-Jun-12	16-Jun-12	19-Jun-12	0d	NIS77,509.02
GFSW30	Interior Walls & columns of GF(steel, f	4d	23-Jun-12	19-Jun-12	19-Jun-12	24-Jun-12	0d	NIS170,161.22
Roof Slab & Stairs		23d	19-Jul-12	24-Jun-12	24-Jun-12	21-Jul-12	0d	NIS707,993.17
GFSRS10	Slab & Stair Forming of GF	8d	02-Jul-12	24-Jun-12	24-Jun-12	03-Jul-12	0d	NIS92,255.99
GFSRS20	Slab(block, steel, concrete casting) of (	15d	19-Jul-12	03-Jul-12	03-Jul-12	21-Jul-12	0d	NIS615,737.17
Electrical		224d	02-Jul-13	13-Oct-12	09-Dec-12	19-Sep-13	68d	NIS302,947.21
Main Elecrtic Conducting		28d	14-Nov-12	13-Oct-12	09-Dec-12	10-Jan-13	49d	NIS86,729.41
GFEC10	Electric Conduit of GF	28d	14-Nov-12	13-Oct-12	09-Dec-12	10-Jan-13	49d	NIS86,729.41
Electric Fitting		14d	02-Jul-13	16-Jun-13	03-Sep-13	19-Sep-13	68d	NIS216,217.80
GFEF10	Electric finishing (all units) of GF	14d	02-Jul-13	16-Jun-13	03-Sep-13	19-Sep-13	68d	NIS216,217.80
Mechnical		311d	01-Aug-13	02-Aug-12	05-Nov-12	14-Nov-13	90d	NIS863,474.60
Mechanical Conducting		116d	16-Dec-12	02-Aug-12	05-Nov-12	14-Nov-13	285d	NIS541,383.19
GFMC10	Earth drianage & manholes	25d	01-Sep-12	02-Aug-12	16-Oct-13	14-Nov-13	376d	NIS107,258.84
GFMC20	Mechanic conduit of GF	35d	16-Dec-12	05-Nov-12	05-Nov-12	16-Dec-12	0d	NIS434,124.34
Mechanical Fitting		25d	01-Aug-13	03-Jul-13	03-Jul-13	01-Aug-13	0d	NIS322,091.42
GFMF10	Mechanic fitting of GF	25d	01-Aug-13	03-Jul-13	03-Jul-13	01-Aug-13	0d	NIS322,091.42
Finishing		333d	29-Aug-13	05-Aug-12	13-Sep-12	01-Dec-13	80d	NIS1,907,982.60
GFF100	Stone work of GF	23d	01-Sep-12	05-Aug-12	02-Nov-13	28-Nov-13	388d	NIS453,866.57
GFF10	Block partitions of GF	15d	01-Oct-12	13-Sep-12	13-Sep-12	01-Oct-12	0d	NIS285,069.02
GFF50	Doors frames of GF	1d	02-Oct-12	01-Oct-12	20-Mar-13	21-Mar-13	146d	NIS33,967.78
GFF20	Plastering of GF	31d	04-Feb-13	30-Dec-12	21-Mar-13	27-Apr-13	70d	NIS129,851.14
GFF40	Wall tiling of GF	3d	30-Apr-13	27-Apr-13	27-Apr-13	30-Apr-13	0d	NIS23,579.09
GFF30	Tiling ground of GF	15d	19-May-13	30-Apr-13	30-Apr-13	19-May-13	0d	NIS161,012.24
GFF90	False ceiling of GF	3d	23-May-13	20-May-13	27-Nov-13	01-Dec-13	164d	NIS84,088.85
GFF80	Painting of GF	16d	11-Jun-13	23-May-13	15-Jun-13	03-Jul-13	19d	NIS101,585.98
GFF60	Windows of GF	2d	22-Jul-13	20-Jul-13	28-Nov-13	01-Dec-13	113d	NIS572,369.49
GFF70	Doors installation of GF	1d	27-Jul-13	25-Jul-13	30-Nov-13	01-Dec-13	109d	NIS58,885.75
GFF110	Stairs finishing of GF	1d	29-Aug-13	28-Aug-13	30-Nov-13	01-Dec-13	80d	NIS3,706.70
1st Floor		350d	03-Sep-13	21-Jul-12	21-Jul-12	01-Dec-13	76d	NIS3,470,110.57
Structural		29d	22-Aug-12	21-Jul-12	21-Jul-12	23-Aug-12	0d	NIS943,517.82
Walls & Columns		7d	28-Jul-12	21-Jul-12	21-Jul-12	29-Jul-12	0d	NIS222,717.56
F1SW20	Exterior & columns of F1(steel, formwc	3d	23-Jul-12	21-Jul-12	21-Jul-12	24-Jul-12	0d	NIS77,509.02
F1SW30	Interior Walls & columns of F1(steel, fc	4d	28-Jul-12	24-Jul-12	24-Jul-12	29-Jul-12	0d	NIS145,208.54
Roof Slab & Stairs		22d	22-Aug-12	29-Jul-12	29-Jul-12	23-Aug-12	0d	NIS720,800.26
F1SRS10	Slab & Stair Forming of F1	7d	05-Aug-12	29-Jul-12	29-Jul-12	06-Aug-12	0d	NIS85,534.34
F1SRS20	Slab(block, steel, concrete casting) of F	15d	22-Aug-12	06-Aug-12	06-Aug-12	23-Aug-12	0d	NIS635,265.92
Electrical		217d	27-Jul-13	14-Nov-12	10-Jan-13	13-Oct-13	67d	NIS286,816.84

Activity ID	Activity Name	Original Duration	Early Finish	Early Start	Late Start	Late Finish	Total Float	Budgeted Total Cost
Main Electric Conducting		30d	19-Dec-12	14-Nov-12	10-Jan-13	14-Feb-13	49d	NIS83,059.90
F1EC10	Electric Conduit of F1	30d	19-Dec-12	14-Nov-12	10-Jan-13	14-Feb-13	49d	NIS83,059.90
Electric Fitting		20d	27-Jul-13	03-Jul-13	19-Sep-13	13-Oct-13	67d	NIS203,756.94
F1EF10	Electric finishing (all units) of F1	20d	27-Jul-13	03-Jul-13	19-Sep-13	13-Oct-13	67d	NIS203,756.94
Mechnical		223d	03-Sep-13	16-Dec-12	16-Dec-12	03-Sep-13	0d	NIS731,361.01
Mechanical Conducting		40d	31-Jan-13	16-Dec-12	16-Dec-12	31-Jan-13	0d	NIS437,874.44
F1MC10	Mechanic conduit of F1	40d	31-Jan-13	16-Dec-12	16-Dec-12	31-Jan-13	0d	NIS437,874.44
Mechanical Fitting		28d	03-Sep-13	01-Aug-13	01-Aug-13	03-Sep-13	0d	NIS293,486.58
F1MF10	Mechanic fitting of F1	28d	03-Sep-13	01-Aug-13	01-Aug-13	03-Sep-13	0d	NIS293,486.58
Finishing		311d	31-Aug-13	01-Sep-12	01-Oct-12	01-Dec-13	79d	NIS1,508,414.89
F1F100	Stone work of F1	23d	27-Sep-12	01-Sep-12	03-Nov-13	30-Nov-13	366d	NIS453,866.57
F1F10	Block partitions of F1	19d	23-Oct-12	01-Oct-12	01-Oct-12	23-Oct-12	0d	NIS374,587.75
F1F50	Doors frames of F1	1d	24-Oct-12	23-Oct-12	03-Apr-13	04-Apr-13	139d	NIS28,017.22
F1F20	Plastering of F1	37d	19-Mar-13	04-Feb-13	04-Apr-13	19-May-13	51d	NIS156,851.80
F1F40	Wall tiling of F1	3d	22-May-13	19-May-13	19-May-13	22-May-13	0d	NIS22,103.85
F1F30	Tiling ground of F1	15d	09-Jun-13	22-May-13	22-May-13	09-Jun-13	0d	NIS164,979.28
F1F90	False ceiling of F1	4d	01-Jun-13	27-May-13	26-Nov-13	01-Dec-13	157d	NIS88,204.66
F1F80	Painting of F1	19d	03-Jul-13	11-Jun-13	10-Jul-13	01-Aug-13	25d	NIS122,933.61
F1F60	windows of F1	1d	23-Jul-13	22-Jul-13	30-Nov-13	01-Dec-13	112d	NIS44,443.24
F1F70	Doors installation of F1	1d	28-Jul-13	27-Jul-13	30-Nov-13	01-Dec-13	108d	NIS48,472.27
F1F110	Stairs finishing of F1	1d	31-Aug-13	29-Aug-13	30-Nov-13	01-Dec-13	79d	NIS3,954.64
2nd Floor		349d	06-Oct-13	23-Aug-12	23-Aug-12	01-Dec-13	48d	NIS3,908,840.82
Structural		29d	25-Sep-12	23-Aug-12	23-Aug-12	26-Sep-12	0d	NIS943,517.82
Walls & Columns		7d	30-Aug-12	23-Aug-12	23-Aug-12	01-Sep-12	0d	NIS222,717.56
F2SW20	Exterior Walls & columns of F2(steel, f	3d	26-Aug-12	23-Aug-12	23-Aug-12	27-Aug-12	0d	NIS77,509.02
F2SW30	Interior Walls & columns of F2(steel, fc	4d	30-Aug-12	27-Aug-12	27-Aug-12	01-Sep-12	0d	NIS145,208.54
Roof Slab & Stairs		22d	25-Sep-12	01-Sep-12	01-Sep-12	26-Sep-12	0d	NIS720,800.26
F2SRS10	Slab & Stair Forming of F2	7d	08-Sep-12	01-Sep-12	01-Sep-12	09-Sep-12	0d	NIS85,534.34
F2SRS20	Slab(block, steel, concrete casting) of F	15d	25-Sep-12	09-Sep-12	09-Sep-12	26-Sep-12	0d	NIS635,265.92
Electrical		203d	14-Aug-13	19-Dec-12	14-Feb-13	29-Oct-13	65d	NIS365,179.94
Main Electric Conducting		28d	21-Jan-13	19-Dec-12	14-Feb-13	19-Mar-13	49d	NIS101,308.28
F2EC10	Electric Conduit of F2	28d	21-Jan-13	19-Dec-12	14-Feb-13	19-Mar-13	49d	NIS101,308.28
Electric Fitting		14d	14-Aug-13	29-Jul-13	13-Oct-13	29-Oct-13	65d	NIS263,871.66
F2EF10	Electric finishing (all units) of F2	14d	14-Aug-13	29-Jul-13	13-Oct-13	29-Oct-13	65d	NIS263,871.66
Mechnical		211d	06-Oct-13	31-Jan-13	31-Jan-13	06-Oct-13	0d	NIS697,083.31
Mechanical Conducting		40d	19-Mar-13	31-Jan-13	31-Jan-13	19-Mar-13	0d	NIS417,307.81
F2MC10	Mechanic conduit of F2	40d	19-Mar-13	31-Jan-13	31-Jan-13	19-Mar-13	0d	NIS417,307.81
Mechanical Fitting		28d	06-Oct-13	03-Sep-13	03-Sep-13	06-Oct-13	0d	NIS279,775.50
F2MF10	Mechanic fitting of F2	28d	06-Oct-13	03-Sep-13	03-Sep-13	06-Oct-13	0d	NIS279,775.50
Finishing		289d	01-Sep-13	27-Sep-12	23-Oct-12	01-Dec-13	78d	NIS1,903,059.75
F2F100	Stone work of F2	28d	30-Oct-12	27-Sep-12	24-Oct-13	26-Nov-13	335d	NIS545,182.87
F2F10	Block Partitions of F2	23d	19-Nov-12	23-Oct-12	23-Oct-12	19-Nov-12	0d	NIS449,602.00
F2F50	Doors frames of F2	2d	21-Nov-12	19-Nov-12	17-Mar-13	19-Mar-13	101d	NIS47,604.48
F2F20	Plastering of F2	43d	09-May-13	19-Mar-13	19-Mar-13	09-May-13	0d	NIS182,602.85
F2F90	False ceiling of F2	3d	04-Jun-13	01-Jun-13	27-Nov-13	01-Dec-13	154d	NIS83,028.91
F2F40	Wall tiling of F2	3d	12-Jun-13	09-Jun-13	09-Jun-13	12-Jun-13	0d	NIS25,748.57
F2F30	Tiling ground of F2	14d	29-Jun-13	12-Jun-13	12-Jun-13	29-Jun-13	0d	NIS157,689.84
F2F80	Painting of F2	22d	29-Jul-13	03-Jul-13	08-Aug-13	03-Sep-13	31d	NIS143,031.63
F2F60	Windows of F2	4d	28-Jul-13	23-Jul-13	26-Nov-13	01-Dec-13	108d	NIS182,421.85
F2F70	Doors installation of F2	2d	30-Jul-13	28-Jul-13	28-Nov-13	01-Dec-13	106d	NIS82,192.11
F2F110	Stairs finishing of F2	1d	01-Sep-13	31-Aug-13	30-Nov-13	01-Dec-13	78d	NIS3,954.64
3d Floor		348d	07-Nov-13	26-Sep-12	26-Sep-12	01-Dec-13	20d	NIS3,913,914.03
Structural		29d	29-Oct-12	26-Sep-12	26-Sep-12	30-Oct-12	0d	NIS943,517.82

