

ATILIM UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCE
DEPARTMENT OF BUSINESS ADMINISTRATION
BUSINESS ADMINISTRATION MASTER'S PROGRAMME

**COMPARISON OF CPM, PERT AND FUZZY NETWORK ANALYSIS
METHODS IN CONSTRUCTION PROJECT MANAGEMENT**

MASTER'S THESIS

Omar Alhachami

Ankara, 2017

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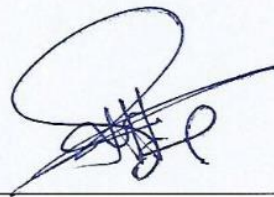
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Omar Alhachami

ÖZ

[Alhachami Omar]. [İnşaat Projesi Yönetiminde CPM-PERT ve Bulanık Ağ Analiz Yöntemlerinin Karşılaştırılması]. [İşletme Yüksek Lisans Tezi Ankara, (2017)].

Bu çalışmada, Fuzzy mantık teorisi ve inşaat projelerinin yönetiminde PERT teorisi uygulanmıştır. Yukarıdaki teoriler kullanılarak ve uygulama sonuçları karşılaştırarak, Irak Cumhuriyeti Elektrik ve Elektronik Bakanlığı, Eğitim ve Geliştirme Dairesi bünyesindeki elektrik eğitim merkezinin inşaat projesinin deneysel sonuçlarına dayanan bir uygulama yapılmıştır. Fuzzy mantığının projelerinin planlanması, özellikle inşaat projeleri, bu proje faaliyetlerinin değerlendirilmesi ve başarıyı etkileyen faktörlerin; iş ve başarı ile doğrudan ilişkisi olan etkilere bağlı olarak önemini açıklanmaya çalışılmıştır.

Anahtar Kelimeler: Proje yönetimi, Şebeke analizi, CPM tekniği, PERT tekniği, Fuzzy mantık, Babil Elektrik Merkezi Projesi.

ABSTRACT

[Alhachami Omar]. [Comparison of CPM, PERT and Fuzzy Network Analysis Methods in Construction Project Management]. [Master Thesis in Business Administration Ankara, (2017)].

In this study applied the theory of Fuzzy logic and the theory of PERT in the management of construction projects. An applied study based on the experimental results of the project of building the electricity training centre in the city of Babylon, Training and Development Department, Ministry of Electricity, Republic of Iraq, by using the above theories and comparing the results of the application. Explain the importance of Fuzzy logic in the scheduling and planning of projects, especially construction projects and evaluation of project activities and factors affecting the achievement depending on the effects that have a direct relationship to the progress of work and achievement.

Keywords: Project management, Network analysis, CPM technique, PERT technique, Fuzzy logic, Project of Babylon Electrical Center.

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INTRODUCTION

Organizations and companies in general, aim to increase production, reduce costs and raise the level of quality in order to increase profits and to ensure that they meet the needs of customers. These organizations and companies must have a continual development to achieve their aims. Any development needs a plan, and this plan needs proficient persons.

The planning of major changes in projects is very different from daily production planning, and controlling the production plan differs from controlling the project plan. These differences happen because any company has ongoing productions throughout its life cycle or throughout the production life, so when any error appears during the production cycle, it will be corrected. The differences can be determined by testing the quality of the previous products in order to find proper ways to improve the future products. The production control system can lead to find out the possibility of saving time and money when these changes fulfil, they will lead to saving time and money in the future. But changes rarely happen with projects because projects are usually achieved only one time so changing the factory place or making a new production line or making another park rarely happen. In this case, projects must be properly planned as much as possible from the beginning because schedules rarely have the opportunity to repeat a similar project and to take advantage of past experience.

A project is a large combination of small works or activities which are related to each other in some way. Some of these partial activities must precede the others, for example; the first phase is making the basis of building, the second phase is creating the structure and the third phase is putting the roof. So project planning means scheduling these activities in a way leading to achieve them in less time and less cost and without interference between them. Previously, the Gantt chart was the usual way of planning large and complex projects. But Gantt chart provides only an overview of the plan and its progress because it is unable to clarify details of the various relationships that exist

between the plan activities, for this reason many methods of networking charts were developed since 1957 and they were used for planning and controlling various large projects. One of these methods is Critical path Method (CPM) which is used, to some extent, in projects to determine the times of various activities accurately. The other method is Progressive Evaluation Review Technique (PERT) which means program evaluation and review technique. It is considered as one of the best-known methods of networking charts. It has been developed by estimating indicators of probability distribution using the theory of Fuzzy sets which studies the effects of qualitative factors: climatic conditions, labour ...etc. on the project activities. There is a new calendar chart technology review (GERT). It subjects to the distribution of certain probabilistic of not required project activities. The advantage of this technique is making inverse links between activities and network. This study clarifies the methods and techniques of project management, and it deals with network analysis techniques using in construction of the buildings of the Babylon electricity training centre, training and development department, Iraqi ministry of electricity.

The Systematic of Study

1. The reasons for choosing topic

There are several reasons for choosing the topic

- Problems faced by most of the projects, especially the delay of achievement which causes to disable the reconstruction movement in all sectors in my country (Iraq), especially very large projects.
- Indicate the importance of using network analysis in achieving projects.
- The Special field of research work, when we used a specialist staff to follow up the work of the project on the financial side, we noticed that there was a total absence of such methods by the contractor and a total ignorance of the existence of such methods.

2. The importance of the study

- Knowing the role of network analysis in making a decision of planning and controlling the industrial and service institutions.
- Clarify the extent of using modern technologies in project management .
- Clarify the concept of project management and deepen in this field.
- The importance of the study represented to the extent applicable of the construction sector.

3. The aim of the study

- Explain how to use network planning methods scientifically in the planning and control process in projects in general and construction projects in particular.
- Deal with the problem of wasting time and the problem of implementation delay that causes higher costs in construction projects, by estimating the time of completion in a scientific way.
- Put a logical sequence for the implementation of construction projects activities and dealing with the mess in the achievement process.
- Monitor the implementation of the project which consists of several stages, and identify the processes that must be placed under continuous supervision because it may break down the whole project.
- Knowing the modern technologies in project management.

4. The problem of the study

The network planning techniques play an important role in planning, organizing and controlling the process of completing projects, that is, follow-up project implementation process, detect deviations crisis and take action on the appropriate time. The problem of the study can be solved by these techniques.

- ❖ To clarify using network planning in project management technique we can ask the following questions:

- Is there a difference between the actual time and the estimated time when the network analysis PERT is used?
- Is there a difference between the actual time and the estimated time when the Fuzzy logic is used?
- How do we get rid of the difficulty of achievement resulting from the non-implementation of activities in accordance with the sequence of precedence?

5. Hypotheses of the study

- There is no statistical difference between the average time estimated to finish the project in the style used by the contractor and its actual average time.
- There is no statistical difference between the average time estimated finished the project by using (PERT) technique and its actual average time.
- There is no statistical difference between the average time estimated finished the project by using (Fuzzy logic) technique and its actual average time.

6. The application of the study

The study sample is the construction and equipping project of Babylon Electricity Training Center. It is one of the administrative units of the training and energy researchers office in the Ministry of Electricity of Iraq. This project constructs buildings and equips equipment and supplies requirements for the training of the staff of Ministry of Electricity in the city of Babel and its neighbouring cities in the centre of Iraq.

In this study, we will explain in the first chapter the importance of management, especially the management of projects and important processes within this administration. In the second chapter, the definition and explanation of network analysis processes and the most important theories used for the networks analysis of enterprise CPM, PERT, Fuzzy logic, and in third chapter the application of theories of network analysis PERT and Fuzzy logic of the construction project Babylon Electricity Training Center / Training and Development Department / Ministry of Electricity / Republic of Iraq. Comparing the results of the application and finally summarizing the results obtained through this study.

FIRST CHAPTER

PROJECT MANAGEMENT

1.1. Theory of Project Management

The economic and commercial movement in the world is constantly evolving. In order to cope with this development, there is a need to understand the scientific, administrative and commercial systems that control the organization and conduct of the economic and commercial movement. One of the important topics in this field is the establishment of projects. To understand the processes of establishing projects and ways of controlling them, this study clarifies the important and necessary processes that fall under this subject. The project management must have three major actions. The first one is completing the project according to the required specifications. The second is using the fastest means to complete the project. The third is achieving the project at the lowest possible cost taking the above factors into consideration. The process of combining the above factors is difficult because it requires a staff with highly theoretical and experimental experience in project management. In our time, the economic projects are complicated and entangled, and they are influenced by several factors which may make it impossible to complete the project process and thus lead to project failure.

1.1.1. The project

There are many types of projects, for example: establishing a building or a factory, producing a new product and cultivating a land. Achieving success on the current level of the project is an important and essential factor in improving the performance of organizations especially when the project aims to satisfy the customer needs or when it is related to a strategic bet of the organization such as new product development and restructuring. So the project must have a special management goes with its requirements and quality during its sequential life cycle. The project management institute provides the following definition:

A project is an attempt to create a unique product, service, or result. Like most organizational effort, the major goal of a project is to satisfy the customer need. Beyond this fundamental similarity, the characteristics of a project help to differentiate it from other endeavours of the organization (Gray, 2011).

The project is a temporary attempt to create a unique product, service, or result. The temporary nature of projects indicates specified beginning and end. The end comes when the project objectives have been achieved (A Guide to the Project Management Body of Knowledge, 2008).

The project is a series of organized events. It has specified beginning and end. This series of events aims to create a unique product which is required by the project. It is a unique process consisting a set of coordinated and controlled activities, with start and end dates. It aims to achieve an objective conforming to specific requirements including constraints of time, cost and resources (Wren, 2003).

The project is a vesicle of economic, technical, and social priorities in the organization. It is a temporary management system which structures the basics upon which the design, development, manufacture, and marketing of a new product depend. So it requires the participation of members who come from different professions and they work to achieve a goal (Hugues, 2001).

Each project has a manner to determine goals according to its own requirements.

Figure 1: The project vision shows simply the project vision.



Figure 1: The project vision

Source: Hugues MARCHAT, KIT de conduit de project, Editions d'organisation, Paris, 2001, P23.

1.1.2. Project properties

According to the Project Management Body of Knowledge (PMBK 2008), the following characteristics can be concluded:

- 1- **Timer:** it means that each project has specific beginning and end. The word “temporary” is not applicable to the project production and service because most of the projects are founded for the purpose of producing a continuous outcome.
- 2- **The result of service or unique product:** the uniqueness is one of the important characteristics of the project deliverables. For example, the development of many thousands of buildings and factories but each one has unique devices and facilities. It has a different owner, a different design and a different contractor. We refer here that there are duplicate elements cannot change the uniqueness of the project work.
- 3- **The sustained reduction:** it is the project characteristic which combines the “timer” and “uniqueness” concepts. The sustained reduction means improving the steps and increasing the development continuously.
- 4- **Project node:** It means the problems which the project faces during its life cycle. The main problem that can happen is the dispute between the project members. The planning, coordination and organizing are the most important factors that help to eliminate these problems.

1.1.3. Project life cycle

Each project has a life cycle. It may not be documented and it may not be understood, but there is a sequence of stages during which the project goes in search of its goal. This cycle is shown in [Figure 2](#) usually has roles such as the study, implementation, and operations.

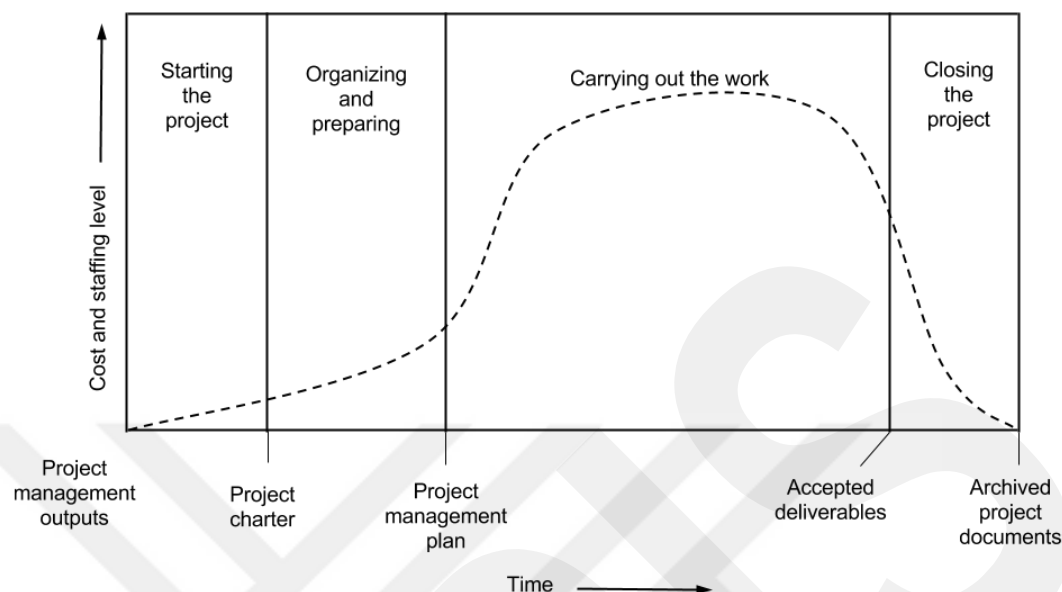


Figure 2: Typical cost and staffing levels across the project life cycle

Source: Imagine Project Management (Kaven, 2005)

1.1.4. Project risk

The risk is the possibility of happening a dangerous thing as a result of the unexpected process due to the uncertainty of the process conditions. This uncertainty due to the multiplicity of variables which enter the process. Scientists and researchers described the process of the construction industry as a multivariate and changeable process during the stages of implementation.

So it is important to know the project risk by studying the project risk management. The project risk management includes the processes of planning, determining, analysing, responding and controlling the project management. Most of these processes are updated during the period of project accomplishment. The project risk management passes through several stages (Michael, 2005):

- ❖ Risk identification: it identifies the expectable risks which can possibly affect the project and document properties of these risks.

- ❖ Risk Measurement: it means risk assessment and its interaction with the project and outputs.
- ❖ Responses development: it means determining the reinforcing the steps of response to turn away these risks.
- ❖ The control in preventing risks: it means controlling the change of risks during the project period (Duncan, 1996).

Figure 3 (Guide to the Project Management Body of Knowledge, 2008) gives an overview of the operations of the project risk management and of the followings:

- ❖ Plan risk management: it is the risk management methodology report and the planning and implementation of the project.
- ❖ Identify risks: identifying risks that may affect the project with the registration of properties.
- ❖ Perform qualitative risks analysis: it is a prioritization of risks for further analysis or its actions on them through evaluating the probability of risk occurrence and its impact.
- ❖ Perform quantitative risks analysis: it is the digital analysis of the impact of well-known objectives overall project risks.
- ❖ Plan risk responses: It is to develop options and procedures opportunities and to minimize the factors which threaten the project goals.
- ❖ Monitor and control risks: It follows the known risks and it monitors and identifies new risks. It also achieves risk response plans and evaluating their effectiveness throughout the project life cycle.