Activity ID	Activity Name	Original Duration	Early Finish	Early Start	Late Start	Late Finish	Total Float	Budgeted Total Cost
Walls & Columns		7d	03-Oct-12	26-Sep-12	26-Sep-12	04-Oct-12	0d	NIS222,717.56
F3SW20	Exterior Walls & columns of F3(steel, f	3d	29-Sep-12	26-Sep-12	26-Sep-12	30-Sep-12	0d	NIS77,509.02
F3SW30	Interior Walls & columns of F3(steel, fc	4d	03-Oct-12	30-Sep-12	30-Sep-12	04-Oct-12	0d	NIS145,208.54
Roof Slab & Stairs		22d	29-Oct-12	04-Oct-12	04-Oct-12	30-Oct-12	0d	NIS720,800.26
F3SRS10	Slab & Stair Forming of F3	7d	11-Oct-12	04-Oct-12	04-Oct-12	13-Oct-12	0d	NIS85,534.34
F3SRS20	Slab(block, steel, concrete casting) of F	15d	29-Oct-12	13-Oct-12	13-Oct-12	30-Oct-12	0d	NIS635,265.92
Electrical		197d	09-Sep-13	21-Jan-13	06-Apr-13	14-Nov-13	57d	NIS384,230.77
Main Electric Conducting		28d	23-Feb-13	21-Jan-13	06-Apr-13	09-May-13	64d	NIS105,771.20
F3EC10	Electric Conduit of F3	28d	23-Feb-13	21-Jan-13	06-Apr-13	09-May-13	64d	NIS105,771.20
Electric Fitting		14d	09-Sep-13	24-Aug-13	29-Oct-13	14-Nov-13	57d	NIS278,459.57
F3EF10	Electric finishing (all units) of F3	14d	09-Sep-13	24-Aug-13	29-Oct-13	14-Nov-13	57d	NIS278,459.57
Mechnical		199d	07-Nov-13	19-Mar-13	23-Mar-13	07-Nov-13	0d	NIS714,222.16
Mechanical Conducting		40d	06-May-13	19-Mar-13	23-Mar-13	09-May-13	3d	NIS427,591.12
F3MC10	Mechanic conduit of F3	40d	06-May-13	19-Mar-13	23-Mar-13	09-May-13	3d	NIS427,591.12
Mechanical Fitting		28d	07-Nov-13	06-Oct-13	06-Oct-13	07-Nov-13	0d	NIS286,631.04
F3MF10	Mechanic fitting of F3	28d	07-Nov-13	06-Oct-13	06-Oct-13	07-Nov-13	0d	NIS286,631.04
Finishing		262d	02-Sep-13	30-Oct-12	19-Nov-12	01-Dec-13	77d	NIS1,871,943.28
F3F100	Stone work of F3	28d	01-Dec-12	30-Oct-12	21-Sep-13	23-Oct-13	278d	NIS545,182.87
F3F10	Block partitions of F3	23d	16-Dec-12	19-Nov-12	19-Nov-12	16-Dec-12	0d	NIS454,250.87
F3F50	Doors frames of F3	2d	18-Dec-12	16-Dec-12	07-May-13	09-May-13	121d	NIS42,645.68
F3F20	Plastering of F3	43d	29-Jun-13	09-May-13	09-May-13	29-Jun-13	0d	NIS182,974.76
F3F90	False ceiling of F3	3d	08-Jun-13	04-Jun-13	27-Nov-13	01-Dec-13	151d	NIS85,037.22
F3F40	Wall tiling of F3	4d	03-Jul-13	29-Jun-13	29-Jun-13	03-Jul-13	0d	NIS34,909.95
F3F30	Tiling ground of F3	15d	21-Jul-13	03-Jul-13	24-Aug-13	10-Sep-13	44d	NIS162,698.23
F3F60	Windows of F3	4d	01-Aug-13	28-Jul-13	26-Nov-13	01-Dec-13	104d	NIS143,371.30
F3F80	Painting of F3	22d	24-Aug-13	29-Jul-13	10-Sep-13	06-Oct-13	37d	NIS143,403.54
F3F70	Doors installation of F3	2d	01-Aug-13	30-Jul-13	28-Nov-13	01-Dec-13	104d	NIS73,514.21
F3F110	Stairs finishing of F3	1d	02-Sep-13	01-Sep-13	30-Nov-13	01-Dec-13	77d	NIS3,954.64
4th Floor		339d	01-Dec-13	30-Oct-12	30-Oct-12	01-Dec-13	0d	NIS2,344,219.43
Structural		26d	28-Nov-12	30-Oct-12	30-Oct-12	29-Nov-12	0d	NIS678,319.21
Walls & Columns		7d	06-Nov-12	30-Oct-12	30-Oct-12	07-Nov-12	0d	NIS217,684.38
F4SW20	Exterior Walls & columns of F4(steel, f	3d	01-Nov-12	30-Oct-12	30-Oct-12	03-Nov-12	0d	NIS75,351.94
F4SW30	Interior Walls & columns of F4(steel, fc	4d	06-Nov-12	03-Nov-12	03-Nov-12	07-Nov-12	0d	NIS142,332.44
Roof Slab & Stairs		19d	28-Nov-12	07-Nov-12	07-Nov-12	29-Nov-12	0d	NIS460,634.83
F4SRS10	Slab & Stair Forming of F4	6d	13-Nov-12	07-Nov-12	07-Nov-12	14-Nov-12	0d	NIS56,279.90
F4SRS20	Slab(block, steel, concrete casting) of F	13d	28-Nov-12	14-Nov-12	14-Nov-12	29-Nov-12	0d	NIS404,354.93
Electrical		183d	25-Sep-13	23-Feb-13	07-Sep-13	01-Dec-13	57d	NIS282,880.98
Main Electric Conducting		20d	18-Mar-13	23-Feb-13	07-Sep-13	30-Sep-13	167d	NIS76,712.64
F4EC10	Electric Conduit of F4	20d	18-Mar-13	23-Feb-13	07-Sep-13	30-Sep-13	167d	NIS76,712.64
Electric Fitting		14d	25-Sep-13	09-Sep-13	14-Nov-13	01-Dec-13	57d	NIS206,168.35
F4EF10	Electric finishing (all units) of F4	14d	25-Sep-13	09-Sep-13	14-Nov-13	01-Dec-13	57d	NIS206,168.35
Mechnical		179d	01-Dec-13	06-May-13	28-Aug-13	01-Dec-13	0d	NIS536,418.19
Mechanical Conducting		28d	08-Jun-13	06-May-13	28-Aug-13	30-Sep-13	98d	NIS208,567.13
F4MC10	Mechanic conduit of F4	28d	08-Jun-13	06-May-13	28-Aug-13	30-Sep-13	98d	NIS208,567.13
Mechanical Fitting		20d	01-Dec-13	07-Nov-13	07-Nov-13	01-Dec-13	0d	NIS327,851.06
F4MF10	Mechanic fitting of F4	20d	01-Dec-13	07-Nov-13	07-Nov-13	01-Dec-13	0d	NIS327,851.06
Finishing		237d	03-Sep-13	29-Nov-12	16-Dec-12	01-Dec-13	76d	NIS846,601.05
F4F100	Roof finishing	4d	03-Dec-12	29-Nov-12	27-Oct-13	31-Oct-13	283d	NIS226,765.92
F4F110	Stone work of F4	16d	19-Dec-12	02-Dec-12	23-Oct-13	11-Nov-13	278d	NIS137,507.52
F4F10	Block Partitions of F4	8d	24-Dec-12	16-Dec-12	16-Dec-12	25-Dec-12	0d	NIS112,502.78
F4F50	Doors frames of F4	1d	25-Dec-12	25-Dec-12	29-Sep-13	30-Sep-13	237d	NIS12,768.91
F4F90	False ceiling of F4	2d	10-Jun-13	08-Jun-13	28-Nov-13	01-Dec-13	149d	NIS45,720.14
F4F20	Plastering of F4	15d	16-Jul-13	29-Jun-13	30-Sep-13	17-Oct-13	80d	NIS62,733.78

Activity ID	Activity Name	Original Duration	Early Finish	Early Start	Late Start	Late Finish	Total Float	Budgeted Total Cost
F4F40	Wall tiling of F4	2d	23-Jul-13	21-Jul-13	17-Oct-13	20-Oct-13	76d	NIS19,450.89
F4F30	Tiling ground of F4	8d	01-Aug-13	23-Jul-13	20-Oct-13	29-Oct-13	76d	NIS86,084.77
F4F60	Windows of F4	2d	04-Aug-13	01-Aug-13	28-Nov-13	01-Dec-13	102d	NIS67,501.67
F4F70	Doors installation of F4	1d	03-Aug-13	01-Aug-13	30-Nov-13	01-Dec-13	103d	NIS22,066.66
F4F80	Painting of F4	8d	02-Sep-13	24-Aug-13	29-Oct-13	07-Nov-13	57d	NIS49,543.37
F4F120	Stairs finishing of F4	1d	03-Sep-13	02-Sep-13	30-Nov-13	01-Dec-13	76d	NIS3,954.64
landscape		222d	21-Aug-13	04-Dec-12	31-Oct-13	01-Dec-13	87d	NIS220,001.13
Hard landscape		9d	13-Dec-12	04-Dec-12	31-Oct-13	11-Nov-13	283d	NIS72,278.48
LH20	Retaining Walls(forming,casting,steel)	8d	12-Dec-12	04-Dec-12	31-Oct-13	10-Nov-13	283d	NIS69,613.12
LH10	Agricultural soil of yards	1d	13-Dec-12	13-Dec-12	10-Nov-13	11-Nov-13	283d	NIS2,665.35
Soft landscape		214d	21-Aug-13	13-Dec-12	11-Nov-13	01-Dec-13	87d	NIS147,722.65
LSO20	Outdoor Rooms & Gates	1d	13-Dec-12	13-Dec-12	30-Nov-13	01-Dec-13	300d	NIS16,463.22
LSO10	Tiling	17d	21-Aug-13	01-Aug-13	11-Nov-13	01-Dec-13	87d	NIS131,259.44

Activity ID	Original Duration	Early Start	Early Finish	Total Float
Palestinian M	880d	01-Feb-11	01-Dec-13	0d
Earthworks	150d	01-Feb-11	26-Jul-11	0d
E10	1d	01-Feb-11	01-Feb-11	0d
E20	149d	02-Feb-11	26-Jul-11	0d
Basement f	646d	27-Jul-11	25-Aug-13	84d
Structural	118d	27-Jul-11	14-Dec-11	0d
Foundatio	62d	27-Jul-11	08-Oct-11	0d
B4SF10	25d	27-Jul-11	24-Aug-11	0d
B4SF20	6d	25-Aug-11	01-Sep-11	0d
B4SF30	30d	03-Sep-11	06-Oct-11	0d
B4SF40	1d	08-Oct-11	08-Oct-11	0d
Shear Wall	14d	11-Oct-11	26-Oct-11	0d
B4SW10	6d	11-Oct-11	17-Oct-11	0d
B4SW20	8d	18-Oct-11	26-Oct-11	0d
Roof Slab	40d	27-Oct-11	14-Dec-11	0d
B4SRS10	15d	27-Oct-11	14-Nov-11	0d
B4SRS20	25d	16-Nov-11	14-Dec-11	0d
Electrical	489d	09-Oct-11	06-May-13	179d
Main Elect	255d	09-Oct-11	05-Aug-12	377d
B4EC10	2d	09-Oct-11	10-Oct-11	0d
B4EC20	14d	19-Jul-12	05-Aug-12	377d
Electric Fit	7d	27-Apr-13	06-May-13	179d
B4EF10	7d	27-Apr-13	06-May-13	179d
Mechnical	234d	19-Jul-12	18-Apr-13	193d
Mechanica	12d	19-Jul-12	02-Aug-12	376d
B4MC10	12d	19-Jul-12	02-Aug-12	376d
Mechanica	14d	02-Apr-13	18-Apr-13	193d
B4MF10	14d	02-Apr-13	18-Apr-13	193d
Finishing	528d	15-Dec-11	25-Aug-13	84d
B4F30	1d	15-Dec-11	15-Dec-11	611d
B4F10	12d	30-Sep-12	14-Oct-12	329d
B4F20	4d	28-Feb-13	05-Mar-13	211d
B4F60	1d	20-Mar-13	21-Mar-13	217d
B4F50	6d	21-Mar-13	28-Mar-13	197d
B4F40	1d	21-Jul-13	22-Jul-13	113d
B4F70	1d	24-Aug-13	25-Aug-13	84d
Basement t	529d	15-Dec-11	26-Aug-13	83d
Structural	57d	15-Dec-11	19-Feb-12	0d
Shear Wall	14d	15-Dec-11	31-Dec-11	0d
B3SW10	6d	15-Dec-11	21-Dec-11	0d
B3SW20	8d	22-Dec-11	31-Dec-11	0d
Roof Slab	43d	01-Jan-12	19-Feb-12	0d
B3SRS10	15d	01-Jan-12	17-Jan-12	0d
B3SRS20	28d	18-Jan-12	19-Feb-12	0d
Electrical	239d	05-Aug-12	12-May-13	174d
Main Elect	14d	05-Aug-12	21-Aug-12	363d
B3EC10	14d	05-Aug-12	21-Aug-12	363d
Electric Fit	5d	06-May-13	12-May-13	174d
B3EF10	5d	06-May-13	12-May-13	174d
Mechnical	236d	02-Aug-12	06-May-13	179d
Mechanica	18d	02-Aug-12	23-Aug-12	361d
B3MC10	18d	02-Aug-12	23-Aug-12	361d
Mechanica	14d	18-Apr-13	06-May-13	179d



Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

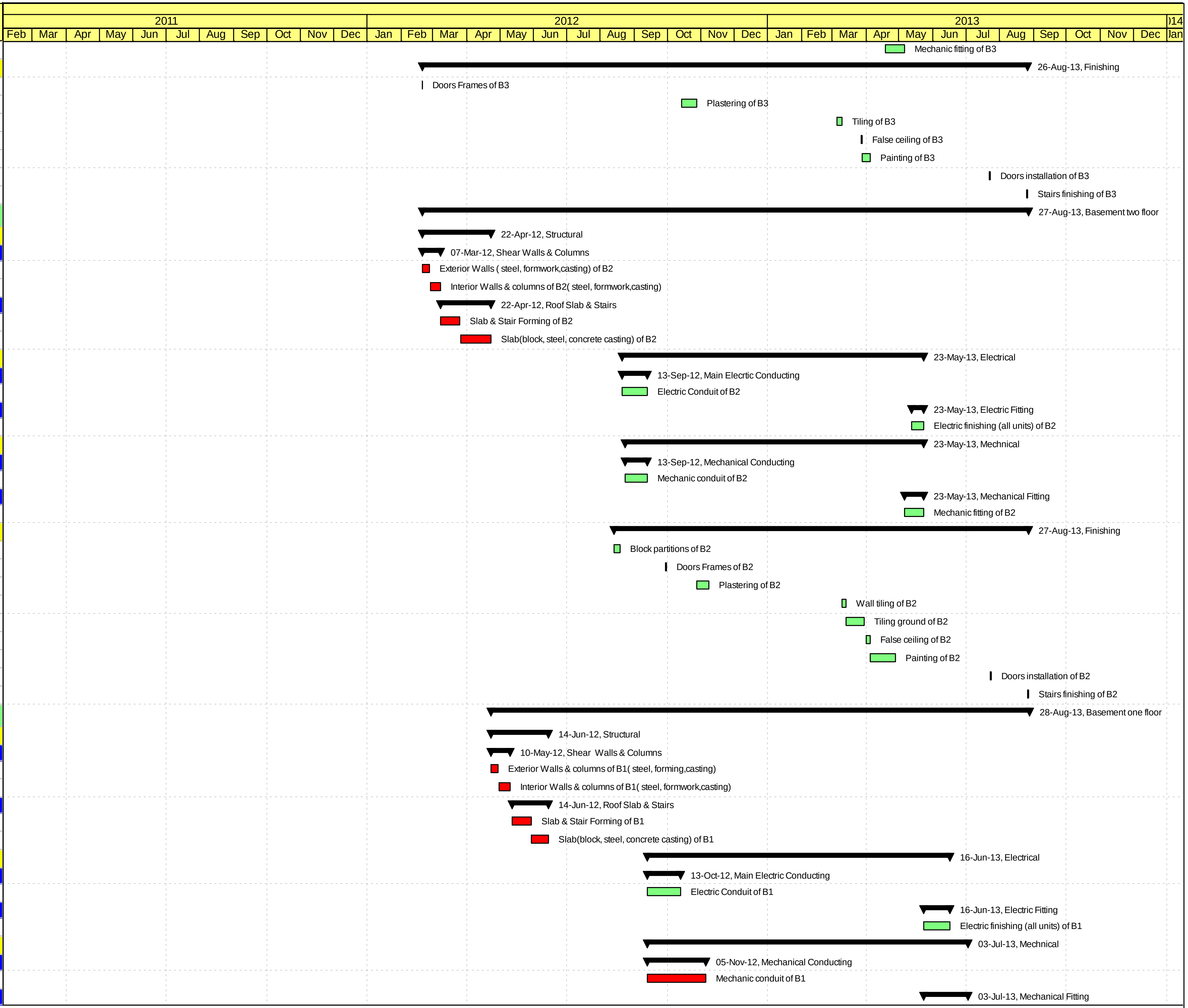
Fig. 2 Bar Chart

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project

Activity ID	Original Duration	Early Start	Early Finish	Total Float
B3MF10	14d	18-Apr-13	06-May-13	179d
Finishing	472d	20-Feb-12	26-Aug-13	83d
B3F30	1d	20-Feb-12	20-Feb-12	518d
B3F10	12d	14-Oct-12	28-Oct-12	317d
B3F20	4d	05-Mar-13	10-Mar-13	207d
B3F60	1d	27-Mar-13	28-Mar-13	211d
B3F50	6d	28-Mar-13	04-Apr-13	191d
B3F40	1d	22-Jul-13	23-Jul-13	112d
B3F70	1d	25-Aug-13	26-Aug-13	83d
Basement t	473d	20-Feb-12	27-Aug-13	82d
Structural	54d	20-Feb-12	22-Apr-12	0d
Shear Wall	15d	20-Feb-12	07-Mar-12	0d
B2SW10	6d	20-Feb-12	26-Feb-12	0d
B2SW20	9d	27-Feb-12	07-Mar-12	0d
Roof Slab	39d	08-Mar-12	22-Apr-12	0d
B2SRS10	15d	08-Mar-12	25-Mar-12	0d
B2SRS20	24d	26-Mar-12	22-Apr-12	0d
Electrical	235d	21-Aug-12	23-May-13	164d
Main Elecr	20d	21-Aug-12	13-Sep-12	349d
B2EC10	20d	21-Aug-12	13-Sep-12	349d
Electric Fit	10d	12-May-13	23-May-13	164d
B2EF10	10d	12-May-13	23-May-13	164d
Mechnical	233d	23-Aug-12	23-May-13	164d
Mechanica	18d	23-Aug-12	13-Sep-12	349d
B2MC10	18d	23-Aug-12	13-Sep-12	349d
Mechanica	15d	06-May-13	23-May-13	164d
B2MF10	15d	06-May-13	23-May-13	164d
Finishing	324d	13-Aug-12	27-Aug-13	82d
B2F10	5d	13-Aug-12	19-Aug-12	351d
B2F50	1d	29-Sep-12	30-Sep-12	335d
B2F20	10d	28-Oct-12	08-Nov-12	311d
B2F40	3d	10-Mar-13	13-Mar-13	207d
B2F30	14d	13-Mar-13	30-Mar-13	176d
B2F80	3d	01-Apr-13	04-Apr-13	205d
B2F70	19d	04-Apr-13	27-Apr-13	171d
B2F60	1d	23-Jul-13	24-Jul-13	111d
B2F90	1d	26-Aug-13	27-Aug-13	82d
Basement c	420d	23-Apr-12	28-Aug-13	81d
Structural	45d	23-Apr-12	14-Jun-12	0d
Shear Wal	15d	23-Apr-12	10-May-12	0d
B1SW10	6d	23-Apr-12	29-Apr-12	0d
B1SW20	9d	30-Apr-12	10-May-12	0d
Roof Slab	30d	12-May-12	14-Jun-12	0d
B1SRS10	16d	12-May-12	29-May-12	0d
B1SRS20	14d	30-May-12	14-Jun-12	0d
Electrical	235d	13-Sep-12	16-Jun-13	68d
Main Elect	25d	13-Sep-12	13-Oct-12	49d
B1EC10	25d	13-Sep-12	13-Oct-12	49d
Electric Fit	20d	23-May-13	16-Jun-13	68d
B1EF10	20d	23-May-13	16-Jun-13	68d
Mechnical	250d	13-Sep-12	03-Jul-13	0d
Mechanica	45d	13-Sep-12	05-Nov-12	0d
B1MC10	45d	13-Sep-12	05-Nov-12	0d
Mechanica	35d	23-May-13	03-Jul-13	0d



Actual Work
Remaining Work
Critical Remaining Work
◆ ◆ Milestone
Summary

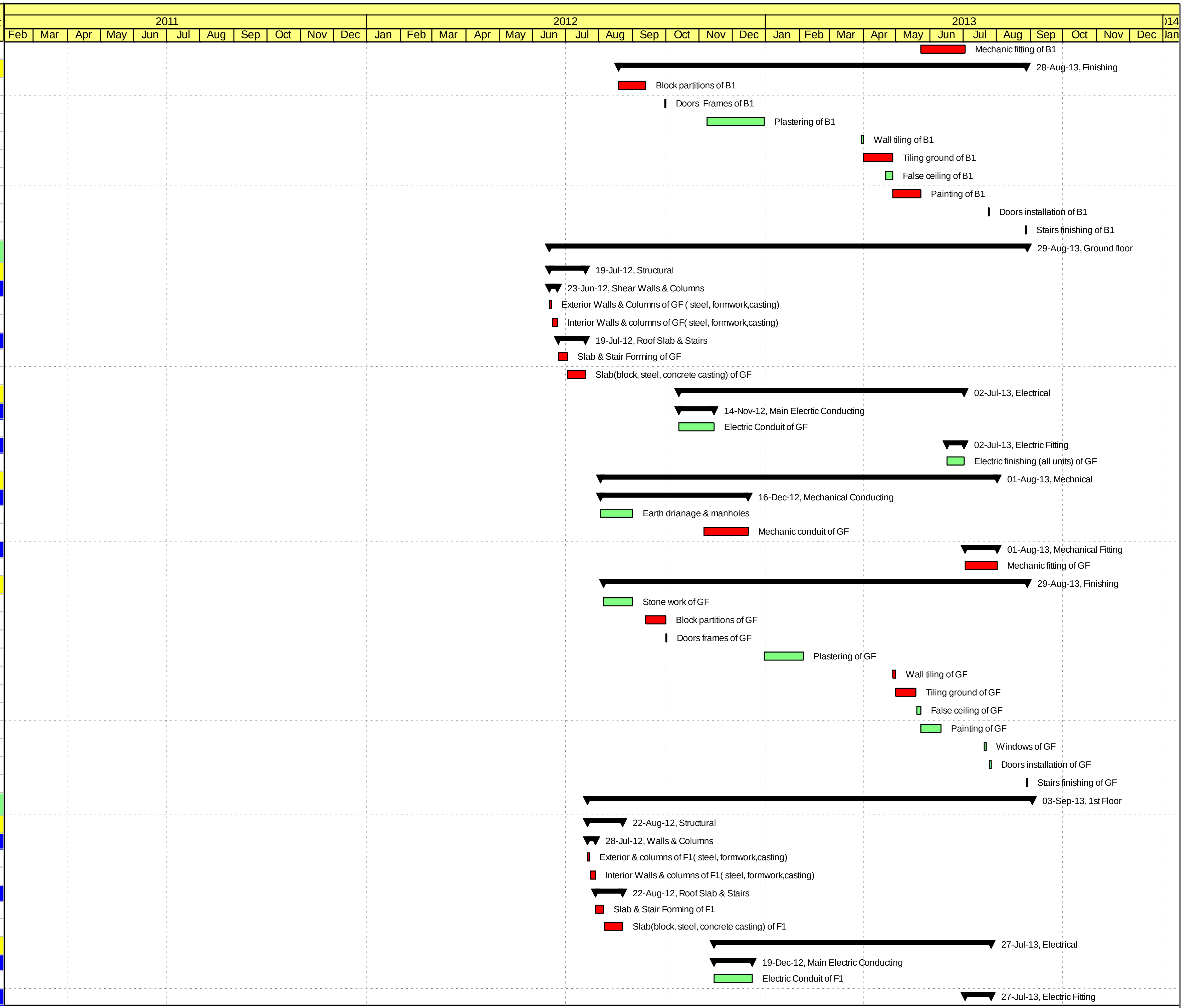
Fig. 2 Bar Chart

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project

Activity ID	Original Duration	Early Start	Early Finish	Total Float
B1MF10	35d	23-May-13	03-Jul-13	0d
Finishing	320d	19-Aug-12	28-Aug-13	81d
B1F10	22d	19-Aug-12	13-Sep-12	0d
B1F50	1d	30-Sep-12	01-Oct-12	286d
B1F20	44d	08-Nov-12	30-Dec-12	253d
B1F40	2d	30-Mar-13	01-Apr-13	176d
B1F30	22d	01-Apr-13	27-Apr-13	0d
B1F80	5d	21-Apr-13	27-Apr-13	186d
B1F70	22d	27-Apr-13	23-May-13	0d
B1F60	1d	24-Jul-13	25-Jul-13	110d
B1F90	1d	27-Aug-13	28-Aug-13	81d
Ground floo	376d	16-Jun-12	29-Aug-13	80d
Structural	30d	16-Jun-12	19-Jul-12	0d
Shear Wall	7d	16-Jun-12	23-Jun-12	0d
GFSW20	3d	16-Jun-12	18-Jun-12	0d
GFSW30	4d	19-Jun-12	23-Jun-12	0d
Roof Slab	23d	24-Jun-12	19-Jul-12	0d
GFSRS10	8d	24-Jun-12	02-Jul-12	0d
GFSRS20	15d	03-Jul-12	19-Jul-12	0d
Electrical	224d	13-Oct-12	02-Jul-13	68d
Main Elecr	28d	13-Oct-12	14-Nov-12	49d
GFEC10	28d	13-Oct-12	14-Nov-12	49d
Electric Fit	14d	16-Jun-13	02-Jul-13	68d
GFEF10	14d	16-Jun-13	02-Jul-13	68d
Mechnical	311d	02-Aug-12	01-Aug-13	90d
Mechanica	116d	02-Aug-12	16-Dec-12	285d
GFMC10	25d	02-Aug-12	01-Sep-12	376d
GFMC20	35d	05-Nov-12	16-Dec-12	0d
Mechanica	25d	03-Jul-13	01-Aug-13	0d
GFMF10	25d	03-Jul-13	01-Aug-13	0d
Finishing	333d	05-Aug-12	29-Aug-13	80d
GFF100	23d	05-Aug-12	01-Sep-12	388d
GFF10	15d	13-Sep-12	01-Oct-12	0d
GFF50	1d	01-Oct-12	02-Oct-12	146d
GFF20	31d	30-Dec-12	04-Feb-13	70d
GFF40	3d	27-Apr-13	30-Apr-13	0d
GFF30	15d	30-Apr-13	19-May-13	0d
GFF90	3d	20-May-13	23-May-13	164d
GFF80	16d	23-May-13	11-Jun-13	19d
GFF60	2d	20-Jul-13	22-Jul-13	113d
GFF70	1d	25-Jul-13	27-Jul-13	109d
GFF110	1d	28-Aug-13	29-Aug-13	80d
1st Floor	350d	21-Jul-12	03-Sep-13	76d
Structural	29d	21-Jul-12	22-Aug-12	0d
Walls & Cc	7d	21-Jul-12	28-Jul-12	0d
F1SW20	3d	21-Jul-12	23-Jul-12	0d
F1SW30	4d	24-Jul-12	28-Jul-12	0d
Roof Slab	22d	29-Jul-12	22-Aug-12	0d
F1SRS10	7d	29-Jul-12	05-Aug-12	0d
F1SRS20	15d	06-Aug-12	22-Aug-12	0d
Electrical	217d	14-Nov-12	27-Jul-13	67d
Main Elect	30d	14-Nov-12	19-Dec-12	49d
F1EC10	30d	14-Nov-12	19-Dec-12	49d
Electric Fit	20d	03-Jul-13	27-Jul-13	67d



Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

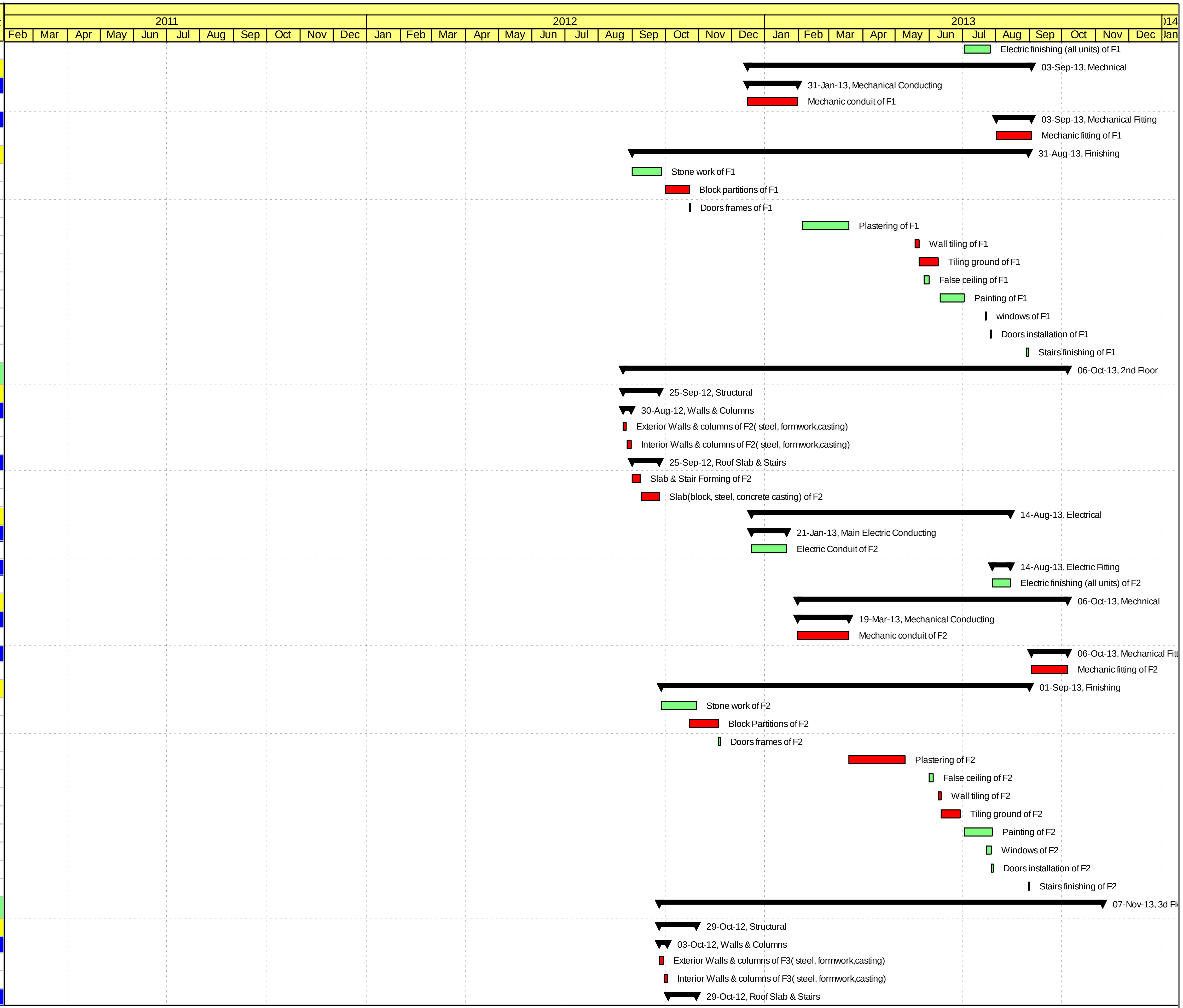
Fig. 2 Bar Chart

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project

Activity ID	Original Duration	Early Start	Early Finish	Total Float
F1EF10	20d	03-Jul-13	27-Jul-13	67d
Mechnical	223d	16-Dec-12	03-Sep-13	0d
Mechanica	40d	16-Dec-12	31-Jan-13	0d
F1MC10	40d	16-Dec-12	31-Jan-13	0d
Mechanica	28d	01-Aug-13	03-Sep-13	0d
F1MF10	28d	01-Aug-13	03-Sep-13	0d
Finishing	311d	01-Sep-12	31-Aug-13	79d
F1F100	23d	01-Sep-12	27-Sep-12	366d
F1F10	19d	01-Oct-12	23-Oct-12	0d
F1F50	1d	23-Oct-12	24-Oct-12	139d
F1F20	37d	04-Feb-13	19-Mar-13	51d
F1F40	3d	19-May-13	22-May-13	0d
F1F30	15d	22-May-13	09-Jun-13	0d
F1F90	4d	27-May-13	01-Jun-13	157d
F1F80	19d	11-Jun-13	03-Jul-13	25d
F1F60	1d	22-Jul-13	23-Jul-13	112d
F1F70	1d	27-Jul-13	28-Jul-13	108d
F1F110	1d	29-Aug-13	31-Aug-13	79d
2nd Floor	349d	23-Aug-12	06-Oct-13	48d
Structural	29d	23-Aug-12	25-Sep-12	0d
Walls & Cc	7d	23-Aug-12	30-Aug-12	0d
F2SW20	3d	23-Aug-12	26-Aug-12	0d
F2SW30	4d	27-Aug-12	30-Aug-12	0d
Roof Slab	22d	01-Sep-12	25-Sep-12	0d
F2SRS10	7d	01-Sep-12	08-Sep-12	0d
F2SRS20	15d	09-Sep-12	25-Sep-12	0d
Electrical	203d	19-Dec-12	14-Aug-13	65d
Main Elect	28d	19-Dec-12	21-Jan-13	49d
F2EC10	28d	19-Dec-12	21-Jan-13	49d
Electric Fit	14d	29-Jul-13	14-Aug-13	65d
F2EF10	14d	29-Jul-13	14-Aug-13	65d
Mechnical	211d	31-Jan-13	06-Oct-13	0d
Mechanica	40d	31-Jan-13	19-Mar-13	0d
F2MC10	40d	31-Jan-13	19-Mar-13	0d
Mechanica	28d	03-Sep-13	06-Oct-13	0d
F2MF10	28d	03-Sep-13	06-Oct-13	0d
Finishing	289d	27-Sep-12	01-Sep-13	78d
F2F100	28d	27-Sep-12	30-Oct-12	335d
F2F10	23d	23-Oct-12	19-Nov-12	0d
F2F50	2d	19-Nov-12	21-Nov-12	101d
F2F20	43d	19-Mar-13	09-May-13	0d
F2F90	3d	01-Jun-13	04-Jun-13	154d
F2F40	3d	09-Jun-13	12-Jun-13	0d
F2F30	14d	12-Jun-13	29-Jun-13	0d
F2F80	22d	03-Jul-13	29-Jul-13	31d
F2F60	4d	23-Jul-13	28-Jul-13	108d
F2F70	2d	28-Jul-13	30-Jul-13	106d
F2F110	1d	31-Aug-13	01-Sep-13	78d
3d Floor	348d	26-Sep-12	07-Nov-13	20d
Structural	29d	26-Sep-12	29-Oct-12	0d
Walls & Cc	7d	26-Sep-12	03-Oct-12	0d
F3SW20	3d	26-Sep-12	29-Sep-12	0d
F3SW30	4d	30-Sep-12	03-Oct-12	0d
Roof Slab	22d	04-Oct-12	29-Oct-12	0d



Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

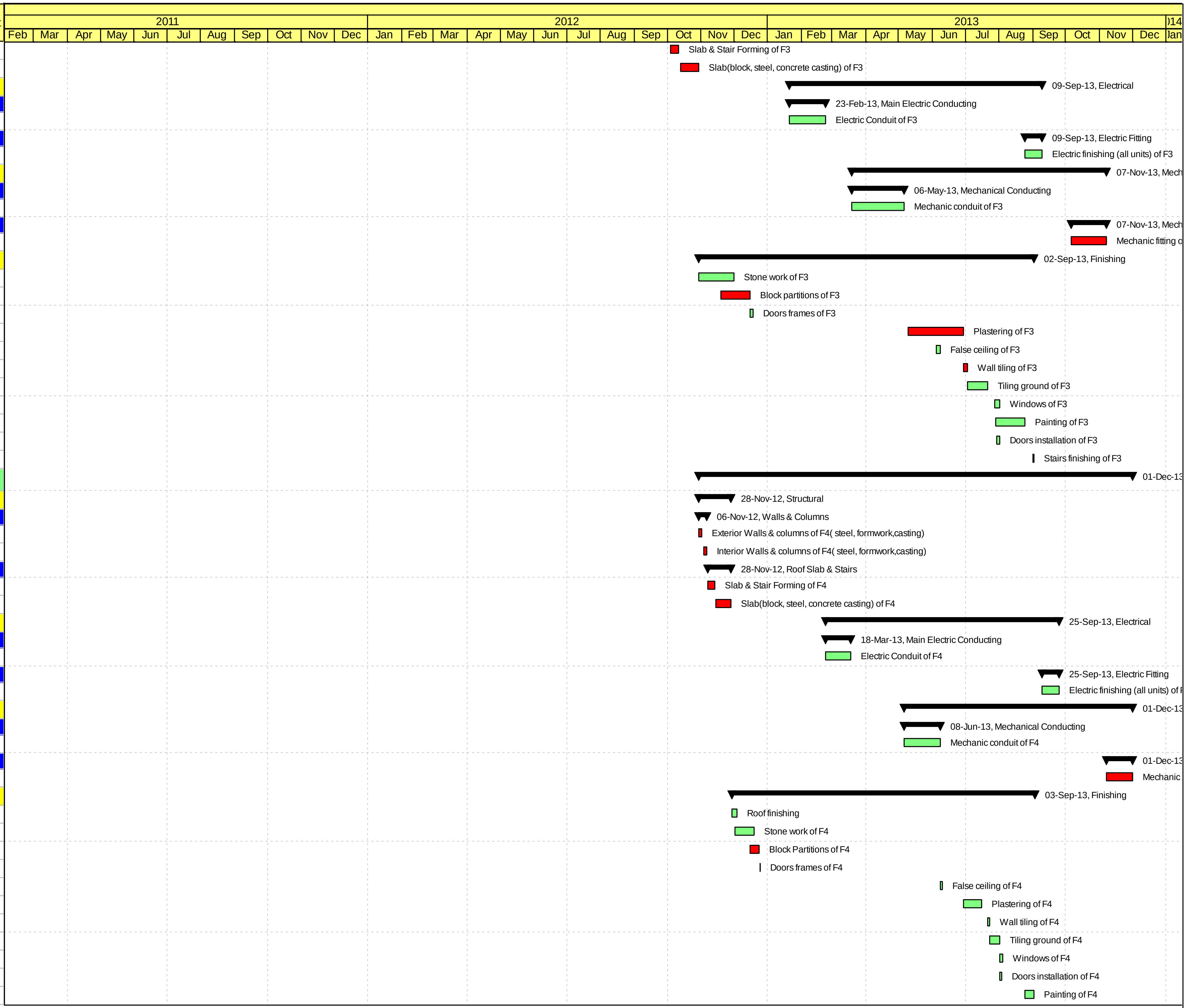
Fig. 2 Bar Chart

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project

Activity ID	Original Duration	Early Start	Early Finish	Total Float
F3SRS10	7d	04-Oct-12	11-Oct-12	0d
F3SRS20	15d	13-Oct-12	29-Oct-12	0d
Electrical	197d	21-Jan-13	09-Sep-13	57d
Main Electi	28d	21-Jan-13	23-Feb-13	64d
F3EC10	28d	21-Jan-13	23-Feb-13	64d
Electric Fit	14d	24-Aug-13	09-Sep-13	57d
F3EF10	14d	24-Aug-13	09-Sep-13	57d
Mechnical	199d	19-Mar-13	07-Nov-13	0d
Mechanica	40d	19-Mar-13	06-May-13	3d
F3MC10	40d	19-Mar-13	06-May-13	3d
Mechanica	28d	06-Oct-13	07-Nov-13	0d
F3MF10	28d	06-Oct-13	07-Nov-13	0d
Finishing	262d	30-Oct-12	02-Sep-13	77d
F3F100	28d	30-Oct-12	01-Dec-12	278d
F3F10	23d	19-Nov-12	16-Dec-12	0d
F3F50	2d	16-Dec-12	18-Dec-12	121d
F3F20	43d	09-May-13	29-Jun-13	0d
F3F90	3d	04-Jun-13	08-Jun-13	151d
F3F40	4d	29-Jun-13	03-Jul-13	0d
F3F30	15d	03-Jul-13	21-Jul-13	44d
F3F60	4d	28-Jul-13	01-Aug-13	104d
F3F80	22d	29-Jul-13	24-Aug-13	37d
F3F70	2d	30-Jul-13	01-Aug-13	104d
F3F110	1d	01-Sep-13	02-Sep-13	77d
4th Floor	339d	30-Oct-12	01-Dec-13	0d
Structural	26d	30-Oct-12	28-Nov-12	0d
Walls & Cc	7d	30-Oct-12	06-Nov-12	0d
F4SW20	3d	30-Oct-12	01-Nov-12	0d
F4SW30	4d	03-Nov-12	06-Nov-12	0d
Roof Slab	19d	07-Nov-12	28-Nov-12	0d
F4SRS10	6d	07-Nov-12	13-Nov-12	0d
F4SRS20	13d	14-Nov-12	28-Nov-12	0d
Electrical	183d	23-Feb-13	25-Sep-13	57d
Main Electi	20d	23-Feb-13	18-Mar-13	167d
F4EC10	20d	23-Feb-13	18-Mar-13	167d
Electric Fit	14d	09-Sep-13	25-Sep-13	57d
F4EF10	14d	09-Sep-13	25-Sep-13	57d
Mechnical	179d	06-May-13	01-Dec-13	0d
Mechanica	28d	06-May-13	08-Jun-13	98d
F4MC10	28d	06-May-13	08-Jun-13	98d
Mechanica	20d	07-Nov-13	01-Dec-13	0d
F4MF10	20d	07-Nov-13	01-Dec-13	0d
Finishing	237d	29-Nov-12	03-Sep-13	76d
F4F100	4d	29-Nov-12	03-Dec-12	283d
F4F110	16d	02-Dec-12	19-Dec-12	278d
F4F10	8d	16-Dec-12	24-Dec-12	0d
F4F50	1d	25-Dec-12	25-Dec-12	237d
F4F90	2d	08-Jun-13	10-Jun-13	149d
F4F20	15d	29-Jun-13	16-Jul-13	80d
F4F40	2d	21-Jul-13	23-Jul-13	76d
F4F30	8d	23-Jul-13	01-Aug-13	76d
F4F60	2d	01-Aug-13	04-Aug-13	102d
F4F70	1d	01-Aug-13	03-Aug-13	103d
F4F80	8d	24-Aug-13	02-Sep-13	57d