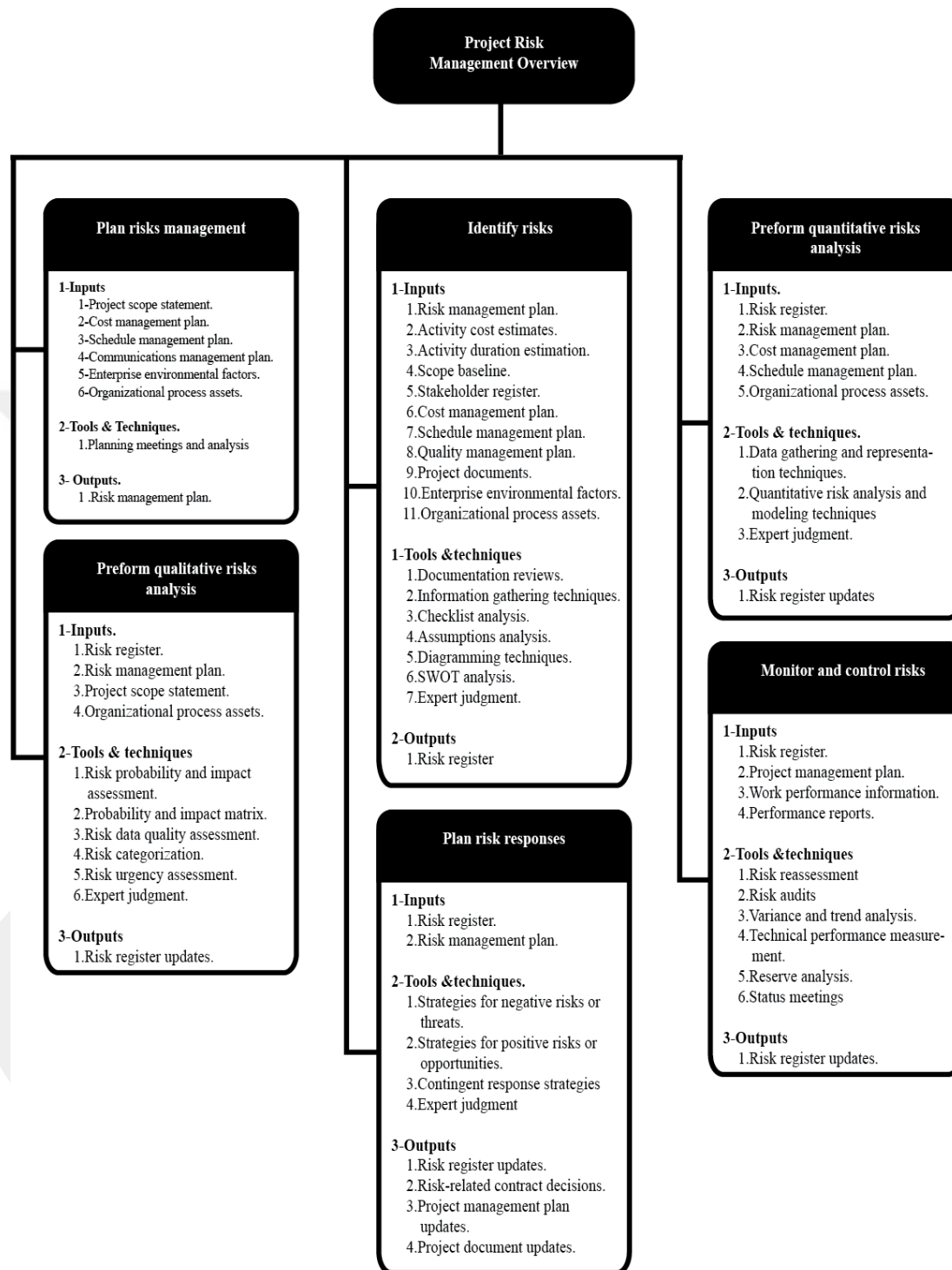


Figure 3: Project Risk Management Overview

Source: (Guide to the Project Management Body of Knowledge, 2008)

A project risk is an uncertain event or condition. It may leave a positive or negative impact on one or more than one of the project goals such as time, cost, quality and scope of business, when the goal of the project is that the delivery must be according to the agreed timetable and also according to the limited agreed cost. The risk may have more than one reason and when it happens, it may have more than one impact.

For example, one reason may be the need of getting a permit for the performance graph work or having a limited number of members who work in the project design. The risk is that the donor of the permit may take more than the planned time of permit issuance, or that the design team is incompetent. If one of these conditions happens, it may influence the project cost or its timetable. The risk condition may include the organization or project environment which can participate in the project risk such as weak project management or the lack of integral project managements and various projects, or depend on external workers who cannot be under control.

The success of the projects is related to each step of this project, from the idea to the achievement and finally the improvement and development. It is important to meet the increasing requirements and the development of projects through a complete service system and creating diverse and sophisticated mechanisms to provide these services. And this thing can be approved by using an effective management of the project planning, organizing, scheduling and control. All of these information have been mentioned in this chapter.

1.2. Concept about Project Management

The development of the project concept in the field of Institutions Department is the most significant event that marked the end of the twentieth century. Despite the idea of the project belongs to the old ages, but the main appearance of the project management concept was in 1950 when a project team was established between air factory MC Donnell Douglas and the US military. And then the project management concept has many developments. (Wren, 2003)

1.2.1. Management concept

A management is a fundamental factor in the propulsion of human affairs. It distinguishes a human being from other living things. When a person needs to arrange his and his family's affairs he must put the management in an organized process. Also, the small institutions and large organizations must put the management in an organized process to achieve their goals. The society needs a process to meet the requirements of its organizations and individuals. All of that can be achieved by the management which can achieve the goals of society and organizations.

There are many definitions of management, including the followings:

Management is the activities which are founded to achieve a number of objectives. So the optimistic time (a) use of materials depends on the various ways and methods of efficiency and effectiveness. These methods can be described by management as a process consisting of some functions which are trained by the director of the organization. So the management of planning, order issuance and coordinate and control processes aim to achieve goals at the lowest cost and the highest quality (Othman, 2007).

Management is a series of functions and processes aims to achieve specific goals. It coordinates the work of the project and organizes it. It also determines the plan of work and the final control on executive managers (Hillwa, 2007).

According to these definitions, we can say that the management has scientific and practical aspects. The scientific aspect means achieving the project according to scientific rules such as studying the time which the worker needs to take in completing the process and the time which must be taken to complete the same process. The practical aspect refers to the project processes such as the planning, organizing, coordinating and controlling. Later will explain the significance of project management to clarify the characteristics of project management duty (Baloot, 2002).

1.2.2. Project management concept

The project operation concept is one of the important concepts that is repeated frequently in economics. It is used to denote different meanings. It describes the process or group of processes that collect the available resources to achieve the goals of the organization such as planning, jobs, control and decision-making.

It describes some individuals who cooperate with each other to achieve specific and significant processes in the organization. Project management is characterized by the characteristics and advantages of the normal management of any organization. To make a project unique, it must have certain processes and measures that are necessary to meet the project requirements.

Briefly, the project managers perform the same functions as other managers. They plan, schedule, motivate, and control a project. However, what makes them unique is that they manage temporary, non-repetitive, activities to complete a fixed life project cycle. Unlike functional managers who take over existing processes. Project managers create a project team and organization which do not exist before (Gray, 2011).

The project managers face challenges and difficulties. They deal with different staffs and their managements. They work hard to meet the project requirements within the limits of the available resources. They stimulate the human resources to create useful inventions. They make a balance between time, cost and performance of the project. They take a right and useful decision.

The Guide to the Project Management Body of Knowledge (PMBK 2008) defines the project management as follows:

Project Management is the application of knowledge, skills, and techniques of project activities. It works hard to meet the customer needs and expectations from the project.

So project management uses some devices and techniques to manage projects (Newell, 2005).

The Project Management Institute defined the project management as the application of knowledge, skills, devices, and techniques of project activities. It aims to meet the project requirements. Project management is accomplished through the appropriate application and integration of the 42 logically grouped project management processes comprising the 5 process groups. These 5 process groups are: initiating, planning, executing, monitoring, controlling and closing (Guide to the Project Management Body of Knowledge, 2008).

1.2.2.1. Project propulsion

Le Project Management Institute defined the project management as the direction and coordination art of human and material resources throughout the project life cycle by using modern techniques to achieve specific goals for achievement, cost, quality, customer satisfaction, the importance of the project (Poulin, 2011).

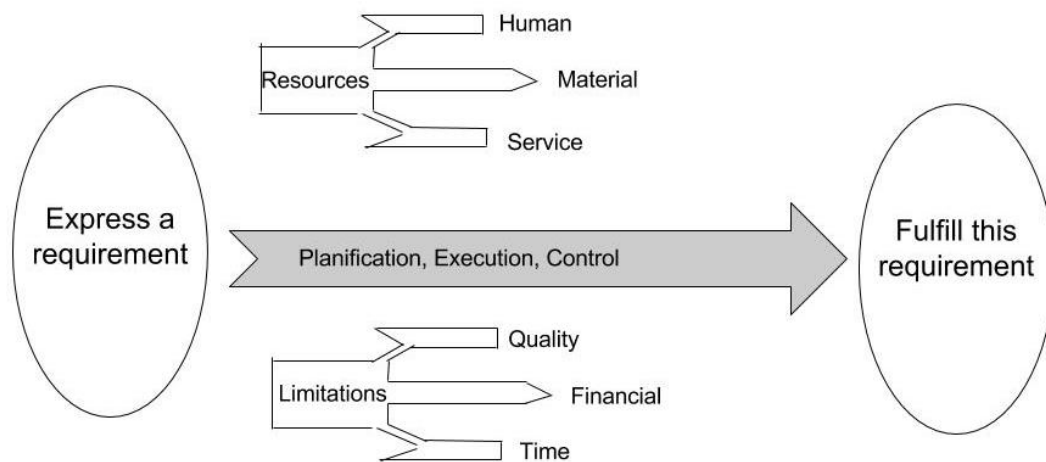


Figure 4: The Project Components.

Source: Hugues Marchat, Kit de conduit project, P 18.

Figure 4 shows that the conduct of the project is based on the conduct of optimistic time (a) human, material and service resources within the dimensions of three restrictions in order to satisfy a need or specific needs, which depends on a range of technologies and mechanisms that help the daily follow-up of the project and take practical decisions.

Hughes Marchat thought that project is based on the propulsion of assembly portions which are connected and coordinated (Hugues, 2001). And he identified this portions as the following definition:

The propulsion of the project is based on the optimistic time (a) propulsion of human, material, services resources in the range of three-dimensional restrictions in order to satisfy specific needs. It is based on some techniques and actions that help the daily follow-up of the project and take practical decisions.

Association francophone de management de projet, said that the project propulsion of some operations, rules and necessary materials to ensure the propulsion requirements, the translation and interpretation of these requirements, drafting of resolutions, and the actual implementation of these requirements. And in addition, the project propulsion system works to achieve the following points:

- ❖ Evaluate and estimate the costs of the project.
- ❖ Control costs.
- ❖ Planning and control proper time.
- ❖ Quality control.
- ❖ Propulsion of resources at the level of the process of various activities.

Project propulsion is an effective way to find the necessary information to understand the project problems, and then to find correct solutions by coordinating the various factors, all the project propulsion must be under the framework of a specific project. The style of propulsion differs from one project to another.

1.2.2.2. The properties which distinguish management from propulsion

The project propulsion represents the necessary acts to follow up the project in order to achieve success. But the project propulsion techniques and devices are not enough to achieve success when other factors were not taken into consideration. The human factor of management staffs, the stimulation system and the ideal use of competencies are the main factors to complete the project propulsion methods and system.

Then we can say that we are talking about the project management which has, in addition to the project propulsion, a managerial factor which has the following responsibilities (Decarlo, 2004):

- ❖ Setting goals and strategy and the means.
- ❖ Coordination between the various sequential and simultaneous activities.
- ❖ Control: it means the ability to change the trajectory or specific time in the case of the rapid progress of the project and in the case of the impossibility of achieving the project objectives within the agreed cost and specific time.
- ❖ Achieve perfect distribution of resources in order to reach the ideal solutions of the cost level and duration of accomplishment.
- ❖ The approval of the various practical decisions which are taken by the project propulsion.

Project management Institute defines the project management as the application of knowledge, skills, devices and techniques on the technical activities of the project to achieve the project requirements (Moselhi, 1996).

Moselhi (1996) illustrated that project management applies the knowledge, skills, devices and technical ways to the project activities in order to achieve the project requirements. The project requirements can be approved by planning, achievement, observation, control and shutdown. The project manager is responsible for achieving the project goals and the project management includes the following:

- ❖ Identification requirements.
- ❖ Setting clear goals and achievable.
- ❖ Competitive balance requirements such as quality, time and cost.
- ❖ Adaptation of specifications, plans and approach towards the concerns and expectations of many stakeholders in the project.

Dr. Hassan Ibrahim Ballout has defined the project management as some organized and directed activities which use the best suitable resources and efforts to achieve the

project specific goals by the best use of materials and the best use of active ways (Ballout, 2002).

Madres Et Clet said that the project management is based on three basic pillars. These pillars are organization, propulsion, and activation (Clet, 1997).

The organization is the identification of roles and coordination of the efforts. It requires decisions focuses on answering the following questions:

- Who does what?
- Where? When and how?

The propulsion is related to the daily follow-up of the project. It provides information about the progress stage of the project accomplishment.

The activation is related to the human element that is designed to give the assurance and kinetics of the project.

Figure 5 shows the main three pillars of project management.

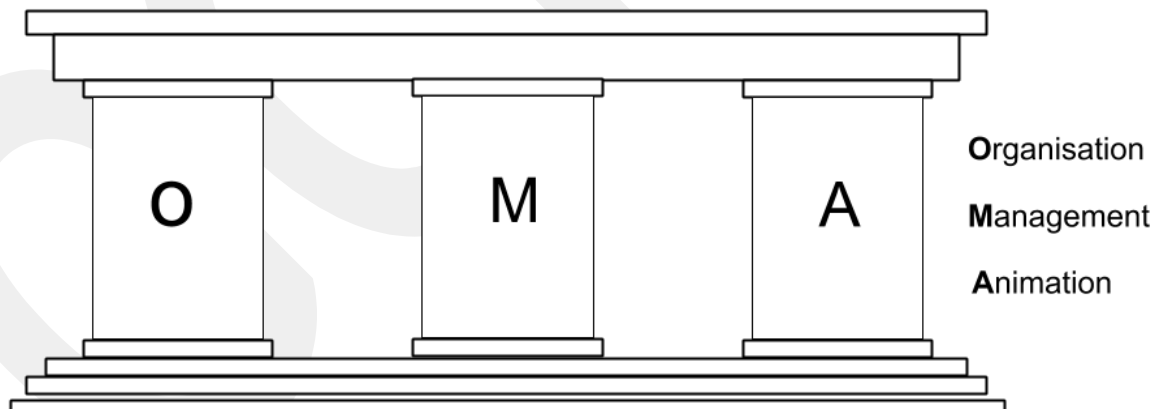


Figure 5: The three pillars of project management.

Source: Association Francophone de Management de Project, P. 8

The project management is an administrative function which includes responsibility for setting goals, organization, planning, scheduling, budget estimation, guidance, and

supervision. These elements are necessary to achieve the technical and temporary goals for the great and complicated project (Maders, 1997).

Project management is a control system that you use to achieve the correct results or goals which have been defined as a dynamic use of appropriate resources. These resources are structured in a practical way and are controlled to achieve some specific goals and strategic needs. It is noticeable that project management involves some restrictions, either software or a specific field of the existing project (Yong, 2005).

The distinction between the conduct of the project term and project management has a great importance. It gives a clear vision about the part of tasks, responsibilities and power of attorney within the project hierarchy. The management of the project is situated at the top of the hierarchy. It includes various strategic and tactical decisions which are entrusted with the following responsibilities (Gray, 2011).

- Determining the objectives of the project.
- Determining the means and various possibilities which are employed to achieve these goals.
- Analysis of various risks which the project development stage and the implementation stage may face.

The process of project management takes care of planning and setting long-term goals, and of allocating resources to achieve them. It holds the strategic side of the leading process.