Actual Work | Remaining Work | Critical Remaining Work | ◆ Milestone | Summary

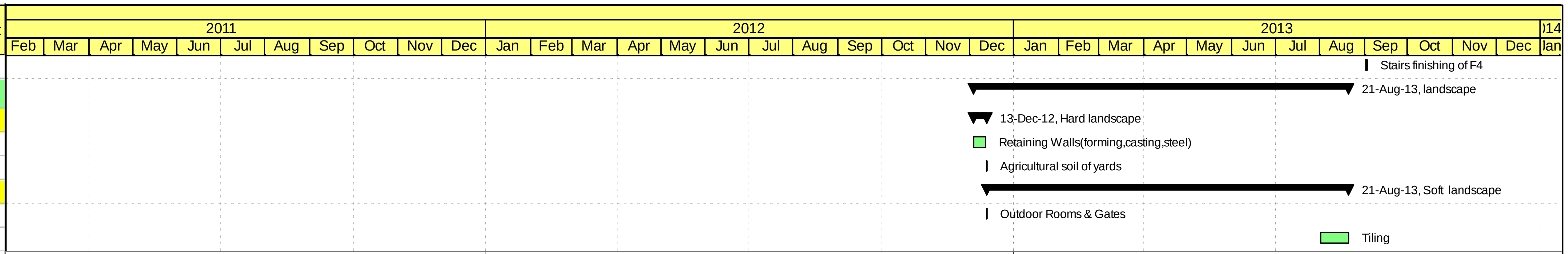
Fig. 2 Bar Chart

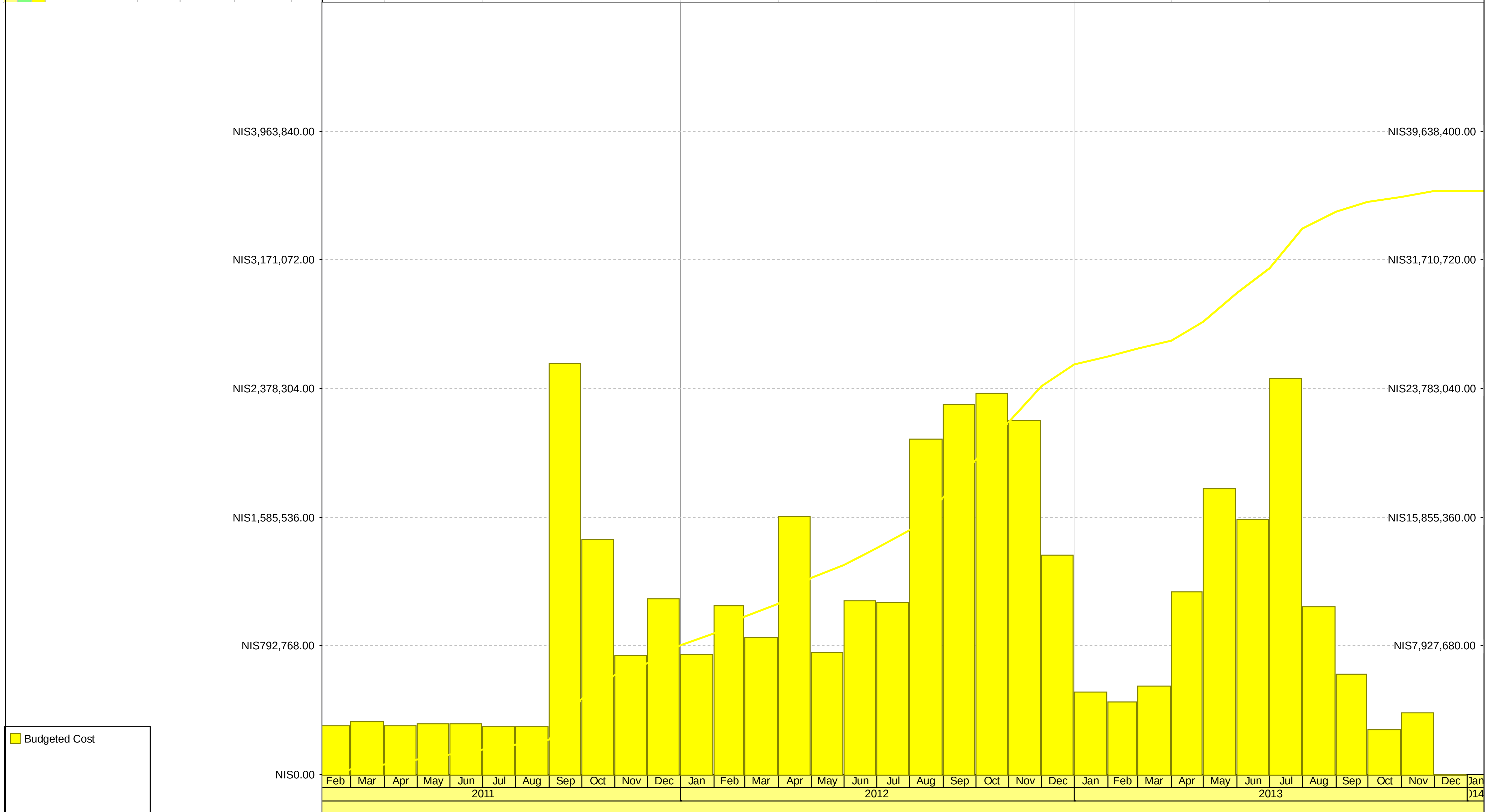
Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project

Activity ID	Original Duration	Early Start	Early Finish	Total Float
F4F120	1d	02-Sep-13	03-Sep-13	76d
landscape	222d	04-Dec-12	21-Aug-13	87d
Hard landsc	9d	04-Dec-12	13-Dec-12	283d
LH20	8d	04-Dec-12	12-Dec-12	283d
LH10	1d	13-Dec-12	13-Dec-12	283d
Soft landsc	214d	13-Dec-12	21-Aug-13	87d
LSO20	1d	13-Dec-12	13-Dec-12	300d
LSO10	17d	01-Aug-13	21-Aug-13	87d





Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

Fig. 2 Bar Chart

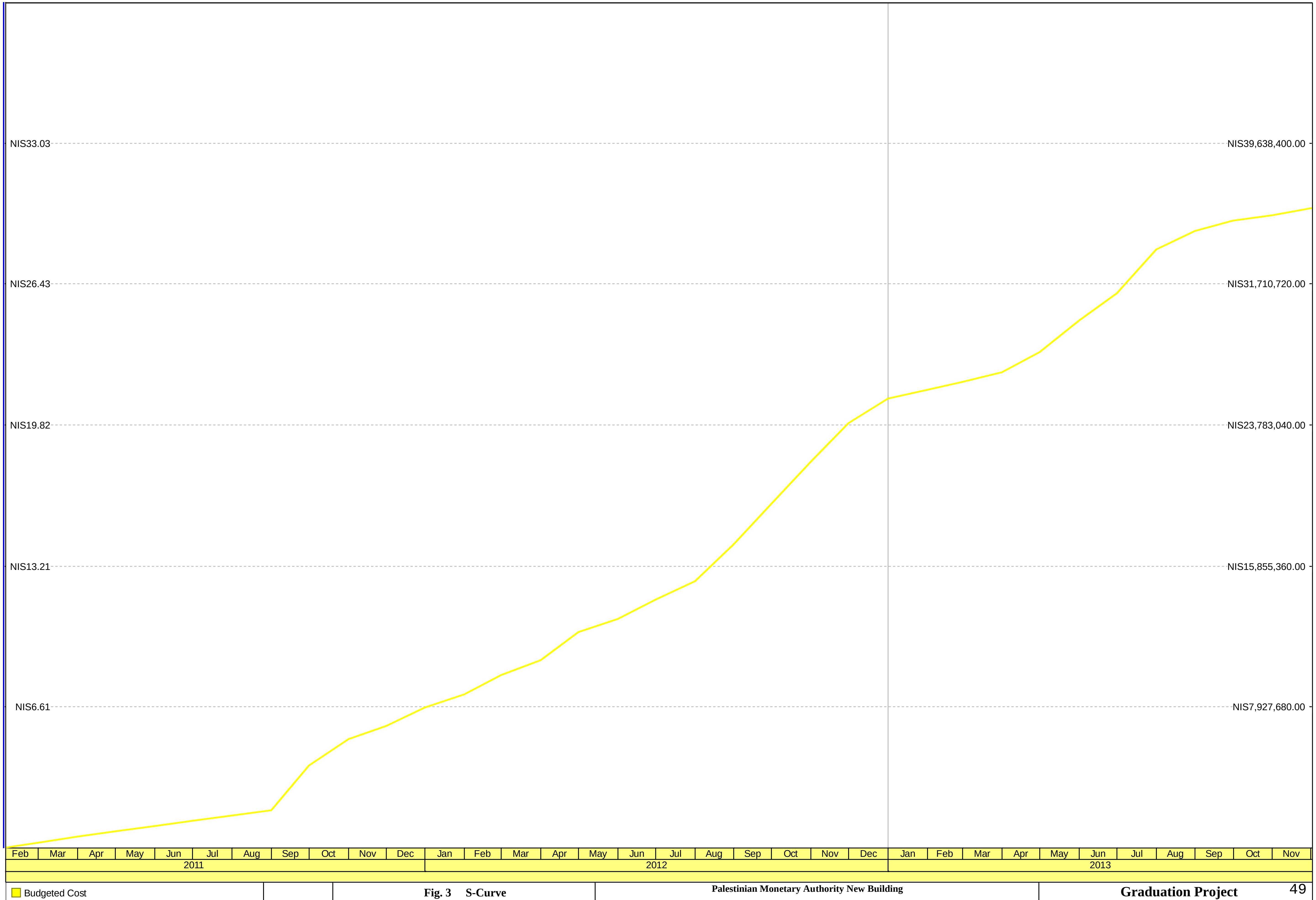


Fig. 3 S-Curve

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project

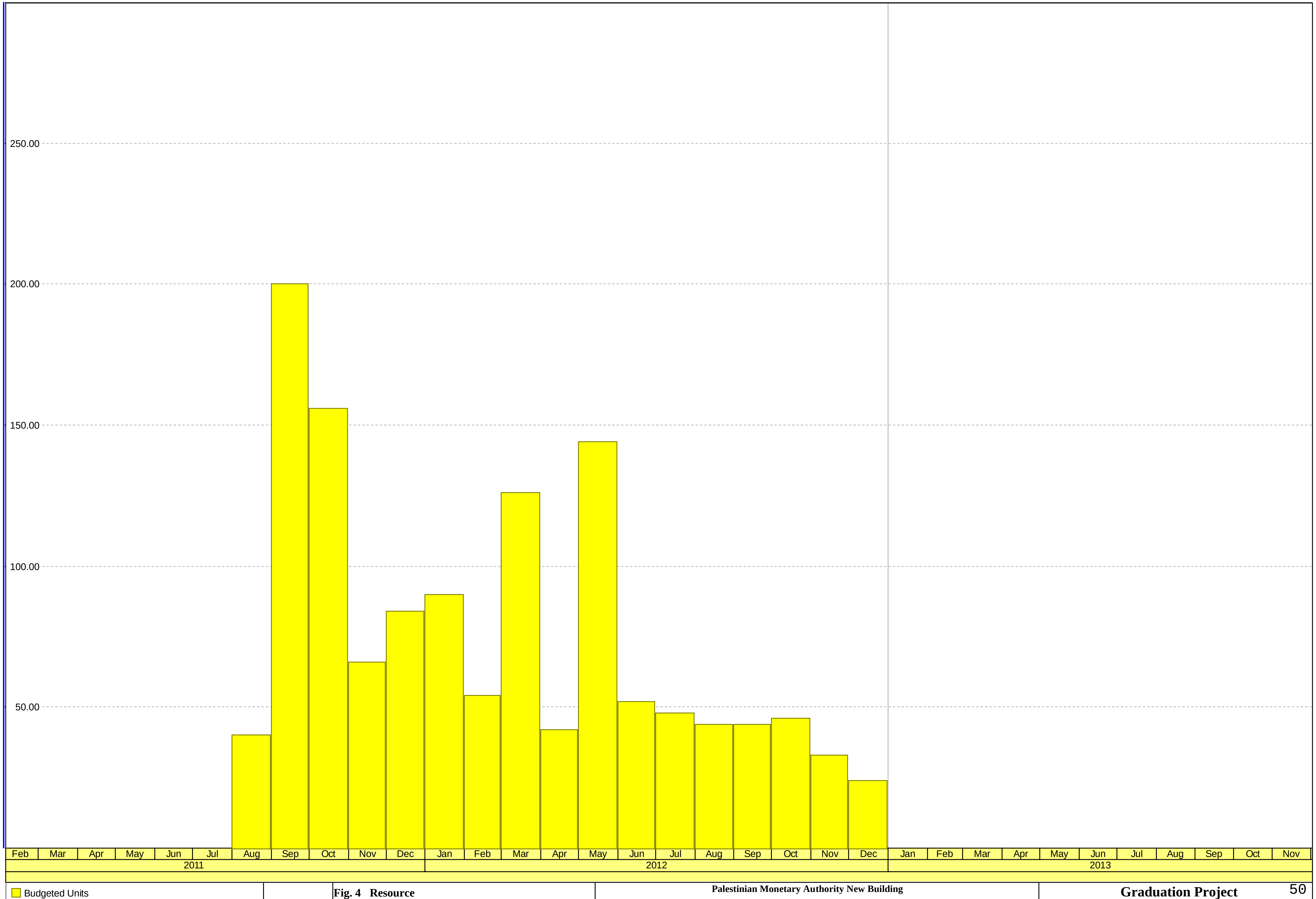


Fig. 4 Resource

Carpenter

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project

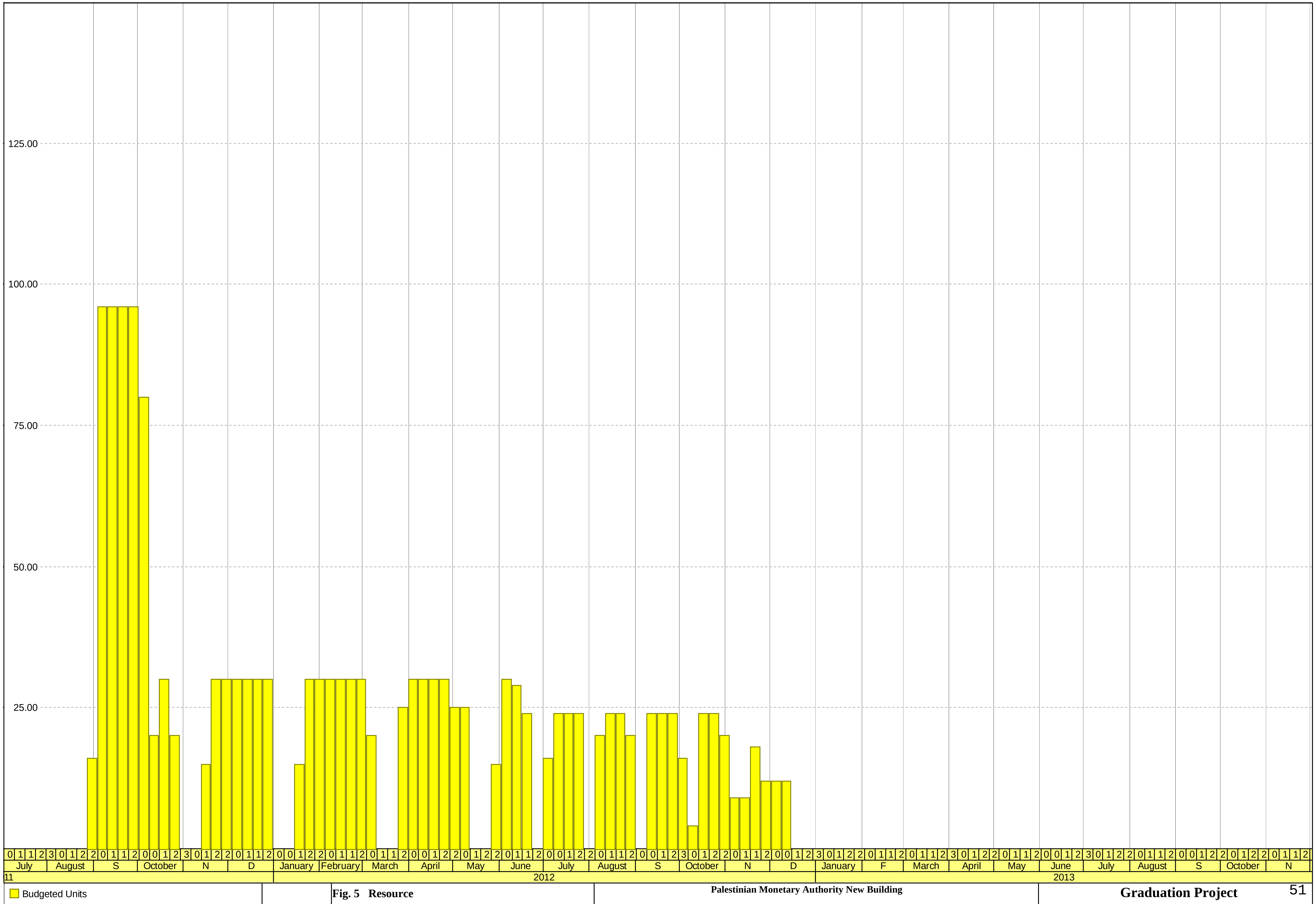


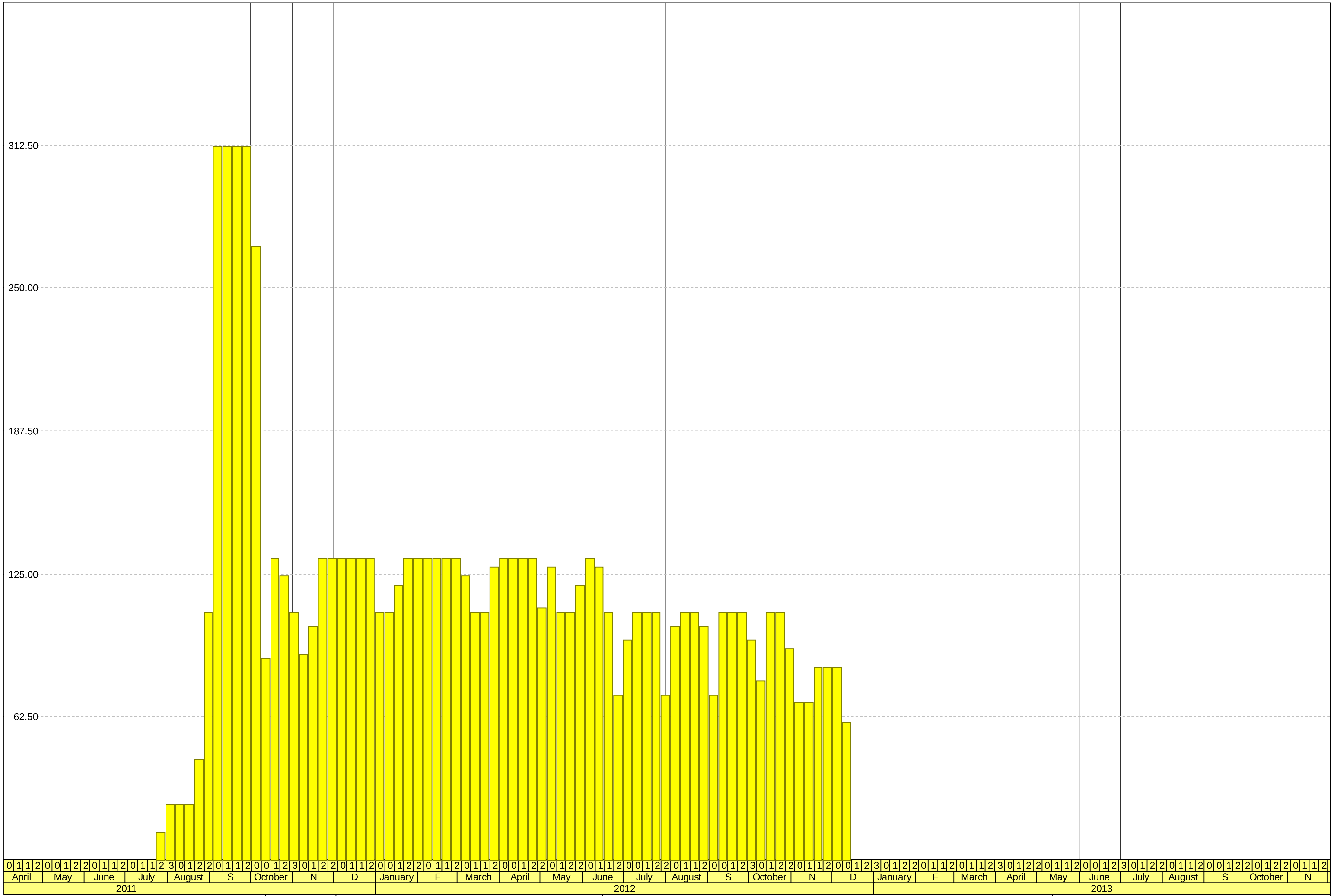
Fig. 5 Resource

Steel Fixer

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project



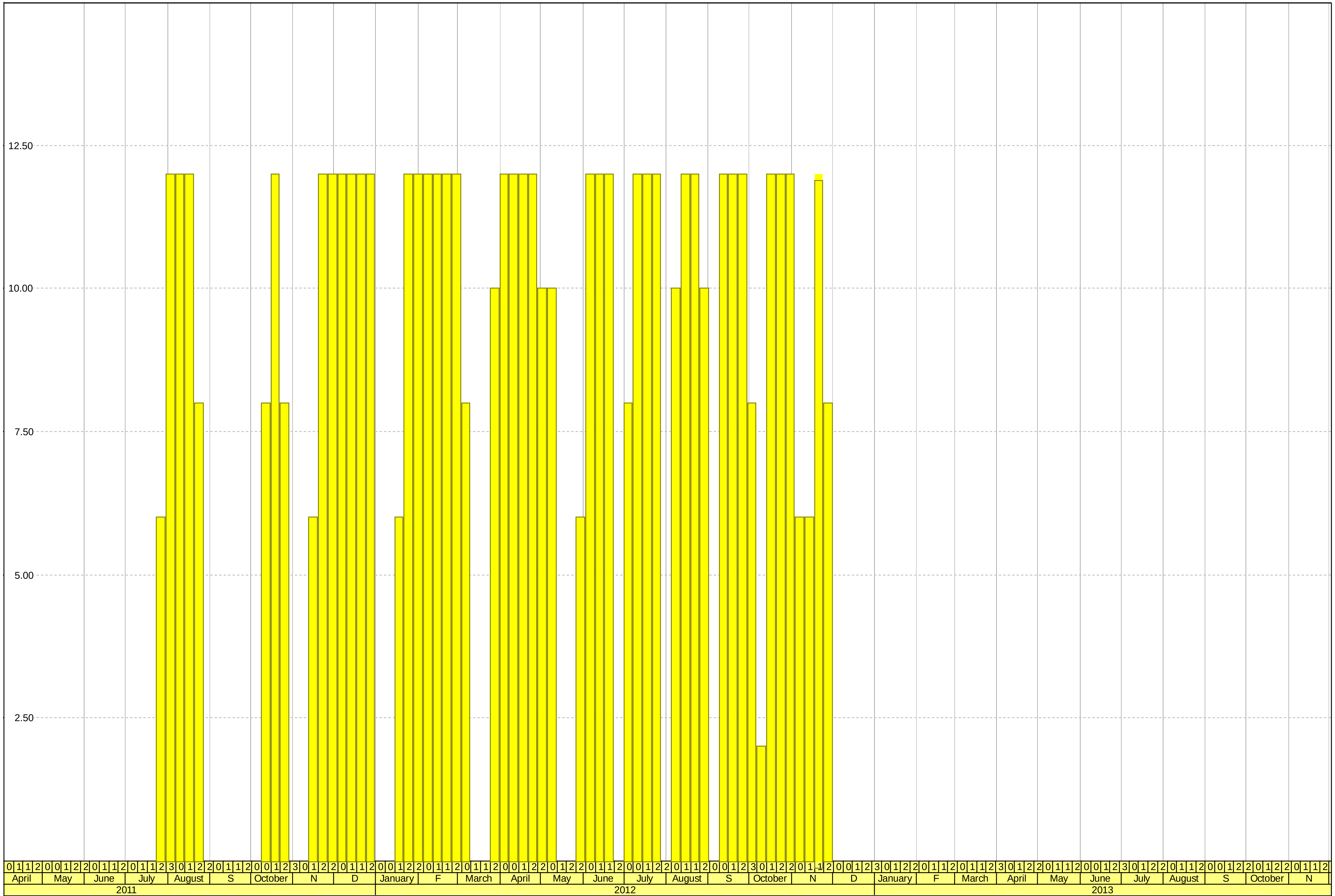
Budgeted Units

Fig. 6 Resource Helper

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project



Budgeted Units

Fig. 7 Resource

Foreman

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project

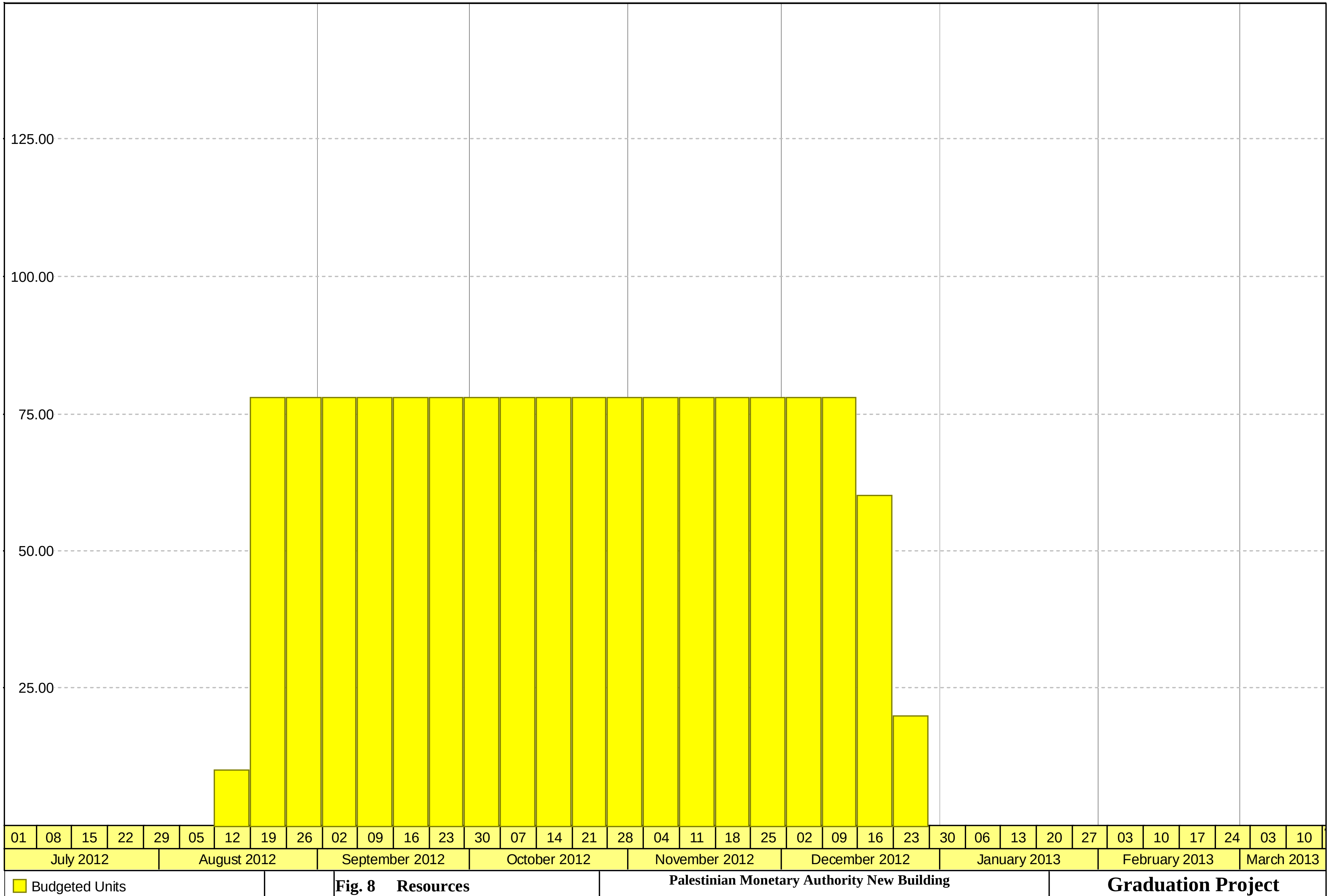


Fig. 8 Resources **Block mason**	**Palestinian Monetary Authority New Building** **AL- Ersal Street in Ramallah**	**Graduation Project**