The propulsion of the project process is responsible for taking practical decisions in the bottom of the hierarchy. It oversees the daily implementation for the project, and using several techniques, including techniques of arrangement and conduct resource technologies, and monitoring financial operations, especially the conduct of the project budget.

1.2.3. The project management contents

Project Management consists of a broader context that includes program management and the Project Management Office. There is often a hierarchy of strategic plan, program, and sub-project. The program consists of several interrelated projects which contribute to achieving a strategic plan.

1.2.3.1. The group and group management

The program is a set of interrelated projects that are managed and coordinated to get the benefits. They also control the projects that are managed individually. Programs include work items outside the scope of the discrete projects, for example (Yong, 2005):

- ❖ A program to manufacture a new modelled car and to design and update all its major components. This process takes place on the assembly line.
- ❖ Many electronics companies are responsible managers for programs of the individual product releases projects and the coordination of Multi releases over a period of time, an ongoing process.

The program management can be defined as exploit project management and operations lurking in a set of nested project management effectively and structurally. They structured to achieve goals clearly defining objectives which serve as strategic demands.

Comparing Project Management with program management, it is the central management coordinating group of projects in order to achieve the strategic objectives of the program and its benefits.

1.2.3.2. Portfolio and portfolio management

A portfolio is a group of projects or programs that work together to conduct effective management in order to achieve its strategic business objectives. It is not necessary that the projects or programs have to be interconnected to the clipboard directly. They can allocate the funding and support on the basis of the categories of risks and benefits or specific or general types of projects. These are infrastructure which improves internal goals.

Organizations manage portfolio based on specific goals and objectives of management of portfolio which increase their value to the upper limit by the slow examination of the projects and programs. The candidate should be connected to the clipboard to get rid of projects that do not meet the strategic goals of the portfolio at the right time. There is an effective use of resources to achieve other goals of portfolio balance among fundamental and growing investment. The senior managers or the senior management team holds the responsibility of Clipboard management organization (Yong, 2005).

1.2.3.3. Subprojects

Projects are often divided into components that can be easily managed. The sub-projects or their preferred components are often assigned to contract the external organization or to other functional units of the company executing the project, for example (Moselhi, 1996).

- ❖ Sub-projects based on the project process, such as single-stage in the project life cycle.
- ❖ Sub-projects include specialized technology such as automated test of computer software in a project to develop a program.
- ❖ Sub-projects according to the requirements of human resources skills, such as the plumbing workers, the electricity required for construction projects.
- ❖ Very large projects can be sub-projects that contains a collection of smaller sub-projects.

1.2.3.4. Project management office

Project management office is defined as an organizational unit to centralize project management and to coordinate under the scope of work that can be referred to the project management office. The Program Management Office oversees the project or program management, or a combination of both offices in connection with work to provide support functions to the Project Management in the form of training. Computer soft wares and standard policies are actual direct management and procedures. The responsibility for

achieving the objectives of the project can also get a certain office as a delegated authority to act as a stakeholder and key decision-makers at the beginning of the project. This process could have the authority to make recommendations or terminate projects to keep the business objectives. A Project Management Office can be shared with workers, the mutual distributors of the project and management team, if necessary as well as the personal ad item to the project.

1.3. Phases of Project Management

The rapid growth and unprecedented in the world has led to mounting pressure on government and private sector institutions to achieve their strategic goals successfully.

To achieve these strategic objectives in an integrated and coherent manner, it is necessary to carefully analyse specific tactical goals, as well to determine the responsible application of these tactics and the necessary time and cost.

To be successful for any of these goals, whatever their nature, we should find a way to ensure the coordination and unification of efforts of all the parties involved, and we must also look at the way that it exists in itself a project and needs to be a successful management to ensure the achievement of the objectives within the period specified the lowest cost and the required quality, taking into account the risks involved in this project.

1.3.1. The project planning

1.3.1.1. The concept of planning

The word "planning" one of the large-meaning words, idiomatically some consider it comprehensive that covers the range from philosophical considerations to specific accurate details. There are those who think of planning as a specific activity, while others believe it is a part of everything done by the individual, and there are those who consider planning as a synonym for the decision-making process. In addition, the expansion in the use of planning leads to the emergence of a lot of different types of planning, that made confusion (Baccarini, 1996).

Thus it is difficult to formulate an accurate and precise definition for the planning because the word planning has different meanings and concepts.

If we want to clarify the definition of the planning, we will find many books and references that contain different definitions. For Paul Danial, planning is the process of obtaining the communication, Information, thoughts, take decisions, and put explanations Mintzberg, (Danial, 1979).

And Henry Mintzbreg said: "The planning is the process look like a tool by which to design decisions and activities of the Establishment routine based on the integrated properties (Mintzberg, 1979).

Mc. Farland said: "The planning means to predict what might happen in the change and development in the future, and try to exercise control over or control the magnitude and direction of this development", which is intended so that the organization is trying to face a change expected to benefit from it and adapt with it (Dalton, 1970). The authors who believe that planning "includes a choice between the alternatives of the objectives, policies, procedures and rules specifying the means to attain them. Others believe that how and when the pre-estimation must be made.

Russell Lincoln Ackoff suggested that the planning is: visualizing desirable for the future, the design of effective means to achieve it. "The planning by Ackoff depends on the level of those responsible planners because the planning tool human judgment used, but is not used alone. When the planning managers from the lowest level set up rites that are related to the subject without leading to a desired future often appear to be impossible (Ackoff, 1973).

1.3.1.2. The principles of the planning

Each project needed to management planning operations to control and monitoring the aim of that project till reach its goal successfully (Ghenim, 1999).

❖ The flexibility

It's planning that deals with the future by what is involved in uncertainty and changing factors, which is why the enterprise admins set the hypotheses for the expected conditions and that implementation will be in the future. It may not be realized this hypothesis, which requires reconsideration of the plans on behalf of new things during implementation and appropriate modifications to the original planning. Therefore, making the planning effective depends on a large extent of elasticity" (Alaqad, 1980), this means that the principle of the flexibility plan for continuous adjustment depends on changing circumstances and on the behalf of the results of the implementation of the plan. The plan placed in a certain period of time, formulated assumptions must be audited. This kind of flexibility is the ability to edit and rectify the impact of these conditions and unexpected changes which did not take into account while doing the planning and preparation of the plan, while retaining the direction of the plan towards achieving the set goals.

Creating a very complex plan and careful drawing artificial models due to extensive planned culture and influence and the skill of the author of the decision may lead to the inability of the plan amendment, and thus to create a sense of the decision-maker to back down and aversion for that plan. Planning is necessary and certainly for any organization of any size, but on condition that if they could get rid of two trap: inflexibility and bureaucracy in negative conception.

The lack of flexibility in the planning system also made it clear than ever before - making them unable to take those changes into account as it closes on itself and become isolated self-center. Lack of flexibility leads to the second trap, namely bureaucratic institution in which the planning process is carefully monitored and may be exposed to the risk of limited and specific to certain standards and controls, which distinguishes the work of the bureaucracy, bureaucracy kills initiatives and freeze proactive and creativity (Kloppenborg, 1999).

❖ The inclusiveness

Flexibility in planning should characterize comprehensive meaning that embraces all aspects of activity in the organization that is not limited to some aspects without

the other. The existence of sub-plans for each part of the organization is linked to all parts with master planning, leading to the unification of efforts towards common general objectives. Such planning leads to the occurrence of bottlenecks and loss of balance and inability to achieve the objectives of the institution.

❖ The realism

The realism means that the plan be drawn within the limits required by the real conditions that allow the successful implementation, but this must be the availability of personnel implementation of the plan and the availability of financial resources that allow them to walk through the various stages (Cicmil, 2006).

❖ The scientific

The scientific is intended to be a planning application which is based on a full understanding of all the elements and factors that contain the enterprise perimeter that shows growth control and determines their direction and place them in the future. The planning at the enterprise level means a voluntary process aimed at drawing the organization and adjust its course to the face that is consistent with the goals. Therefore it is impossible to achieve goals without conscious understanding and in-depth analysis of the reality of this situation derived from all branches of science and scientific methods (Harold, 2013).

❖ The Continuity

Planning is an ongoing process, as that activity does not end for the planner. The planning process involves a degree of speculation or gambling because it is popular and there are variables in most areas in addition to the full facts which may not be available. Such changes and incomplete facts should be evaluated with the development plan on the basis of available information. When the plan is put into effect, the changes that occur in the circumstances and assumptions require modifications on an ongoing basis in order to avoid any situation or stalemate, it may be an obstacle to the achievement of the desired goals (Pellegrinll, 1997).

1.3.1.3. The importance of planning

The management is based on planning, as most organizations are working in changing conditions over time, and to deeply clarify the importance of planning we can redefine it as follows: “to achieve the goal efficiently, planning should be prior to physical implementation. Therefore we can say why planning is important? It can be answered through the following points (Ghenim, 1999):

- Planning determines the main purposes and aims of the organization.
- Planning defines a framework for work and helps to make decisions in the organization, and this is important because the lack of planning leads to a lack of knowledge of future risks and development opportunities, planning does not fully identify the potential risks, but at least helps to reduce these risks.

The most important variables that affect the planning function (Alselmi, 1978):

- ❖ Technological change: The level of accelerating and development in productivity operations and its effects on various aspects of the economic activity.
- ❖ A change in government policy: What is the effect of government policies on the organization?
- ❖ The change in the behaviour of the competition: the level of competitor organizations to understand the possible changes in the market.
- ❖ The general change in the economic activity: the basis of which can determine the level of changes in any country from within the environment surrounding business organizations.
- ❖ The change in the human and material resources: understand these changes enforce the planning operation.

1.3.1.4. The stages of project planning

Project planning process begins with the definition of the project and determines its goals through several operations reaching the final delivery of the project. These stages help organizations to create an integrated system in the operations of the project, and these stages are as following (Ballout, 2002):

- ❖ The phase of project definition: The start begins with serious thoughts to implement the project and specifying the need for implementing it.
- ❖ The analysis phase: It cares about studying and specifying the alternatives dysfunctional in marketing and technological fields for the project, and the results are presented. Data and maps that help you understand the process specifications are known as in this case of the completion of the buildings, the scheme of the block and the outline of the site.
- ❖ Design phase: the design is aimed at project broken into parts of the process, provided that these parts bind with one another to relate to designing administrative headquarters of the required construction. This process helps to marketing, and to the extent that a harmonious design with the program established by the beneficiary as far as offering to approve the accomplished".
- ❖ Programming phase: it is to collect the information needed to phase the previous design in the program showing the steps agreed on completion of the project is complete, at this stage of the project actually accomplished.
- ❖ The explore phase: where the actual Explorer of parts are of the project, and the interconnectedness of these parts to do the whole project phase. This aims to make sure that all the parts with matching designs and specifications are specified.
- ❖ Acceptance phase: At this stage, the beneficiary of the project is asked to disclose it and its parts are also called delivery interim phase because in the case of the reservations the adjustments are required by a person who has done.

The implementation phase: This phase of the project is used by the user, if this has been accepted as the beneficiary of this project is user, in the case of a minor errors were

noted during application process is corrected, and this, according to the contract between the beneficiary of the project is the person who did it.

The process of project planning starts with defining the project and then determines its goals through several operations until reaching the final delivery of the project. These stages aim to help organizations in creating an integrated system in the sequential operations of the project. This stage is very important because it is considered as a future planning which the project managers depend on. It finds and reaches the most important documents for the project which is the main reference for what the project has been generally agreed upon (Nah, 2001).

1.3.2. The organization of project

1.3.2.1. The concept of organization

There were many organization concepts and varied according to specialists. Many of whom consider it to determine the best conditions for the completion and implementation of the work, and after obtaining the experimental discovery of the elements of employment laws which can be applied. In all aspects of human life some of them see necessary cooperation between the members of the group, in order to achieve a set of goals and therefore, the cooperation is essential for the existence of organization workers. These workers are considered as one of the main function of management functions concerned with the identification and allocation of responsibilities, and authorities of each administrative unit with determining relations and coordination among them in order to reach the desired goals (Mazi, 2000).

To clarify the concept of organization concise words we can say the organization is to identify the necessary actions to do the necessary functions to accomplish, and includes the identification of the duties, authorities, the powers and responsibilities of the various organizational relationships and put regulatory specific form. Well, you know the process by which the building and the formation of relationships between functions personnel and physical factors are, in a way that leads to acts direct towards achieving the goals of the institution and the distribution of powers and responsibilities and coordination among

them in order to achieve the desired goals. These relationships are related to the distribution of tasks and roles in the organization and evaluation of the power that is associated with the responsibility. The administrative function, which is practised by which all managers' responsibility, and that contribute to an effective contribution to achieving the objectives of the institution (Hanefy, 1993).

According to the classical school is defined: such as the design and drafting of the structures methods, and systems, necessary to achieve the goal or specific targets in advance special conditions (Equilbey, 2003).

1.3.2.2. The foundations of organization

The organization is based on the following four pillars according to (Backendorff, 1995):

- ❖ The principle of division of labour: The division of labour leads to benefit from the advantages of specialization and also to identify the components and elements of primary and secondary, and we mean this principle segmentation the major tasks to precise and specific operational tasks in time and according to the required degree qualification. I have confirmed many of the scientists, according to this principle in maximizing machine productivity, equipment and personnel allow the replacement of any worker at any time or change to another centre without requiring its own configuration. It also allows the individual absorption assigned and gain job experience fast resulting in an increase in production volume without increasing costs.

It can distinguish between two types of divisions horizontal partitioning (functional) Representative of in the creation of jobs and business specialist on the same organizational level and partition the vertical (draft), which is characterized by adding new levels in the organization as a result of the delegation of authority by delegating people of responsibility. Their mission is limited to ensuring the continuation of work well and do coordination and motivation.

- ❖ Centralization and decentralization principle: This principle is based on determining the decisions taken centrally, and not to take a central and balancing

between them, leading to efficiency speed and flexibility of action and decision-making within the institution. Since the degree of centralization, decisions are based on the organization structure and choices taken in the field of participation.

- ❖ The principle of delegation of authority: The authority for power, passing the power to lower administrative level to enable them to perform their responsibilities better.
- ❖ The principle of coordination: coordinating the administrative efforts between different units on a subject or joint decisions which affect more than one unit, it is the integration of activities and units to take the common goal, and Considered a key element of the regulatory process, so the effective coordination depends on the existence of a joint effort and goals, and the unity of the act (Kalika, 2010).

1.3.2.3. The organizational structure in the organization

The company executing the structure of restrictions on the availability of resources within a range of functional, and to draft their diverse structural matrices see (Table 1) (Guide to the project management body of knowledge, 2004) as it shows the basic characteristics relating to projects for the main types of organizational structures:

Table 1: The influence of organizational structures on projects.

Source: Project Management Institute, Guide to the project management body of knowledge, 3rded, USA, 2004 p28

Organizational structure, Project Properties	Functional	Matrix			Project
		strong	stable	Weak	
Validity of project manager	Little or nothing	Moderate to high	Low to moderate	Limited	High
Availability of resources	Little or nothing	Moderate to high	Low to moderate	Limited	High
Who controls the project budget	Executive manager	Project manager	Mixed	Executive manager	Project manager
Project manager role	Part time	Full time	Full time	Part time	Full time
Administrative labour of management project	Part time	Full time	Part time	Part time	Full time

By (Table 1) we find that the basic characteristics of projects for the main types of organizational structures are:

Functional organization: it is an organizational tree for each employee where the head of one specific Figure 6 (Guide to the Project Management Body of Knowledge, 2004) is divided according to their specialities. For example engineers of marketing production, accounting ... etc., and that at the top level, then it can be divided into functional disciplines regulatory branches that support the work of these disciplines. For example,

engineering department is divided into mechanical engineering, electrical... and the rest of these functional groups are the other projects. However, the project scope is usually confined to the functional limits, engineering management within the functional organization of the normal work independently from the Departments of manufacturing or marketing. When ongoing new product development in the organization include only the design phase employed in Engineering Management, then if the administration manager who consults director of manufacturing is questioned on manufacturing system by the organizational structure, then the Engineering management Director will be answerable

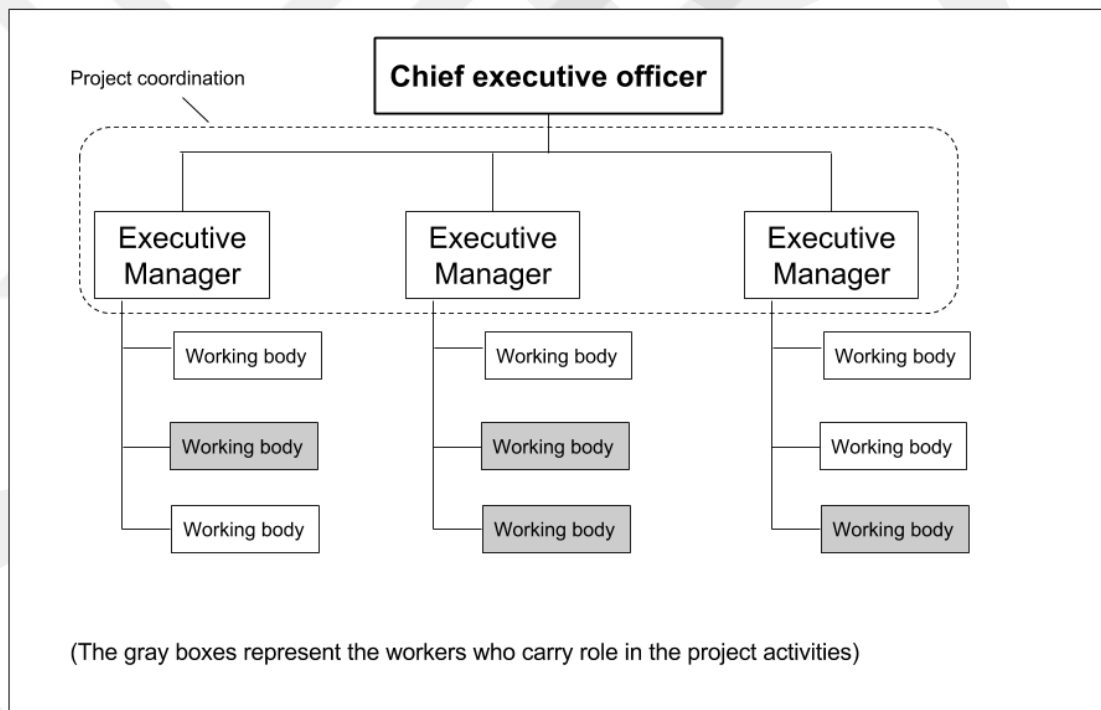


Figure 6: The functional organization

Source: Project Management Institute, Guide to the project management body of knowledge, 3rd ed, USA, 2004, p29

Regulation of the project: The division in this case-by-project see Figure 7 and have team members often mutual within the project organization, most of the organization resources and required roles in the project work, where project managers have the great

amount of responsibility and independence, and for them Multi powers, often these organizations have other organizational units have their own management, but these groups are either headed by project manager directly, or they provide support services for various projects.

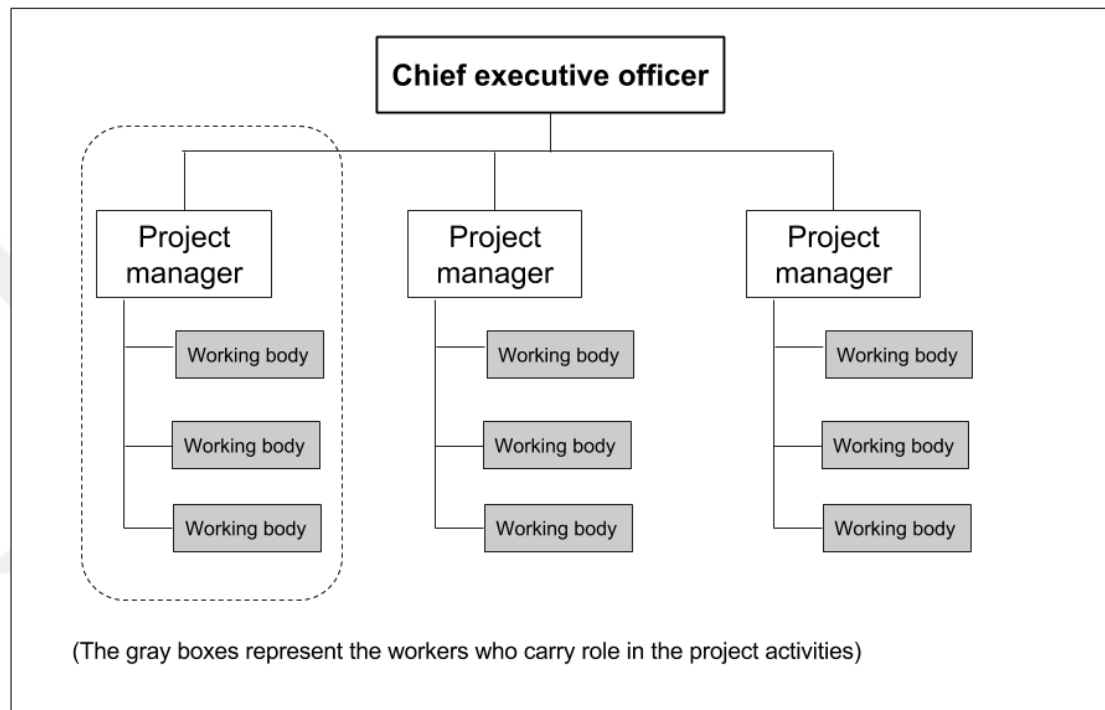


Figure 7: The project organization

Source: Project Management Institute, Guide to the project management body of knowledge, 3rd ed, USA, 2004, p30

In the Figure 8 functional characteristics of the largest and legitimacy as the director plays the role of coordinator more than a manager and an admin, and the person who controls the budget is the functional manager. The role of the project manager shall have less power than the functional manager (Guide to the Project Management Body of Knowledge, 2004).

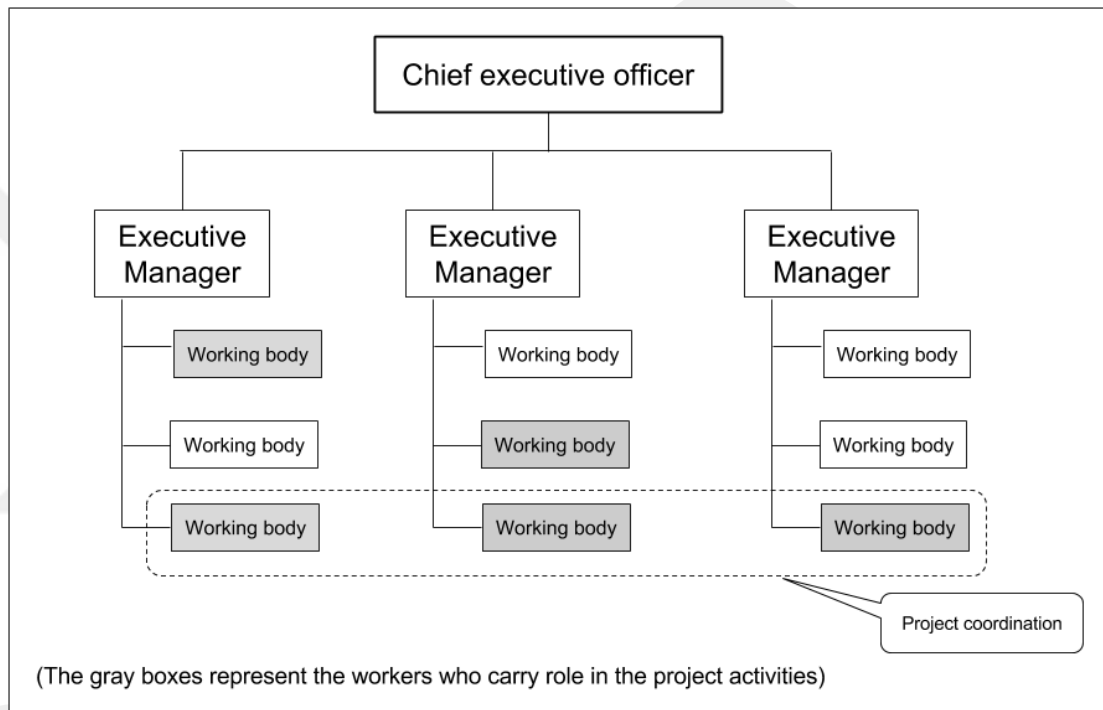


Figure 8: The weak matrix organization

Source: Project Management Institute, Guide to the project management body of knowledge, 3rd ed, USA, 2004, p30

In the Figure 9 characterized by the existence of Project Manager due to the urgent need to but the manager does not have full authority on the project and its financing process as the functional manager has shared with him the project and its financing (Guide to the Project Management Body of Knowledge, 2004).

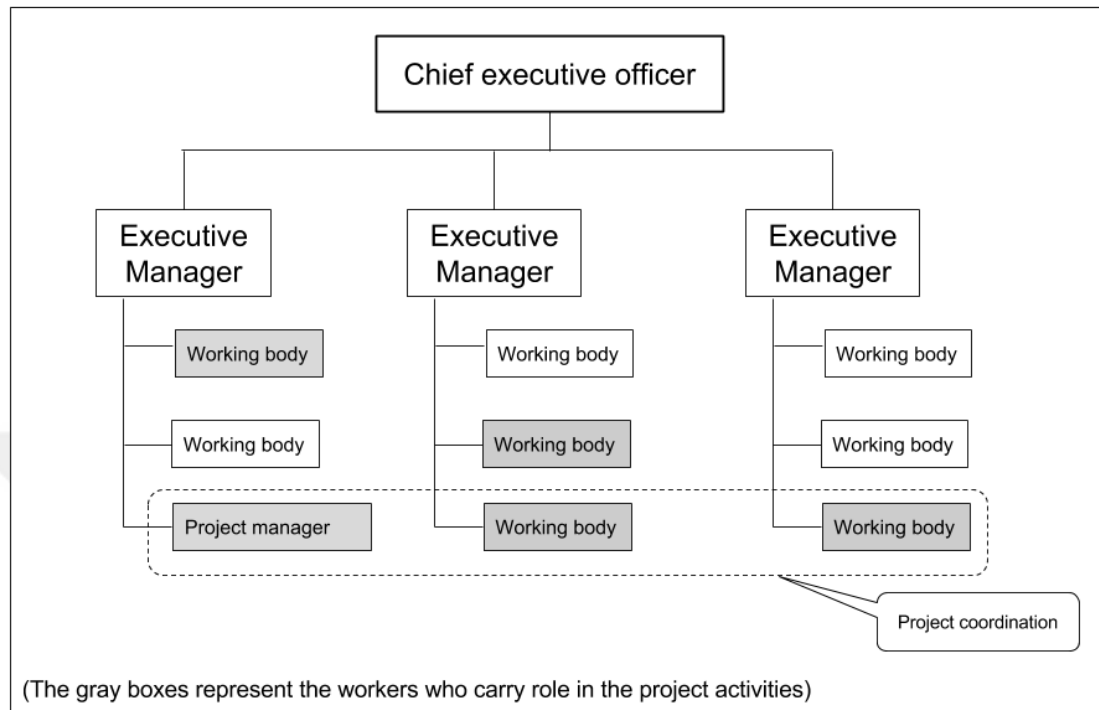


Figure 9: The stable matrix organization

Source: Project Management Institute, Guide to the project management body of knowledge, 3rd ed, USA, 2004, p30

The organization's strong matrix Figure 10 (Guide to the Project Management Body of Knowledge, 2004) it is characterized by organization's characteristics, the project larger than the functional organization as the project manager powers, saying he is the person who controls the project budget. And in some cases with the project manager, sub-managers of the units for the project and its administrative body dedicated to projects.

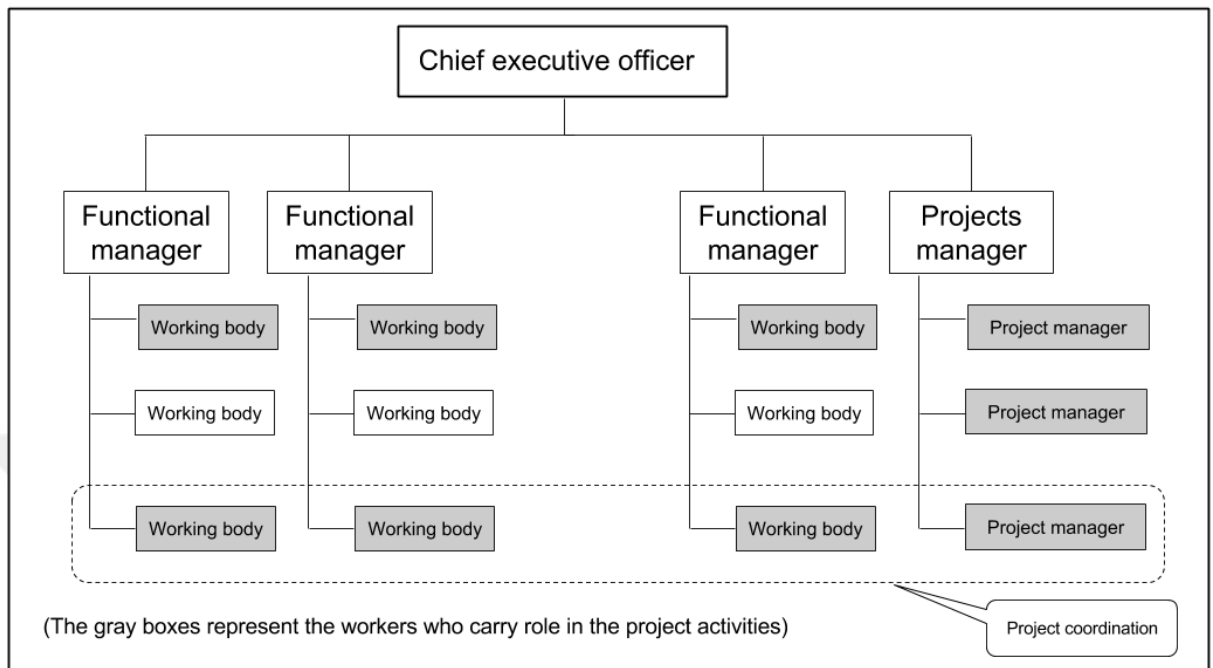


Figure 10: The strong matrix organization

Source: Project Management Institute, Guide to the project management body of knowledge, 3rd ed, USA, 2004, p31

1.3.2.4 The project team

It is the teamwork to achieve a common goal, but this definition is not enough to describe the scope of work for the project team, and it usually does not recognize work part from the teamwork, which is known as a required creative effort, for this reason, real teamwork cannot be achieved only partially.

The project team element addresses the topic of workers in the organization, and it is considered the standard for selecting of personal trends, specific qualifications and skills required for each stage in the project, and they should form the efficiency standard that includes special qualities and necessary qualifications for the selection of the main persons such as project manager, business manager, system engineer, planner, subcontractor manager, and may require management's best ways to change some of the main positions during the project progress in its session.