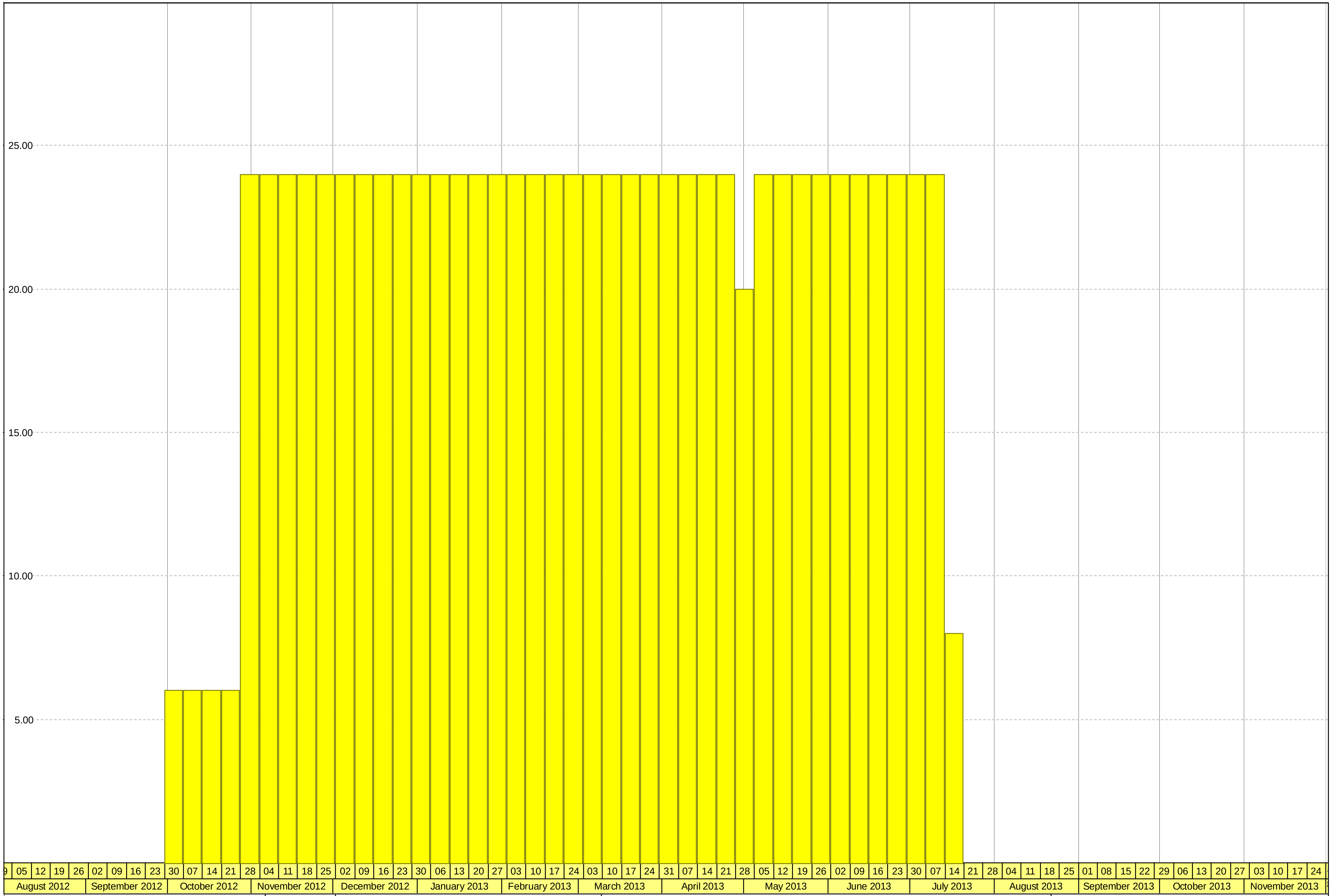


Fig. 9 Resources

Plaster mason

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project

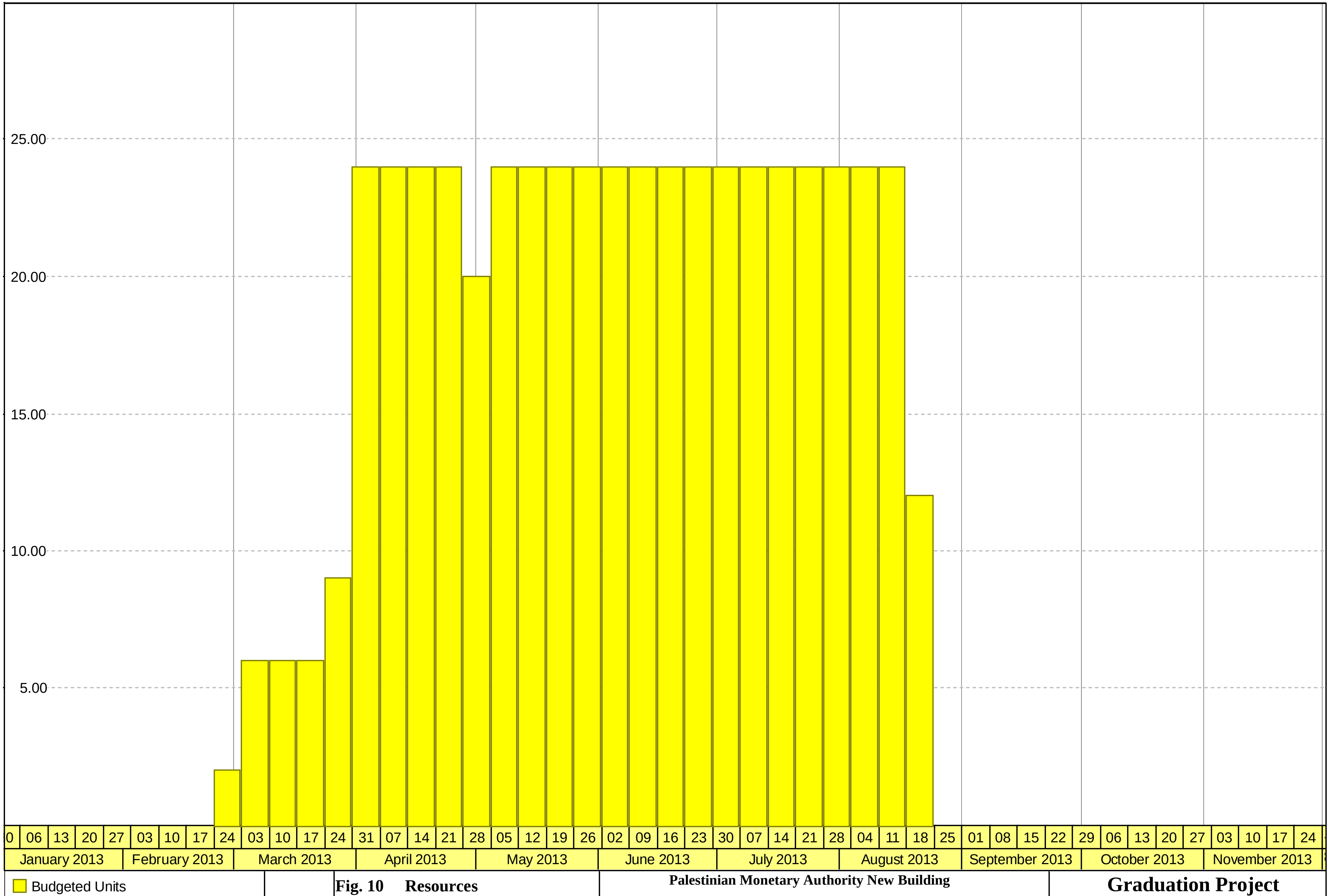


Fig. 10 **Resources** **Tile mason**	**Palestinian Monetary Authority New Building** **AL- Ersal Street in Ramallah**	**Graduation Project**