The effectiveness of the team on the basis of many things such as emotions, attitudes and motivation sources, and the completion of the work depends on (Kaven, 2005):

- ❖ The formation of a group capable of becoming a team.
- ❖ Create work environment for the team and preservation.
- ❖ The significant growth of the work team through leadership.

In order to ensure homogeneity between team members should develop each of the following basic elements (Najim, 2008):

- ❖ The common goals and have a clear definition of the objectives of the group and outlining for the roles and responsibilities required to achieve the goals.
- ❖ Recognition of the interdependence and mutual respect because it is necessary for the harmonious team.
- ❖ Bonuses joint is often shared recognition of all the team members that contribute is more important than the financial rewards for successful project because workers motivate to do a good job and to cooperate with each other when they trust the individual performances in addition to the team's performance, and it should be financial rewards in a fair and equal team on the basis of each center.
- ❖ The team spirit and vitality is done for the purpose of team collaboration interrelation with the culture of competition "preference-defense" held by most people through education and practical experience.
- ❖ The general behaviour rule is the common conduct for all workers and without putting differences between team members.

Most project teams fail to address these special factors. The team is adequately addressed, whereas the manager must implies and understand the rules carefully.

1.4. Project Scheduling

The project scheduling is an important step in project management because it shows us the project milestones and what it needs to accomplish each stage of the project.

1.4.1. Concept of project scheduling

The concept of project scheduling shows us when the project begins and when it ends according to all project activity (Mazi, 2000), and also the follow up of these activities. The project scheduling is known as the methods which help the staff who works in the detailed planning of the project and they include the followings:

- ❖ The project is divided into activities.
- ❖ Determining the relationship between the sequences of activities.
- ❖ Completion of the project network.
- ❖ The completion of the necessary time which is estimated for each activity.
- ❖ Completion time maps related to the project.

It is defined as the actual transformer of the project plan (Ballout, 2002). It puts the project in a schedule of time to make all the project work. So it is used as a basic rule in the regulation and control activities of the project.

Also it is known as a system, and this system consists of several elements (Kaven, 2005):

- ❖ Scheduling the input system: It means the required information for the scheduling process. It includes allocating the energy of productive orders and setting priorities for these orders.
- ❖ Scheduling the outputs system: it is the decisions of scheduling activities and these decisions include the followings:
 - *The loading*: It means reconciling materials with required energies for achieving the product orders and the available energies. The end of loading activity customizes orders on individuals and machines to minimize the process costs.
 - *Sequence*: It is intended to follow the implementation of production orders.
 - *Control*: it makes sure of proper implementation, loading, orders productivity and the amendment procedures in case of finding differences between what was planned and what is actually done.

- ❖ Restrictions on the scheduling system: It is about things that have to be taken in account during the scheduling process because they are very necessary in the completion of the project and these restrictions are:
 - Energy extent, as an example, the machine work time.
 - Operations and activities sequence.
 - The limitation of resource constraints and staff.
 - The minimum reserve stock.
- ❖ Decision variables of scheduling system: it means a number of variables that affect the process of preparing and monitoring the scheduling and organization which can control these variables. We found the following examples of these variables:
 - Time of daily work.
 - The production rate in real time.
 - The function of resource work which includes workers and machines.
 - The activities and orders sequences of work centres.
- ❖ Performance Standard of Scheduling System: by this standard, we can understand the scheduling system according to the achievement of its goals, such as delivery and technical specifications of the project.

1.4.1.1. Importance of the project scheduling

The project scheduling has a great importance to the organization in general and to the project in particular (Garold, 2000). This importance is represented in the followings:

It is a key tool for the project management by setting the various project activities and organizations. Then the required stages will be achieved.

- ❖ It gives to the organizations the opportunity to exploit experiences and create a large production capacity inside the organization.
- ❖ Monitor and control project resources during the period of implementation.
- ❖ Collecting information about the project has an advantage in the current and future projects.

- ❖ Select the best ways which the organization uses to complete the project as well as to clarify the activities that must be monitored and given great importance.
- ❖ Collecting information about the project which the organization uses in the case of emergency.

The goal of project scheduling techniques is to create a network of relations between the functions and activities of the project which describes the serial relationships for these activities. This network of relationships is an effective factor in the planning and monitoring of the project and its positives (Ballout, 2002). It is represented in:

- ❖ It is considered as a model for the project planning, scheduling and controlling.
- ❖ It clarifies the periods of time and finding a special staff for the activities of these periods.
- ❖ It helps to provide communications between the sections of the project.
- ❖ It determines the expected end of the project period.
- ❖ It shows the critical activities that cannot be delayed. If this delay happens, the specified period of project achievement will be late.
- ❖ It shows the activities which do not affect the period of the project accomplishment. So if we need, we can delay it during the achievement process.

1.4.1.2. Project scheduling techniques

There are many techniques used in project scheduling, among them (Delal, 2008):

- ❖ Gannet's Chart: The idea of this scheme depends on dividing the required project into small activities. Each activity has a specific time and staff that are required to achieve the project. It illustrates the planning and delivery of these successive activities.
- ❖ Critical path method (CPM): It is a device for the planning, executing and controlling large and complicated projects by using a single time factor for

each activity. It is based on the identification of some activities that must have great attention in the planning and implementation process.

- ❖ Progressive evolution review technique (PERT): In this technique, only one time is used instead of three times. These three times are: optimist time, pessimist time and moderate time. Then the time of activity is counted according to the probable way within these three times.
- ❖ Method of evaluation and review charts: It allows probabilistic treatment for each of the logical network and the estimated time period of activities, some activities may not work at all, some activities may work partly and the others may work one time or more than one time.

The project scheduling process gives the project a quantitative feature and prepares detailed timetables which show the beginning and end of the project. It clarifies the financial, human and material resources which the project needs (Ballout, 2002).

1.4.2. Censorship project

1.4.2.1. The concept of censorship

The concept of censorship is a managerial concept. It is one of the management activity elements. There are many different writings define this concept. We can mention the following examples of these definitions:

Censorship is "checking everything of the selected plan, given orders and principles in order to clarify the errors and deviations, and then correct them and avoid falling in them again (Lozi, 2000).

Terry defined censorship as "clear determining and checking of implemented methods of performance evaluation which have been achieved. And then taking corrective action, when it is necessary, to make the actual performance agree with the plans and objective goals (Mansour, 1999).

It was defined as: "one of the management functions which does the follow up performance and adjusts the organization activities according to the goal achievement."

It was also defined as the process of organizing, setting and adjusting their organizational activities in a way that help to achieve the goal. It provides us with the basis of controlling the actions and completing the strategic plan. By this way the management can be able to see the development in achieving the plans and can see also the quality of performance and what are the modifications or the changes that have to be made and where these changes occur (Hanefy, 2000).

It was also defined the function of measuring the success in achieving the goals and the completion of activities and to ensure that all the actives are going according to the required method or plan. It takes the necessary corrective action in the case of happening any deviation or difference between the planned performance and actual performance (AbuKahf, 1994).

From these definitions, we find that the censorship is a function of the institution in the process of follow-up performance. It organizes and adjusts their activities and measures the success of the organization in achieving its goals actually. When the institution reaches their goal, this means that all the activities are going according to its own program or plan and then it means that the institution of the censorship function succeeds.

1.4.2.2. The regulatory process stages

The construction of any control system is going through four main steps see [Figure 11](#) (Alshareef, 2003), these steps are: setting performance standards, measuring actual performance, actual performance compared to the performance standards, evaluation and modification.

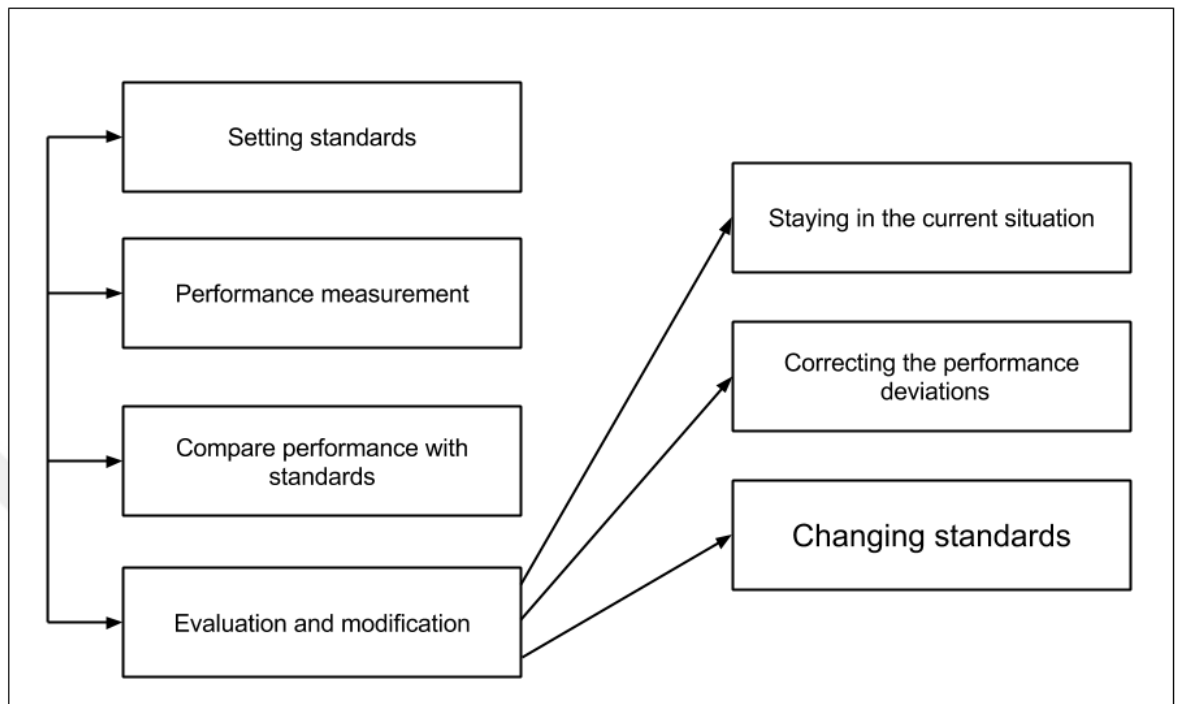


Figure 11: The regulatory process stages

Source: Management and contemporary, Egypt, 2003, p 374

- ❖ Setting the performance standards: The standards are the objectives by which the performance is evaluated. Setting the performance standards is the first step of the control process. This step depends on the planning process. It puts the plans or rates of the performance levels which must be achieved. The criteria levels differ according to the differences of the organizational levels. There are performance standards of high management level, then there is a set of functional performance criteria, and also a set of performance standards at the departmental level, and finally, there are some standards for the performance of individual executives. These standards may be a material which represents quantities of produced goods or service units, or it may be statistical which facilitate comparison or measurement process (Maher, 2005).

In our study, there are three standards on the basis of assessment. These standards are cost, time and quality of the technical specifications of the project.

- ❖ Actual performance measure: it is the second step in the control process. It is the measure of employee's performance. This step is logical in setting the performance standards. These standards represent how to determine the development in achieving the process. So it becomes necessary to compare between what has been accomplished and what was planned, and then we will be able to determine the differences. This step determines the expectations of the plans and the organization success in achieving its goals. It must be mentioned here that the distractions often happen because there is an exact match between the standards and the level of actual performance.
- ❖ Comparing the actual performance with the performance criteria: it compares between the results or the criteria development of the first and second regulatory process stages. These results may be higher or lesser than the criteria. So we must determine the differences. This step helps to judge the accuracy of the plans predictions, and to judge the success of the organization in achieving its goals, we mention here that it is difficult to find an exact match between the standards and the level of actual performance (Awad, 2000).
- ❖ Evaluation and modification: the control process is not completed unless you take the necessary steps to correct extractor deviations by discovering them and finding their causes. And, in general, the corrective actions take one of the following three forms:
 - *Maintain the present situation*: it is in the case of modification absence, and this happens when the actual performance is better than or equal to the standards.
 - *Make adjustments*: It happens if the actual performance is slightly less than the standards. These adjustments are executed in the performance style.

- *Changing standards*: When there is a big deviation between results and standards, it will be required to change the standards of plan.

The regulatory process is to determine the necessary actions to do what is required to accomplish the job, and these requirements identify the responsibilities and powers of each member of the project team by choosing an appropriate project manager, putting an organizational structure of the project, and finally putting an executive office to look after all the operations of the project.

1.4.2.3. Types of censorship

There are three types of censorship

1. **Previous Censorship**: This Censorship aims to make sure of the input resources quantitatively and qualitatively before making they enter the production system.
2. **Ongoing Censorship**: it means the censorship during converting the process inputs to outputs, for example, the organization has set up checkpoints at the beginning of each stage of the industrial process to detect any problems before the start of the next stage (Alshareef, 2003).

Usually, the ongoing censorship gives a special attention to the processes conditions and the level of achievement which go to the expert managers. It has been observed that the financial resources, in particular, are subject to this form of censorship through the periodic review of the monetary level and customers recoveries.

3. **Subsequent Censorship**: This Censorship focuses on the regulatory activities of outputs, after the completion of these activities. And it fulfils three roles in the operational level (Hanefy, 2000):
 - It provides managers at the operational level with the information that will assist them in evaluating the effectiveness of the performance of the regulatory activities and their administrators.

- Subsequent censorship is used as a basis for assessing and rewarding the members. By determining the role of each member in the project achievement, we can determine the reward which the member deserves.
- The subsequent censorship helps post-audit at this level manager to know who is responsible for the inputs or the production process in order to make the required adjustments in any one of these stages.

The project censorship process is the most important stage of the project management because it makes sure of achieving the planned matters, and makes sure that the unplanned matters have never happened. It also the appropriate corrections in the exact time of happening a problem during the completion of the project. It depends on three constraints: time, cost and quality (Smith, 2013).

1.4.2.4. Project oversight

The project oversight is often misunderstood because many projects contain control organization for the project which writes reports about the effectiveness and the situation more than watching anything else.

The project oversight is necessary to make sure of achieving the planned matters, and to make sure that the unplanned matters have never happened. And in our pattern, we defined the censorship control as the control of the process. Every part of the process should have a standard of control, authority to monitor, control mechanism and system exploration. The project supervision is the supervision of a proactive and emotional previous censorship and control ongoing. The system which is designed and used to minimize the risk is (Kaven, 2005):

1. Proactive censorship the baseline, and emotive censorship implementation.
2. Proactive censorship the project plan and control emotive variables in the implementation of the project plan.

3. Administrative methods which help to ensure that the results have been achieved according to the plan. The corrective action is taken when the results have not been achieved according to the plan.

Censorship projects depend on three basic aspects (Nigel, 2002):

- ❖ Time: it is to monitor the compatibility between the project accomplishment and the settled timetables.
- ❖ Cost: it is to monitor the compatibility between the financial budget during the project stages and what has been planned before.
- ❖ Quality: it is to monitor the compatibility between the achievement development and the technical specifications which have been identified by the standards.

Getting a successful project management process is very difficult because we cannot depend on a personal experience and intuition only. So every project manager must be cooperative with the other members of the project team and understand all the project parts in order to get an efficient management.

1.5. Literature Review

For the importance of project management in various industrial fields, there have been numerous studies that show the project management processes in recent years and the most important things which pay attention to them and to the mechanism that accomplish the project successfully and achieve the basic objectives of each project. Two of the most important things in managing projects are completing the project within the specified cost and time available for each project. The following are studies of the most important subjects that fall under the management of projects.

Proactive researchers about project management as a temporary organization and the most important factor affecting the success of the project management.

Turnera (2003) defines the project as a temporary organization in the perspective of organizational theory. It describes a productive function that needs resources and produces objectives. The results of projects are usually new and with a unique endeavour. He

explains the structure of the project and the hierarchy of the project as a temporary system. He defines the project manager as the assistant of the owner who must have the experience to enable him to work in this field and clarifies his duties as a control agent for the implementation of the project, the monitoring of activities, the implementation of the objectives of the schedule and monitoring of good performance. Turne explains that the goals of the project manager are consistent with the owner and do not conflict with the interest of the work. The task of the project manager is to support the team and monitor them to achieve the objectives of the project. The research of Turnera clarifies the difference between the project as a temporary system and the regular organizations with continuity of work and production criticizing some acquaintance that, in his view, may not cover the true meaning of the project. (Turnera, 2003).

Turner (2005) applies the definition and analysis of project management and the related characteristics through academic sources and a research methodology that assesses and measures the vitality of project management. In his research, he depends on the formation of ten groups at a time to study the interdependence of administrative topics. The analysis of the results of the work of these groups results in seven outcomes that reveal the project's organizational work. The results refer to several theories: organizational theory, innovation theory, social and psychological theory. Moreover, there may be a need for a stronger body for strategic research in the future. The analysis compiles the project as a secondary system as well as the work of the main work system. The importance of this analytical conclusion is attributed to the business of the project as this knowledge is relevant to more new theories and administrative applications in the field of business. (Turner, 2005.).

Turner (2009) achieves a success in managing projects. The project manager has a clear impact on the project, the project success and the achievement of the objectives. The weakness of the project management has caused the failure of the project. There is a difference in the management of the project, depending on the type of project. So it is clear that the effective project management is a critical success factor in the management of organizations. Effective management also leads to better performance. (Turner, 2009).

Crawford (2006) analyzes the articles of the International Journal of project management and comparing the trends identified in this study with the focus trends in a variety of previous studies of variables in this field to find the results, to provide an overall impression of change in this area and to examine the most important trends in project management such as project evaluation, resource management, risk management and good performance resulting in high quality performance and cost and time pressure. A broad interest in project management is noticed in recent years from several directions to meet the requirements of development and changes in the management community and areas of application of new project management. (Crawford, 2006).

Hwang (2012) concentrates on the impact of project manager on the success of the project. He clarifies the importance of the efficiency of the project manager. His study identifies the challenges that the project managers face. It relies on the survey and interviews with project managers to establish a knowledge base for project managers. In his research, he takes the managers of green building projects in Singapore as a model for the project manager due to the challenges and pressures which they face during completing the project. The study concludes that project managers play an important and decisive role in the success of the project. They must make important and decisive decisions based on knowledge, skill and efficiency to meet the various challenges of project completion. (Hwang, 2012).

Chinowsky (2010) applies a method to enhance the performance of the project team, in terms of high concentration, professional confidence and strong communication between team members. His study shows data for four organizations that meet to work on one project. The data is gained and recorded from these organizations. It concludes that organizations should reduce barriers between task forces and focus on strengthening trust, communication and knowledge transfer relationships, thereby strengthening the efficiency and effectiveness of the project team. (Chinowsky, 2010).

Shenhar (2001) determines the outstanding success of the projects and provides a set of proposals and guidelines for project managers. He describes the projects as strong strategic means that create economic and competitive value, and that the managers of these

projects are the strategic leaders who bear the responsibility of the projects. Strategic management evaluates and identifies the project. He suggests that the project is successful when it meets the factors of time, cost and performance. His aim is to develop multi-dimensional frameworks to assess project success. He identifies four main axes that are considered as the most important dimensions of success. First, the efficiency of the project. Second, effect on the client. Third, business and organizational success. These dimensions vary are important for time, level of technology and level of uncertainty in the project. He explains how these dimensions are dealt with in the planning and implementation stages of the project. (Shenhar, 2001).

Al-Harbi (1999) is applied the Analytical Hierarchy Process AHP in project management, which is used as one of the most important methods that help to make complex decisions to select the best available offers. This method depends on the mechanism of pre-analysis of the structure required for the completion of the project and the prioritization of this structure according to the criteria which are required for the project. This method is based on the study and analysis of each stage of decision-making and all aspects of the project, which helps to make correct decisions. (Al-Harbi, 1999).

Newell (2004) identifies the relations between the members of the social capital team. He examines the strength of these relations and compares them with the external relations. His study discusses the positive impact of the social capital strength in the work process and the factors affecting the project and urges the extension of social relations bridges for the members of the work team and that the stronger social relations make stronger team in performance to become a strong social cohesive unit able to effectively integrate and respond to business requirements which positively affect the project. (Newell, 2004).

Pant (2008) focuses on human skills and their impact on the success of the project. He deals with the lack of educational curricula that concern with project management and the preparation of project managers for this important aspect of management. He believes that human skills are essential to enterprise success. The importance of balancing difficult human skills and soft skills must be identified in terms of importance in performance and achievement. The educational curriculum should be strengthened with project

management in all aspects related to human skills, because of its importance and impact on the project. (Pant, 2008).

Grabher (2004) discusses the concepts of the context of projects and the processes of establishing knowledge, learning and acquiring skills in the project. This study has two axis; the first is the analysis of projects and community organizations of the project environments, and the second is the analysis of the theoretical concept of the project environments; where the organizational structure of the project is revealed and the experience gained and accumulated through the cumulative work and compared with the theoretical logic. The advantages of work on this comparison are to precipitate and consolidate the scientific value of the factors affecting the project environment. (Grabher, 2004).

Davies (2002) finds the real success factors on projects that affect the success of the project. The factors are divided into three main axes. The first axis is the factors influencing the success of the project. The second axis is the factors that lead to a successful project. The third axis is the factors leading to successful projects. He depends on his research on a questionnaire of more than 70 multinational institutions and organizations. These factors have a direct relationship to human factors, so they have different effects depending on the individuals and the way they treat to make the appropriate decisions. (Davies, 2002).

Ahmed (2005) examines all stages of the project structure, organization, work environment, required resources and other important details. In addition, it examines and analyses the best commercial and industrial practices. It does not create a plan for the project that reduces the expected risks and helps to avoid the acute crises. It also provides an opportunity to exploit opportunities for future interest. The research deals with the known risk management techniques in projects and others. It is important to avoid risks and seize opportunities. It also indicates the importance of applying these techniques by the team of the project, which positively affects the progress of plans and treats risks. (Ahmed, 2005).

Zhi (1995) deals with risk management and specializes in risk management of construction projects in a new environment. He examines in his research the risk management of construction projects in an external environment where there is insufficient information to identify potential risks. The study is based on a case from China. It is difficult for a newcomer to identify new risks in a new environment and it is difficult to assess these risks and the exact impact of their relationships. Ignoring these risks leads to unrealistic decisions. On the other hand, the assessment of all new risks is very complex, time-consuming and costly, especially when there is not enough information and time. How to identify vital risks effectively and provide a technique for risk assessment and risk analysis have an impact on technical response to the external vital Risks. (Zhi, 1995)

Prabhakar (2005) clarifies the importance of transformational leadership in project by making a research throughout twenty-eight nations. He applies an analysis of leadership in project management practices in 153 projects in 28 countries. His research is divided into two axes: the first is to study 46 projects in 14 countries, and the second axis 107 projects in 25 countries. Where the results of data analysis in the first axis of the study, which helps to develop the questionnaire in the second axis of the study, which in turn reveals the results and links between different aspects of leadership and also provides a list of factors that strongly affect the success of the project. The main objective of this study is to identify the importance of project leadership and the factors that are key to the success of the project. (Prabhakar, 2005).

Baccarini (1996) points out that the concept of complexity in project management has not paid much attention since project management is a complex process and needs good management to manage. Construction projects are more complex than regular projects and require exceptional management. A management with a regular capacity may not be able to manage very complex projects. In such projects, critical decisions determine the appropriate procedures for managing them successfully. Projects must be interpreted and must find solutions and alternatives that face the contract. The natural consequence of

complexity is the integration of work in terms of coordination, communication and surveillance. (Baccarini, 1996).

Soderlund (2003) finds building theories of project management that discuss academic research on project organization and project management. It raises a set of questions about the project management system and what are the similarities and differences of this system in various projects. This has an impact on the causes of success and failure and the enhancement of project management knowledge. (Soderlund, 2003).

Proactive researchers about scheduling and organizing the project and analysing the activities within the project and coordination among them.

Dvira (2003) finds an empirical analysis of the relationship between project planning and project success. Successful planning may not be necessary for the success of the project, but inefficient planning contributes significantly to the failure of the projects. Dvira, in his research, examines the planning efforts and its impact on the success of the project. His research focuses on three axes: definition of project requirements, development of technical specifications and project management procedures. This is discussed in three perspectives: the first perspective is end user, the second one is project manager and the third is office of contracting. This research is based on 100 development research in defence projects which aims to develop weapons systems and support equipment in Israel. It includes statistical analyses of variables. It concludes that the success of projects depends on the level of implementation of administrative processes, which are supported and developed through education and training in the methods of project management. On the other hand, the success of the project is related to the full knowledge of the requirements and the development of technical specifications. (Dvira, 2003).

Jin (1996) applies the process of organization and coordination of activities within the project. He is interested in explaining and interpreting the virtual design team, and in determining the mechanisms used to coordinate project activities by developing a virtual design team model that calculates and analyses all processes of project activities such as

attention allocation, capacity allocation, and communication and performance assessment. The Virtual Design team evaluates the project organization performance by measuring project time, cost and quality of coordination. Jin points out the importance of collaborative work in various disciplines in projects in general and in complex projects in particular. The evaluation of the design team model concludes the following: the qualitative consistency between the predictions, the simulation model and the experience of project managers. These three axes have a significant impact on the performance of projects. He explains the coordination and organization processes using the virtual design team from the internal and external side of the project. (Jin, 1996).

Brucker (1999) applies the scheduling of projects, limited resources, models and methods used in the scheduling of projects. Scheduling projects is a topic rich in research and studies. Bruckers specializes in studying the important aspect of the scheduling of projects with limited resources. He aims to highlight the methods used for automatic scheduling and gap between them and the scheduling of the same activity and attempt to fill this gap by presenting a classification scheme describing the resource environment, the characteristics of the activity and the function of the target, which are compatible with the scheduling mechanism and allow the classification of the most important models that deal with them. He also proposes to standardize the codes used in the classification of algorithms to reduce errors and achieve accurate and rapid results. His other aim is to review recent developments of the algorithms used to schedule projects and to present the problem of time of activity, costs and other factors affecting project scheduling. (Brucker, 1999).

Herroelen (1997) deals with scheduling problems and demonstrates a classification system for project scheduling. His research depends on three axes. The first axis is the resource of the problem. The second axis is the project activities. The third axis is performance. He discusses the relationships between different problems that facing project scheduling and provides graphs showing different interrelationships of classification values and the most common problems in scheduling projects. He proves that the taxonomic system has sufficient rigidity and flexibility to contain all kinds of

problems facing the scheduling of projects. (Herroelen, 1997) Herroelen (2002) deals with the problems facing project scheduling in the case of uncertainty. These problems must be resolved according to the project implementation environment and the pre-set schedule of implementation. The scheduling activities of these activities are gradually solved during the implementation period. Scheduling systems, simulation and logic are used to schedule projects in order to reduce the cost and time of the project activities and the distribution account of the standard deviation of the activity time. Project scheduling, which uses the uncertainty approach, is usually related to the environment of the project, the used equipment and the human resources. Therefore, the research of Herroelen clarifies the scheduling system mentioned above that should be used to solve the problems and risks of project scheduling. (Herroelen, 2002).

Hang (2004) applies PERT and CPM techniques and their role in the random nature simulations of the times of the activity completion. The estimation of the activity time has a direct impact on the total project time and therefore delays in the execution of activities may cause delays at the end date. The research of Hang demonstrates the importance of PERT to simulate and analyse activities and reduce uncertainty. It is based on the practical application of this method in more than one way and then writes a simulation program in C ++. It works on virtual groups by using three networks representative of the PERT and obtained results saved from the costs by 6.6% to 56.2 less than the traditional method of simulation. (Huang, 2004).

Proactive researchers about the most important theories which are used in scheduling business network and analysing project activities to identify critical points.

Sharon (2010) clarifies the development of systems engineering management processes depending on project management techniques that include PERT and CPM techniques and their role in randomized nature simulations. Most of the applications of the systems engineering department use the project management methods. The actual practice of systems engineering management is crystallized by the continuity of knowledge perception between systems engineering in the field of product and project management. The research of Sharon focuses on seven methods of project management

and introduces the first managers during the engineering of the field, whether they consider the idea of the project and the scope of the product. The second factor is the extent and nature of the methods used in the management of systems engineering so that the methods of project management are effective to support them. Sharon takes the case of the UAV as a case study and applies simulation to it and concludes that the systems engineering department implements the methods of managing the project life cycle and that these methods are the actual bridge between engineering department systems and project management processes. (Huang, 2010).

Kanapeckiene (2010) defines the construction industry as a systematic approach to the education of construction projects carried out using the KDSS, CPM model. Previously, it was not a curriculum for construction projects to improve the capacity of project managers and professionals with implicit skills and limited project management experience. Kanapeckiene clarifies the benefits of knowledge of projects, especially the management of construction projects and focuses on the importance of knowledge and learning of all aspects and stages of this administration. He offers in his study an integrated development of the construction industry projects and explains this system for its multiple benefits, especially in decision making. CPM provides analysis and comparisons of these models. (Kanapeckiene, 2010).

Fisher (1983) applies PERT network, expressions of mean, variation, and distribution of reaction time. Where the method was largely based on the translation of the partial arrangement of operations and the drawing of a detailed outline showing the distribution of the mean and the time variance of the processes. He explains the importance of this method in dealing with schedules and accurate details under random time. (Fisher, 1983).

Cornelis (2004) applies the theory of Fuzzy logic and how to deal with the Fuzzy logic group. The increasing demand to learn the concepts of the mechanism of dealing and discrimination between the various aspects of inaccuracy leads to create this study, which illustrates the mathematical models that lead to these services. The study is to illustrate the theory of Fuzzy logic and define and explain it in detail using sophisticated structures. Production processes base on logical and illogical reasoning assumptions and

use the Fuzzy approach as a model to simulate inaccuracy and applications. (Cornelis, 2004).

Zimmermann (2010) applies Fuzzy theory in various disciplines. His study is concerned with explaining and detailing the Fuzzy theory since its inception and its use in various disciplines and sciences in detail. He describes in detail the mathematical applications of this theory and explains its importance in practical and scientific reality and shows the possibilities of this theory to solve complex problems, especially the problem of uncertainty. (Zimmermann., 2010).

Zielinskib (2000) applies the concept of critical path and the activity of critical activities by using the Fuzzy theory. The study is to explain the activities of the project and identify the critical activities and determine the critical path and the impact on the completion of the project within the specified time and cost. In his research, he depends on the theory of the Fuzzy set analysis and its mathematical application and drawing up the project network analysis to clarify and identify the critical activities. Detailed and educational study of the applications of this theory leads to control the activities and evaluate the work performance. (Zielinskib., 2000).

Mikhailov (2003) clarifies the importance of evaluation of services and activities by using the Fuzzy logic of the hierarchy of analysis of activities under uncertainty. He examines the importance of evaluating activities and determining their requirements due to their importance in decision making, based on the Fuzzy logic and its mathematical processes to analyse and schedule activities, thus avoiding managers from making mistakes and lead them to perform their duties in a good administrative format. This study shows the possibility of Fuzzy logic to identify activities and explain possible alternatives and identify the procedures of achievement, allowing managers to make the right decisions in the uncertainty. (Mikhailov, 2003).