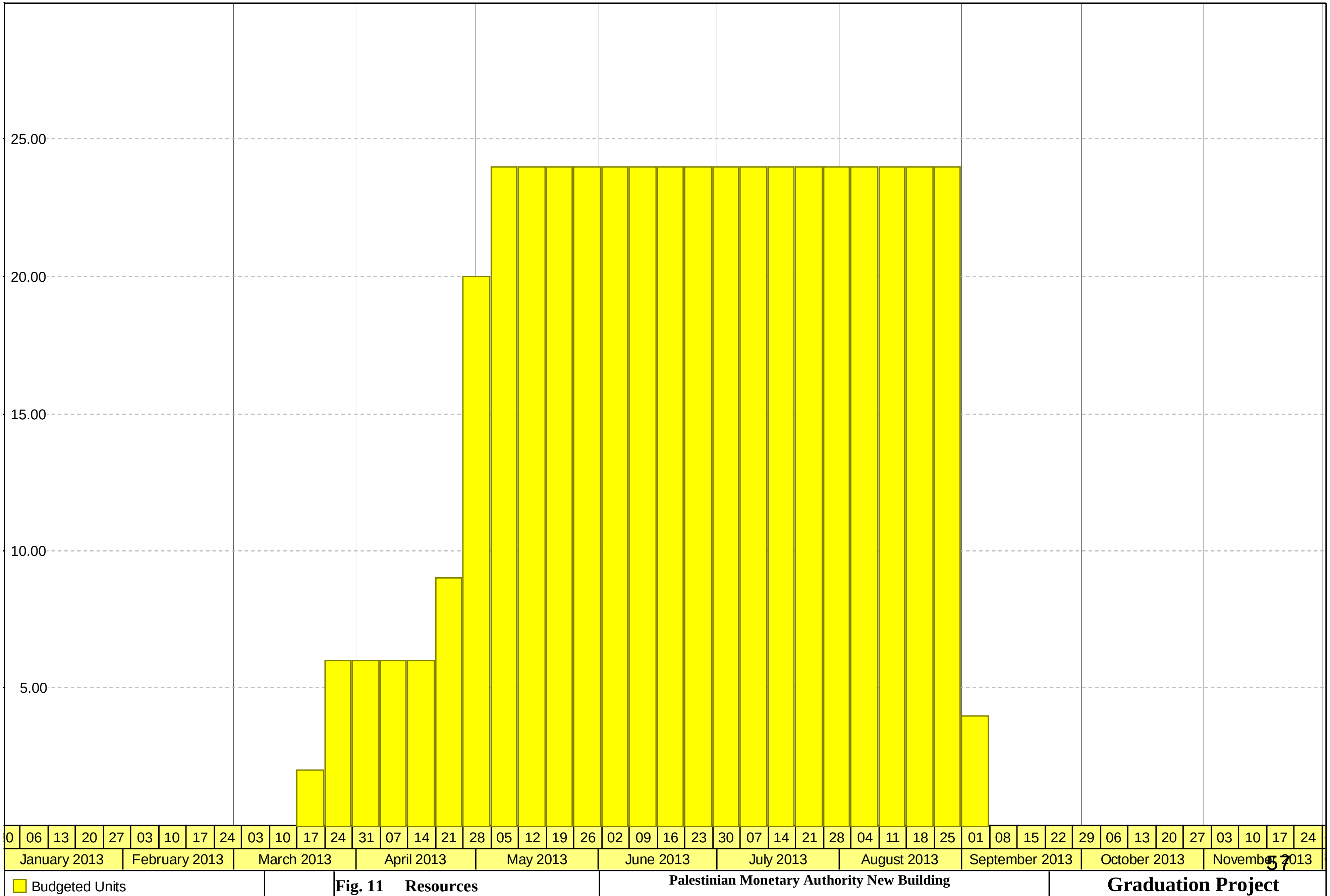


Fig. 11 Resources

Paint mason

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project

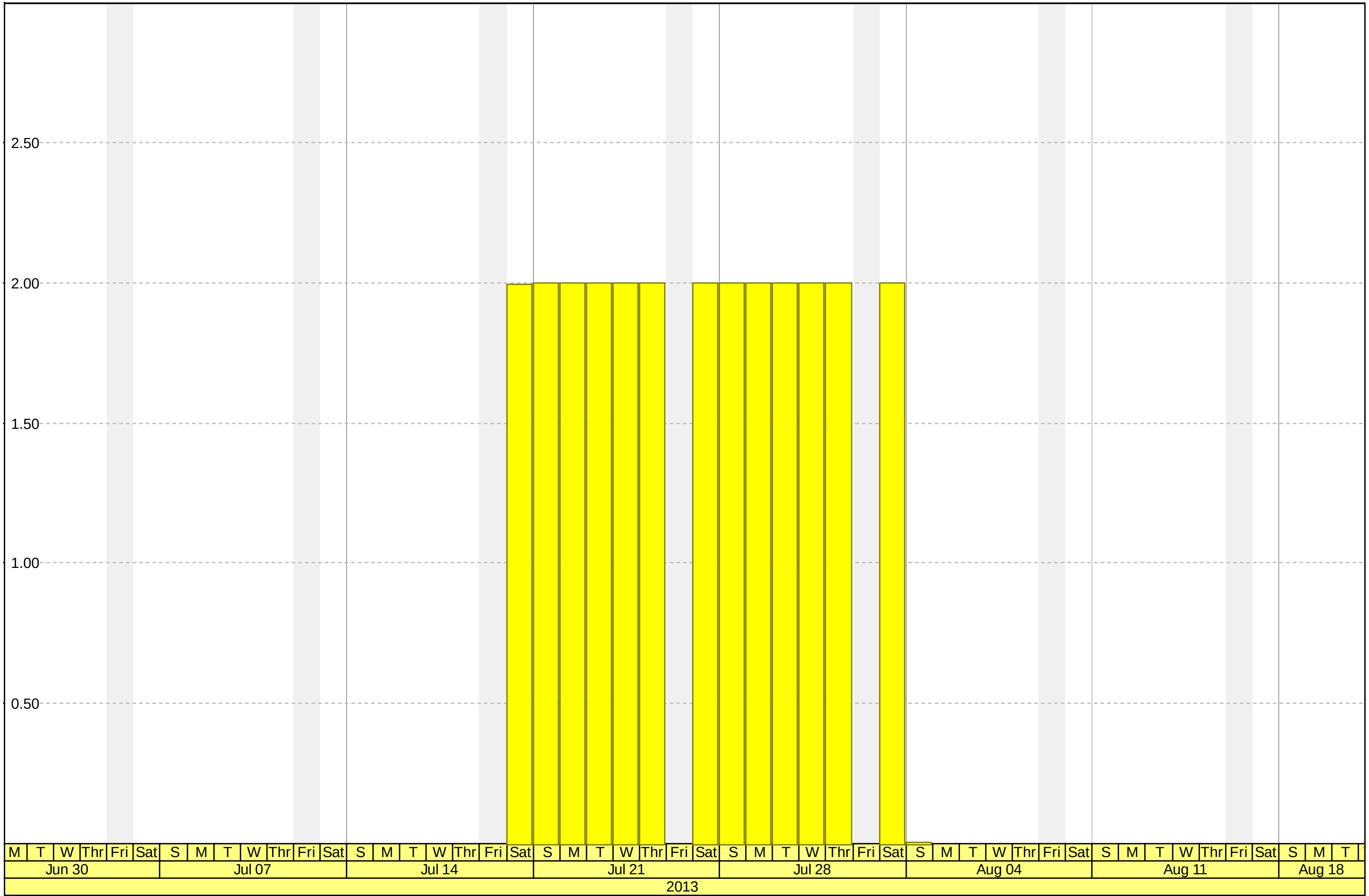


Fig. 12 Resources

Widows mason

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project

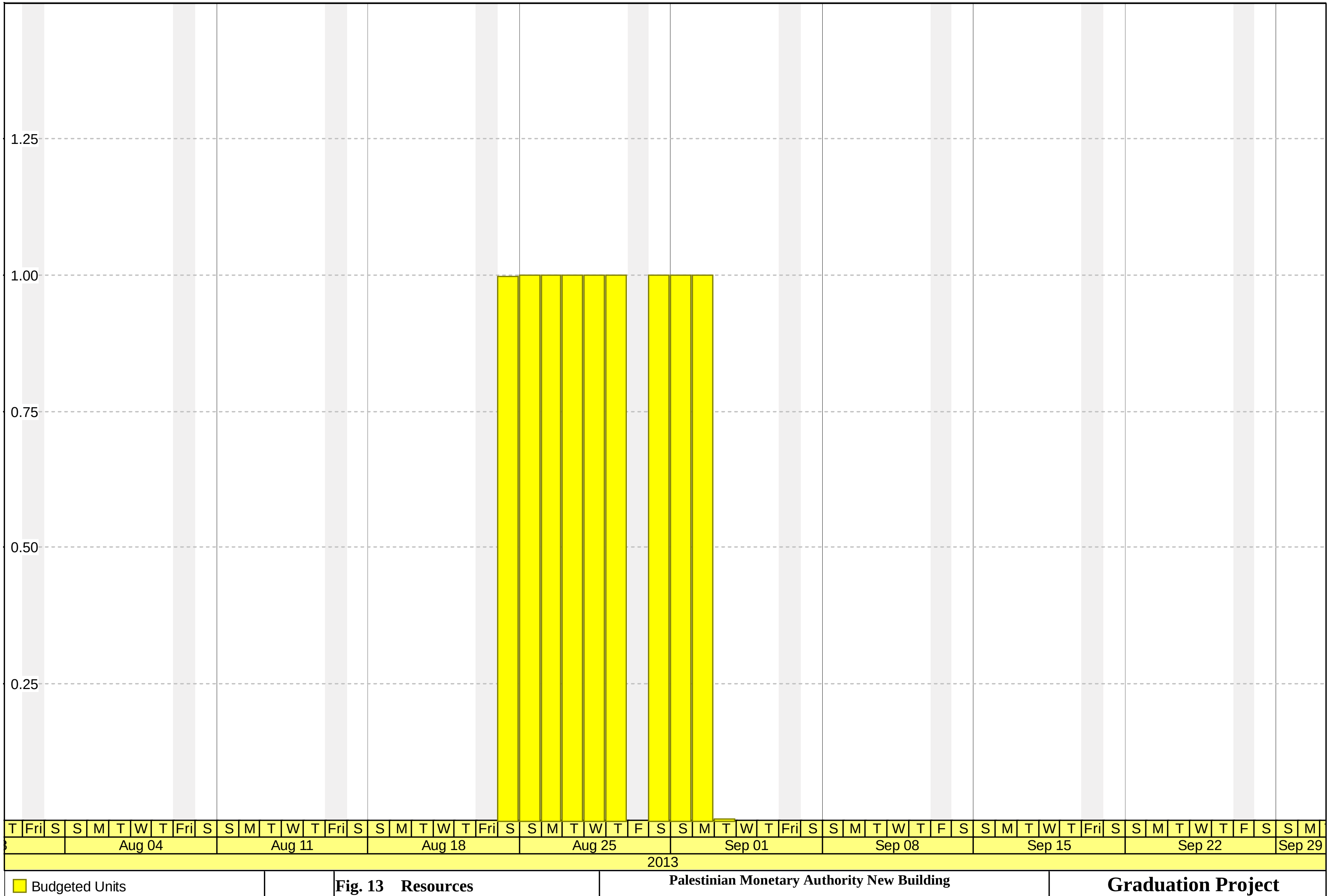


Fig. 13 Resources

Stair protection mason

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project

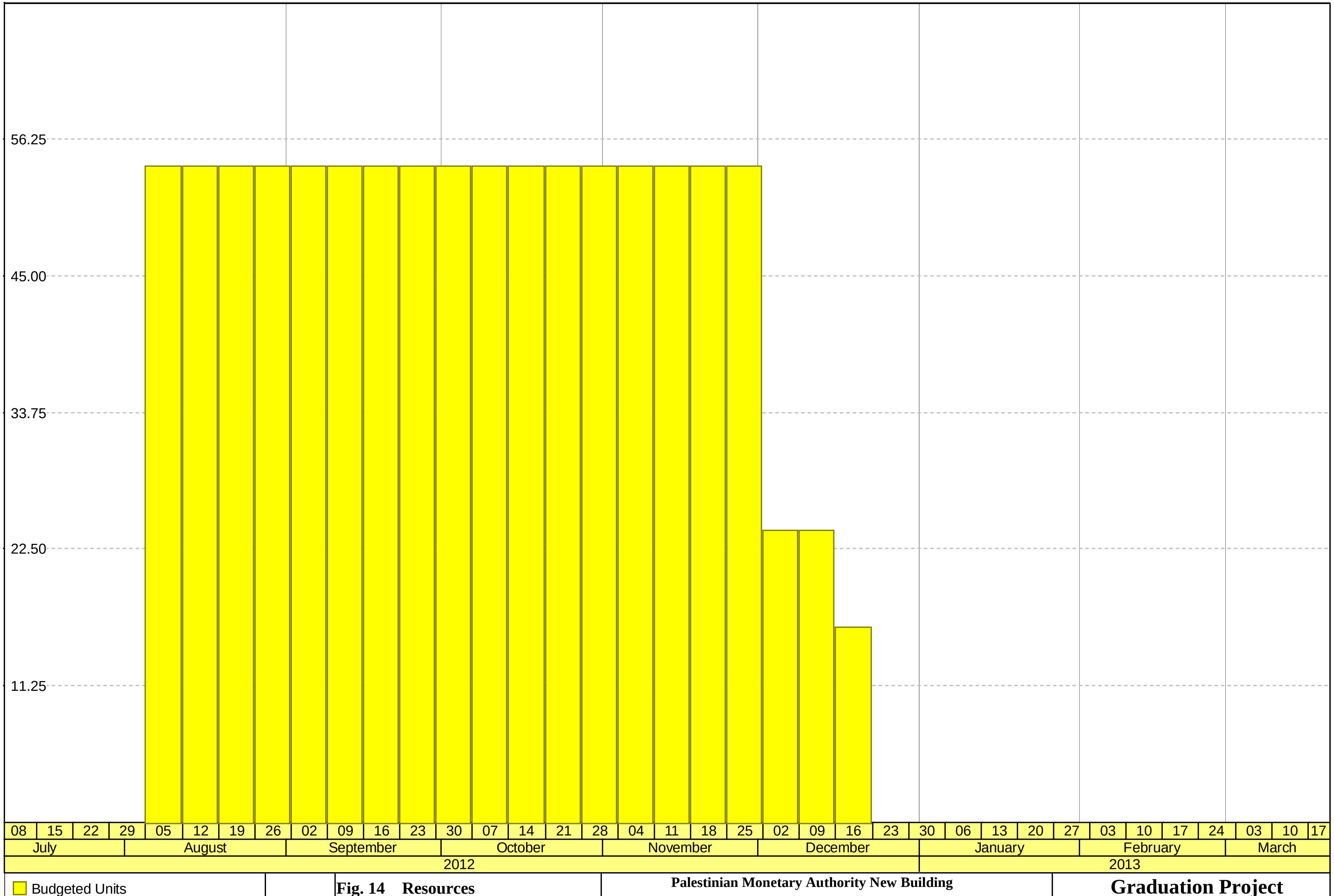


Fig. 14 Resources

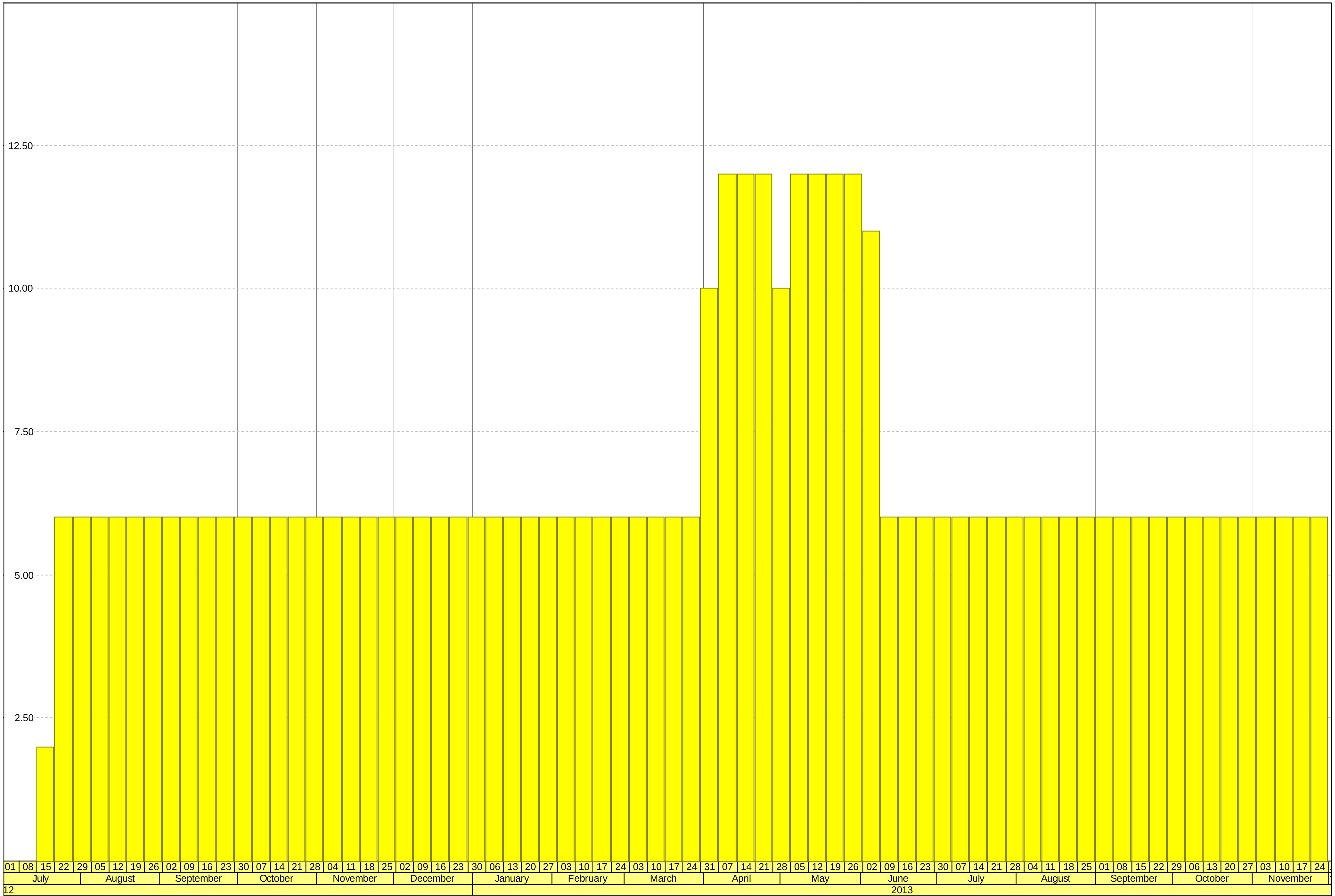
Stone mason

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project

Fig. 15 Resources **Electric Team**	**Palestinian Monetary Authority New Building** **AL- Ersal Street in Ramallah**	**Graduation Project**



Budgeted Units

Fig. 16 Resources

Mechanic Team

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project

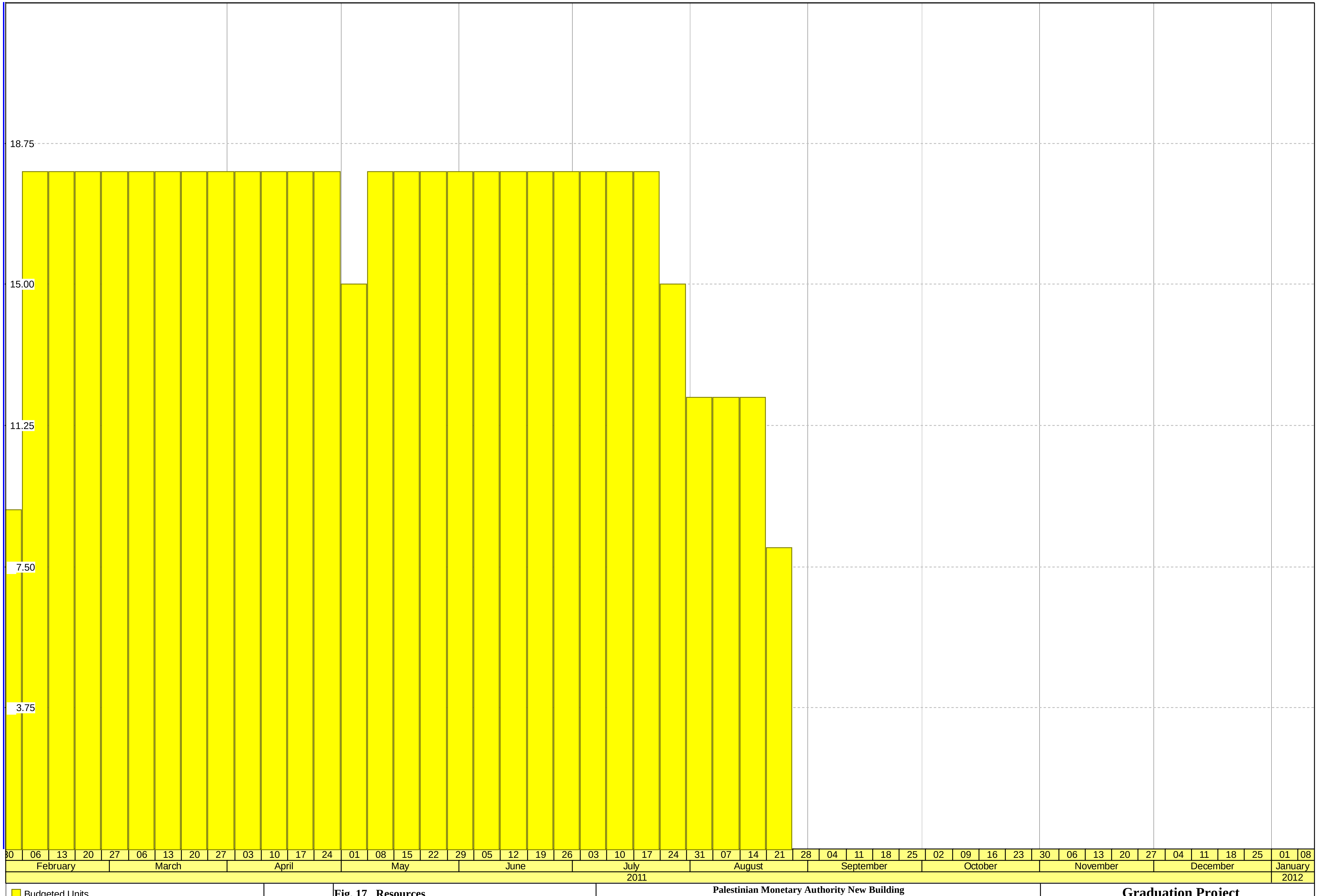


Fig. 17 Resources

Excavators

Palestinian Monetary Authority New Building

AL- Ersal Street in Ramallah

Graduation Project

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