CHAPTER TWO

THE NETWORK ANALYSIS

2.1. The Network

Decision makers in the institutions and workshops often face the problems of organizing and scheduling the works of these institutions and workshops in reaching the desired, perfect and high-quality objectives in less cost and short time. When the propounded problem is about arranging a group of secondary actions that lead to achieve this project, the method of arranging projects is responsible for preparing a chart which helps to meet the goal in a shorter time with the possibility of having the best propulsion of project stages by knowing what kind of activities should be performed at specific dates without any delay, and what kind of activities can be delayed without influencing the project date of delivery. In this chapter, we will try to delve into the analysis of various aspects of the network.

The networks are considered as one of the important ways in project management. It helps the project manager in planning and scheduling the various operations which are necessary to perform a particular operation in the highest possible efficiency. They are widely used especially in the field of project completion. They help to control the various activities of project and to reduce the costs.

The Network is a binary nation of the activities related to it, and it is a way that makes up a particular project. It shows the sequence of events and activities to complete the project according to a technical and logical sequence. To establish this network, there must be a technical staff who can select all the activities that make up the project, show which the activities that must start out first, and then move on to the next activity.

The term “networking scheme” is defined as a set of methods that have evolved to provide a management device which helps in planning the process and controlling the projects. These methods depend on the clarification of the interrelationships between work

and various activities, so the overall project will be with a clear identification of critical activities in the project x which can be defined by Bobanha as a set of points called the events, a set of curves called the activities, and what connects between them (Alshumary, 2010).

2.1.1. Some of the concepts and terminology used in network planning

There are some basic concepts will be mentioned in the study, and will be relied upon to clarify the scientific basis of the subject of study. We will mention the following concepts:

- ❖ **Event:** is a period of time indicates the completion of certain activities and the beginning of the next activity. Beginning and end of each activity are expressed in two events, the first event is the beginning and the second is the end (H.A.Alsamarray, 1997). Event is also defined as a time interval or a point of time indicates the beginning and end of the activity (Bokara, 2004) and it is represented on the network by a circle, square or rectangle just like [Figure 12](#).

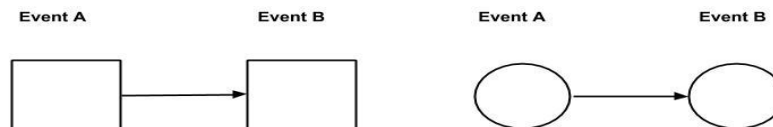


Figure 12: The different representations of events

Source: Ali Husain Ali, Project processes and their applications in the institution functions, Dar Alzahrn, 1999, Amman, Jordan, p282.

- ❖ **Activity:** is a necessary work that must be accomplished between a past event and next event. And it is represented by an arrow connects the start event with the next event. It is also defined as a part of the project consumes time and resource, and has a beginning and an end.

The activity is characterized by the following:

- It needs time and resource.
- It is represented by an arrow. The sequence of events linked with activities. The length of the arrow does not reflect the time of activity. The time of achievement is written on the activity.
- Each arrow represents one activity only (Moder, 1983).

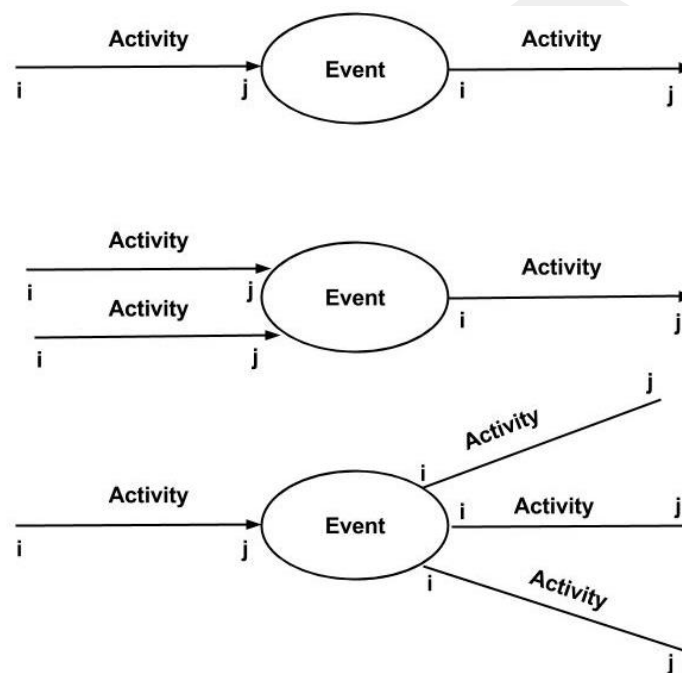


Figure 13: The activity in network

Source: Project Management with (CPM, PERT) and Precedence Diagramming, 3rd edition, P 23.

- ❖ Dummy activity is an activity that does not consume time and resources, and it is used in representing activities with the events that have the same beginning event and the same end event and it is represented as in Figure 14.

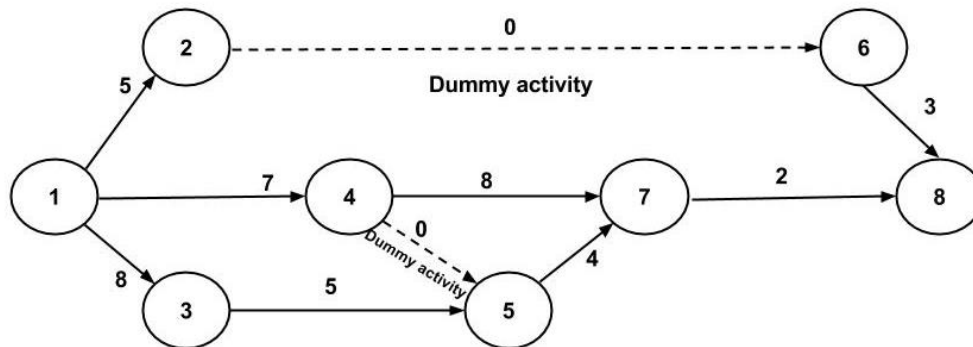


Figure 14: The dummy activity on network.

Source: Operations Research, P318.

The Dummy activity has an importance in clarifying the processes involved in the events that has same beginning and end. It is used only in events oriented system and does not need to be used in the activities oriented system.

- ❖ The activity: is a series of sequential activities and events. It starts at the beginning of the project and finishes at the end of the project.
- ❖ Critical Activity: is a series of critical activities which need the longest completion time. It connects the beginning and end of events in the activities on the stocks.
- ❖ Cost: The total project costs have the following two basic types:
 - Direct cost: an amount of monetary units expended to accomplish one or more activities such as staff and machines costs. This cost varies according to the required resources to complete the activity in terms of quantity and quality. In view of the resources influence on the time of completing the activity that has an inverse relationship with the activity cost, the availability of required resources in completing the activity will lead to achieve this activity in less than the time it takes and will increase the direct cost of this activity according to the inverse relationship between time and cost activity (Kasir, 2000).
 - Indirect costs: These costs consist of the following items (Kasir, 2000):
 - Monetary units spent for the entire project, they are not owned by a particular activity but are directly related to the total component activities

of the project, including administrative expenses, rents, buildings, taxes ... etc.

- Monetary units owed for beneficiary of the project when a delay happens in the project completion by the management of the project.
- The benefits obtained by the entity which is responsible for implementing the project, when it complete the project before the appointed time.

The relationship between time and indirect cost is linear relationship and direct, it increases with increasing the project duration.

2.1.2. The importance of network planning

According to the Winston, Business networks are used in the programming of construction and industrial projects as well as in the field of maintenance. Project programming is a general word includes two functions as planning and control. These functions are the main functions of the administration. Through the planning function, the goals which should be achieved are formulated into plans that can be implemented. The institution is divided into several small sub-activities. Specifying the required materials and equipment for each activity, determining the completion time for each activity and coordination between different activities help to achieve the general goals (Winston, 2004).

The control function can discover the happening deviations in the actual performance of the actual plans and take the necessary measures to complete the completion as planned. It is noticed through experiment and survey that the nature of the activity of many enterprises is large in terms of expansion and complexity. It is worthy to mention that the normal human capacity cannot be familiar with all the required tasks in the projects, so it reflects the importance and efficiency of the performance of planning and control functions.

Hence, there is an urgent need to follow the models of network analysis. These models are described as effective factors contributing in the decision-making process such

as planning, scheduling and controlling the under construction or under manufactured goods of the project, especially in large projects.

It is worthy to mention the importance of applying the scientific theories and practical experience of project manager in a distinct performance and in achieving the specific goals at the lowest costs. The project manager should have this experience because project management differs from regular management methods. The first project management has a defined age and this specified age is known in advance. While the usual management methods are related to the management of the company and its divisions that do not have a fixed age. It is assumed that the life of a company extends indefinitely or at least has no definite end.

The second difference is an inevitable result of the first difference. Projects use temporary resources. With the completion of the project, the need for these resources will end. While the general management style assumes that the need for these resources in companies is a constant need without any specific end in terms of time. All companies and projects need resources to achieve their goals. These resources include both human resources such as employment, staff, managers and non-human resources such as land, buildings, raw materials, machinery and others.

As a result of these differences, there were great difficulties in managing projects by managers who are not trained in project management. As a result of the increasing interest in project management in the recent period, this chapter is devoted to clarifying the most important scientific theories and practical experience. The project management has an importance in planning, scheduling and monitoring all the activities involved in the completion of a specific project, especially those projects which consist of many activities that require coordination among them, so it ensures the completion of the project in the shortest possible time and at the lowest costs.

The most important advantages of network analysis (Shamarti, 2009):

- ❖ Provide the possibility of preparing accurate plans that have the capacity to absorb the different stages of project implementation.

- ❖ Determining the expected time for completing the entire project in advance.
- ❖ Identify the needed resources to complete the project. So as to ensure the use of available resources.
- ❖ Determine how to use specific resources which help to reduce project completion time from that predetermined time.
- ❖ Determine the starting time and completion time of a particular activity.
- ❖ Identify activities that must be completed in a timely manner so as to avoid delaying the completion of the entire project. The activities on the critical path are critical, so they should be given special care and attention by the administration to ensure the completion of the project in a short time.
- ❖ The possibility of transferring resources from non-critical activities to critical activities in order to complete the project in a shorter time.
- ❖ The possibility of determining the period in which no critical activities can be postponed without affecting the time of the entire project completion.

The networking project planning depends temporally on the basis of structural analysis. According to a logical order for its activities, and this requires a completion of so different resources. Relying on such an approach in planning and scheduling the construction projects, service or productivity and control have an important role which is reflected in the following points (Atoum, 2011):

- ❖ The trade-off between time, cost and quality: it allows business networks models to differentiate between time, cost and quality which are the elements of the project forces. It determines the optimistic time (a) plan for project implementation, the time required to complete the project, the completion date, the least cost and the better quality which is one of the most important power at the moment and it must be taken into account more than time and cost. Good quality is important because it reduces the cost, especially those resulting from internal and external failure. Bad quality leads to long-term losses which are represented in the decline in market share and loss of sales.

- ❖ Determine the cause of the achievement delay: the work scheme can determine the required human resources to complete the project by selecting the necessary number of these resources for each project activity according to the project need of specializations and technical and scientific skills. So it defines the role and responsibility of every human element in the project implementation. And in case of any delay in the completion of an activity, the reasons of this delay will be founded and determined whether they are technical reasons coming from breakdowns in machinery that are used in the completion of the activity, or they are not suitable for the human ability in fulfilling his or her job in the implementation of the activity. The reasons may be administrative, technical or economic, such as the non-availability of necessary material and immaterial resources for the completion of the activity and other reasons (Winston, 2004).
- ❖ Provide information system: the project manager is responsible for planning and controlling the project. To do this job, it needs accurate information and suitable time because the factors and circumstances upon which the plan estimates are subject to change in order to make the right management decisions. The absence of information system leads to the weakness of the administrative decision and creating crises during the process of achievement. This information is based on the division of work structure offered by the schemes retina in detail and the measurement of what is prescribed in the original plan. This information is insufficient if it is obtained from data based on irregular and non-scientific basics and if it is taken from brief and no constructive reports. There is no doubt that the good and accurately achieved project provides an extensive data utilized in the process of estimating the indicators of plans for future projects which are similar to the achieved project. If these data have been not collected, it will certainly be lost, and the information system which enables us to provide business networks models will be also lost.
- ❖ Achieving the principle of management by objectives: Management defines objectives or results as a "method of planning and management evaluation that has specific objectives for a given year or for another period of time." This method is

based on that all the results, which should be accomplished if the overall objectives of the project are realized at the end of this time period, will be measured by the basic objectives and the expected results that the manager is responsible for achieving (Rory, 1992). Most managers, who do not plan their activities, assume that all activities are consecutive; because they are waiting for the completion of an activity to begin another. However, network diagrams show interrelationships between activities related to a goal other than the logical sequence, such as synchronization relationships between activities that begin together to accomplish the goal; because reducing the time period is a goal in itself that all kinds of institutions work to achieve.

- ❖ Achieving the principle of exception management: The exception management technique is complementary to the management system by objectives. Where the attention of the director focuses on important and essential activities that needed to be effectively monitored. When these critical activities are accomplished, the project objectives will be achieved.

The network analysis is used widely, especially in the governmental and industrial fields. The following fields are some of them:

- ❖ Research and development of new products.
- ❖ Construction of buildings, roads, factories and aircraft.
- ❖ Maintenance of large and complex equipment.
- ❖ Design and implementation of computer systems and accounting systems.
- ❖ Planning traffic in airports and streets to reduce the risk of accidents and bottlenecks

2.1.3. A historical overview of business networks models

Project management techniques appeared during the First World War when the American scientist Henry Gantt designed the chart of columns that he called "Gantt Scheme". He designed it to meet the need of military officers in planning and controlling projects during the war. It was firstly designed to control the time element of the project

by placing the core activities of the proposed project in a list of scheduled times for start and finish. It was later used to reduce the time required to build cargo ships. The Gantt Scheme developed his scheme in (1917) and derived other schemes from it such as the schemes of employment and other resources.

The failure of this scheme in detailing the activities of the project and clarifying the logical relations between these activities. The appearance of large and complex production projects are the most important factors that led scientists and researchers to look for a new method. The researchers succeeded in finding a network scheme in the mid-fifties of the last century which is an improved result of the Gantt scheme. It overcomes the disadvantages and meets the needs of the technical and economic development.

These researchers created project management methods. By these methods, project processes are represented on a network that reflects the chronological and logical sequence of these processes. The most important of these techniques are (Albert, 1970):

- ❖ Critical path method (CPM): It is a method for planning, implementing and monitoring large and complex projects, using only one-time factor for each activity. It is based on the identification of a range of activities that should give particular attention to planning and implementation because completing the project at a specific time and specific costs depend heavily on the activities of the critical activity.
- ❖ Progressive Evolution Review Technique (PERT): This technology enables managers to plan, schedule and monitor large and complex projects by employing three-time estimates for each activity: pessimistic time, optimistic time (a) time and most likely time. The time is estimated to be carried out in a probability manner depending on the potential beta distribution because estimates of this distribution have the quality standards of statistical estimates more than other distributions according to the results of the research presented by the scientist Vanslyke about the effect of potential distribution change on project time.

These two methods are developed in both Britain and United States at the same time. In 1956 British DUPONT Company faced a problem in achieving the chemical projects. This problem is the problem of time bottlenecks between project plans and their actual implementation. As a result of solving this problem in 1957, the basics of scientific and theoretical foundations of critical path method had been created by a team of research processes of this company, led by Mr. Walker in cooperation with J. Ekelly Affiliate of Remington Corporation Rand. CPM applied these basics for the first time in 1965 by London Transport in the establishment of the Victoria underground railway line. By this project, 60 million pounds sterling was preserved. The project involved more than 9,000 activities. In the same period when the CPM method was created, the special projects office of the US Navy attended to study the possibility of planning and controlling the project of POLARIS missiles production by Allen, Hamilton and Booz. The first report on PERT technology was released in July 1958. The second report in August 1958. The latter ensures the mathematical foundations and the scientific methods of applying this method. As a result of using this method, the POLARIS project was completed before two years of the expected completion time (Almansoori, 1987).

The equilibrium line is another method used in production planning. Presented by the US Forces Office in 1952. It aims to calculate the required resources for each stage of production which created by Charnes and Cooper (Moder, 1983). In the same year, the (PERT) cost system was developed and designed as a result of the solidarity of the National Aeronautics and Space Administration Research Administration NASA and the Defense Service. This system has identified cost control steps for (PERT) methods.

Over the past few years, several studies have appeared in estimating the times needed to complete the project, including Fuzzy logic, taking into account several factors such as weather and performance.

In 1965 the theory of Fuzzy logic was developed, and in 1974 its first application to industrial processes was presented in Mamdani. Fuzzy logic provides means to deal with nonlinear systems. Its flexibility and simplicity make Fuzzy logic controllers suitable for many industrial applications (Garc az, 2006).

2.1.4. The basic steps to build a business network

To talk about the scientific bases which must be followed in building the network analysis for each system, we must point out the basic steps that should be done before determining the system used to build the network and presenting information about them. These steps are (Hafez, 2003):

- ❖ Project identification and definition: it means defining the working range of project, putting a plan for it and determining its objectives and its end time.
- ❖ The division of labour structure: The project is divided into basic and partial phases, processes and activities, depending on its size. The large project is divided into basic stages, each one of them is a project in itself. This facilitates the management process of large and complex projects. These basic stages are divided into partial stages consisting of a group of parts. These stages are the processes and activities of the project. The medium projects are divided into partial stages. And then they are divided into processes and activities. While small projects are divided directly into activities.

We point out that any mistake committed in the process of division or omission of any activity makes the activity plan ineffective. And therefore the adoption of a network of work does not enable us to complete the project on time. So the scheme must be careful and the process of division must be accurate, taking into account the following things (Shamarti, 2010.):

- Separating the activities which are carried out in different parts of the project at different times or by different teams.
- Separating the activities that the responsible parties of their implementation are different.
- Identify activities which require a specialized work.

- Identify activities which require different materials from other activities.
- Separating the activities which require equipment of different types.
- ❖ Determine the relationships between activities. These relationships are:
 - Synchronization or interference relationship. It means that the activities which have the same starting time, they should have the same end time.
 - Sequence or consecution relationship. It means that activities cannot begin if the previous activities still not finished.
 - Relationship of independence or parallelism. It means that activities do not require completion of another specific activity. They are independent and in parallel with other activities.
- ❖ Estimate the time required to complete each project activity. The estimation method differs according to the network model adopted in developing the project work plan. This is what will happen while the form is displayed.
- ❖ Determine method of activity implementation, taking into account available resources of employment, machinery and raw materials.

2.2. Traditional Business Networking Models (Event oriented system)

The network business models appeared in two systems. The first is the event oriented system, which follows the way of presenting the project activities by arrows on the network analysis. The second system is the activities oriented system, in this system the project is represented by a circle on network. These regulations are presented below.

This system is one of the most widely used systems in building the network analysis of the project so that the elements of the network are drawn according to this system including the following:

- A circle indicating the time events. They represent the end of past activities and the beginning of subsequent activities.
- Indicative arrows indicating activities which must be completed. They extend between two circles. The first is called the starting event of the activity. The second is called the end event of the activity. Figure 15 illustrates this:

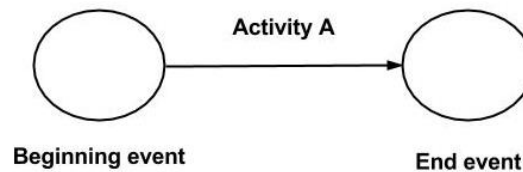


Figure 15: Representing activity by event

Source: Muaid Abdulhusain Alfadhil, Accounting processes researchers, Ithraa for publishing and distribution, Jordan, 2008, p 299.

- Intermittent arrows indicate the dummy activities used to clarify logical and sequential relationships between project activities.

Building the network according to the event oriented system is subject to certain rules that the planner must observe:

- ❖ An activity should not have the same start and end of another one. When such a case appears, we resort to use dummy activities that help to keep the network logic.
- ❖ An activity can have one beginning event or one end event of another activity. In some cases, it is preferable to use dummy activities when the relationship of the parallel or tangential activities affects the start or end of other activities as illustrated in the following figure. We find that activities A and B finish at the same time, they are related to each other by a tangential relationship. When the start is with the activity D which is related to the activities A and B, and when the start is with the activity B which is related to the activity A, we use the dummy activity to maintain the logic of the network (Morgan, 2012).

Dummy activity has been used in network building in order to reduce the errors and control distributing activities in organized form. Figure 16 representing the dummy activity on the network.

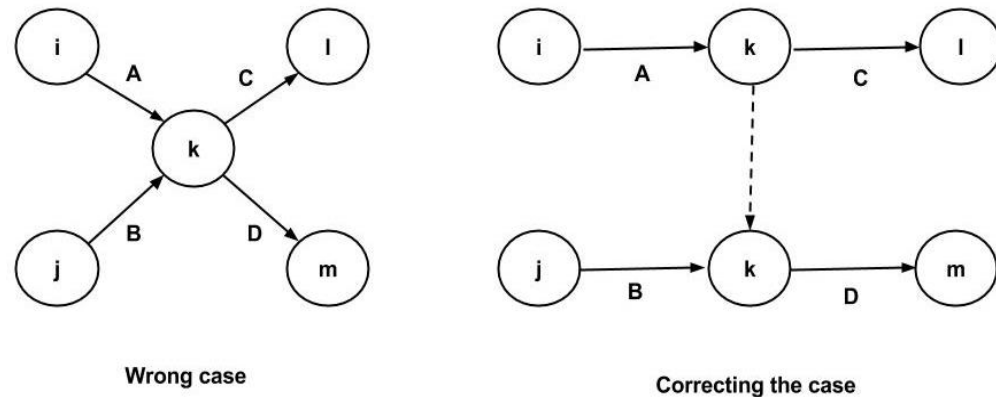


Figure 16: Dummy activity on the network

Source: Operations Research, P324.

- ❖ An activity cannot start unless all previous activities have been completed.
- ❖ Presenting the project activities logically and sequentially in a forward itinerary prevents the rotation and draws cross-pointing arrows.
- ❖ Cross arrows should not be drawn because they obstruct the understanding and clarifying of the network.
- ❖ Every event in the network must have to come and going arrows, except the start and end event.

The elements of the network analysis in this system have specific indicators for events and specific indicators for the activities which are represented by business arrows. These indicators are:

- ❖ Specific event indicators. The event indicators are as follows (Arab, 2009):
 - Numbering events in the network: There are several ways of numbering the network events. However, a common method is to give the first event in the grid number (1) and other events are given consecutive numbers.

Taking into account the logical sequence and relationships of precedence to be observed when building the network.

- The Earliest start time of the event: it represents the least time needed to reach the event E. It is symbolized by E_i symbol. It indicates the number of consumed time units. In the case of a merger event, the event is not completed until the previous activities have been completed. The number of calculated time units is taken according to the longest activity. We want to mention that the assumed starting time of the project is zero. Meaning $E_1 = 0$.
 - Latest completion time: it represents the maximum time needed to complete the event. It symbolizes by L_i . This time is calculated in the opposite direction by making the delayed event of the project end equal to the early event of the same event ie $E_n = L_n$. And when calculating the end event of the other events we distinguish two cases:
 - If event A represents a start event for a single activity (i, j), **$L_i = L_j - D_{ij}$** . **D_{ij}** represents the time of completing the activity **ij**.
 - If event i represents the start event of more than one activity we will have the following relationship: **$L_i = \min (L_j - D_{ij})$** .
 - Reserving time of event: It is calculated to determine if the event is a critical event or not. When it is equal to zero, the event will be critical. It is given in the following relationship (**$S_i = L_i - E_i$**). It reflects redundant units that can be used for network compression.
- ❖ **Activity indicators:** The indicators are calculated for the analysis of the network diagram (Taha, 2008).
- Activity number: Activity is indicated by either alphanumeric characters or illustrative terms, but it is best to use the start and end event numbers.
 - Earliest start time: it is indicated by the symbol (ES). It expresses the least time at which activity can start, on condition that all the preceding activities have been completed. It equals to the early time of the start event of activity.

- Earliest finish time: it is indicated by the symbol (EF). It expresses the minimum time at which the activity must finish. It is calculated by combining the early time of the start of activity plus the time of activity completion.
- Latest start time: it is symbolized by the symbol (LS). It represents the maximum time to start the activity so as not to delay the date of project completion. It is calculated by finding the difference between the late-time of the activity end event and the time required to complete the activity.
- Latest finish time: it is symbolized by the symbol (LF). It represents the maximum time at which the activity must end. It is equal to the late time of the end event.
- Total time reserve: it is symbolized by the symbol (TF). It is defined as the total time elasticity in which the activity can be implemented without affecting the total period. It is given in the following relation: $(TF=L_j-E_i-D_{ij})$.
- Free reserve time: it is symbolized by the symbol (FF). It is defined as the available time for delay when all other activities are accomplished in their early time. It is given in the following relationship: $(FF=E_j-E_i-D_{ij})$.

2.2.1.1. Activity oriented system

This system is used to set up a sequential network of the project by defining the range of project work, the structure of work division, the preparation of a list of project activities, and defining their logical relationships. And also after estimating the time required to accomplish them. The network elements of this system are:

- Circles represent activities: Each circle represents one activity that starts from the left of the circle and ends at the right. As shown in [Figure 17](#) (Alfadhil, 2008):

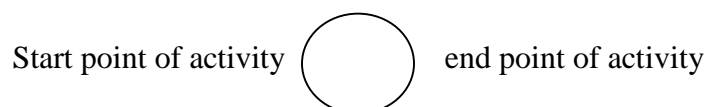


Figure 17: Representing the activity by a circle

- Guided arrows: They reflect the logical relationships between project activities. They assume that time flows towards it. These arrows represent the following logical relationships (Arab, 2008):
 - Finish - Start Relationship.
 - Start - Start Relationship.
 - Finish - Finish Relationship.
 - Start - Finish Relationship.
 - Complex Relationship Start - Start and Finish -Finish.

The network elements in this system have the following indicators:

- Activity Number: Sequential network activities are sequential and serial. Each activity is given only one number. The alphabetical letters or illustrative statements can be used instead of numbers.
- Earliest start and finish time: it is assumed when calculating these two indicators that each activity begins with the earliest possible time. Before clarifying how to calculate these indicators, we want to clarify the following symbols:
 - i: The previous activity which has no prior activity.
 - j: Subsequent activity of activity (i).
 - ES: Earliest start time.
 - EF: Earliest finish time.
 - D: Time required to complete the activity.
 - T: Total time to complete the project

After defining the variables that we will use, we now show how these two metrics are calculated:

- The activity which is not preceded by any activity: $ES_i=0$ and $EF_i= ES_i+D_i$.
- The activity which is preceded by one activity: In this case we take into account logical relationships between activities:
 - Finish - Start Relationship. $ES_j= EF_i$, $EF_j= ES_j+D_j$.
 - Start - Start Relationship. $ES_j= ES_i$, $EF_j= ES_j+D_j$.

- Finish - Finish Relationship. $EF_j = EF_i$, $ES_j = EF_j + D_j$.
- Start - Finish Relationship. $EF_j = ES_i$, $ES_j = EF_j + D_j$.
- The activity which is preceded by several activities, in this case the relationship is $EF_j = ES_j + D_j$, $ES_j = \max(EF_i)$.
 - Latest start and finish time: The calculation of these two indicators assumes that each activity ends in the maximum possible time for completion. Before explaining how these two indices are calculated, we state the following (Al-Sheikh, 2009):
 - i: Subsequent activity and there is no any activity later.
 - j: Previous activity of activity i.
 - LS: Latest start time.
 - LF: Latest finish time.

After identifying the symbols we will use, we now show how these two metrics are calculated by case:

- Activity that has no subsequent activity: $LF_i = T$, $LS_i = LF_i - D_i$.
- Activity with only one subsequent activity: In this case, consider the logical relationships between the activities of this system:
 - Finish - Start Relationship $LF_j = LS_i$, $LS_j = LF_j - D_j$.
 - Start - Start Relationship $LF_j = LS_i + D_j$, $LS_j = LS_i$.
 - Finish - Finish Relationship $LF_j = LF_i$, $LS_j = LF_j - D_j$.
 - Start - Finish Relationship $LF_j = LF_i + D_j$, $LS_j = LF_i$.
- When there is more than a subsequent activity of activity that we want to reckon with the late crisis here we find that: $LF_j = \min(LF_j)$, $LS_j = LF_j - D_j$.
- Total time reserve: Symbolized by (TF_i) and calculated using one of the following equation.
 - $TF_i = LF_i - E_fi$.
 - $TF_i = LS_i - E_{si}$.
- Free time reserve: Symbolized by (FF_i) and calculated by using the following equation.

- $FF_i = ES_j - EF_i$

2.3. Network Analysis by Critical Path Method –CPM-

The critical path method is the oldest method of network analysis. It is used in the planning and scheduling of projects. This method is simple and easy to use, understand and apply. They are designed either with the event oriented system or the activities oriented system. The researcher is free to choose the system, which will be used, according to the level of control (Calvert, 1995). In this section, we will use the event-oriented system because it is easy in the process.

This method considers that the time of completion of the activity D_{ij} has one confirmed quantity, which is based on the experience and knowledge of the project implementation process or based on previous data of a similar project. The main objective of this method in determining the time required for project completion and to determine the time required to implement the critical activities in a single course in the network which has a total time reserve TF_{ij} equals zero. This cannot be tolerated during the process of completion because this will lead to increase the time required to complete the project.

2.3.1. Methods of determining the critical activity

The process of determining the critical path is according to two methods:

- Full narration method: This method relies on identifying the critical path by (Shamarti, 2010):
- Determine (p) the set of activities in the network which have number (m) activities.
- Identify the constituent activities for each activity that has the number (k).
- Calculate the duration of each activity in the group (p) by the following equation:

$$T(P_i) = \sum_{l=1}^k D_{ij} \quad (1)$$

Where, $T(P_i)$ denote the total time of activity, $I = 1, 2, 3, \dots, m$, $i = 1, 2, 3, \dots, K$, and D is the activity time.

- We choose the maximum value for the sum of the number of activities (m) that is: $\text{MAX } T(P_i) = T(P_c)$. $T(P_c)$ expresses activity that has the time numbered c . The activities should be given an attention and should be provided with manpower and resources to be achieved as planned avoiding any delay in completing the project.
- Analytical method (Consultants, 1967): We have seen previously how to calculate the early and late time and time reserve for each activity according to each system. We know that activities which do not have a reserve time are critical activity. The non-critical routes, consisting of critical activities (with no free time reserve) and non-critical activities (with a free time reserve greater than zero), need a completion period less than the completion period of the critical activity. It has a surplus time and this feature differentiates between the time of the critical path and the time of non-critical activity.

Example:

Determine the critical path of the following network diagram explained in [Figure 18](#) which shows an example for distribution of activities. The required time of completing each activity is mentioned on the arrow (Shamarti, 2010).

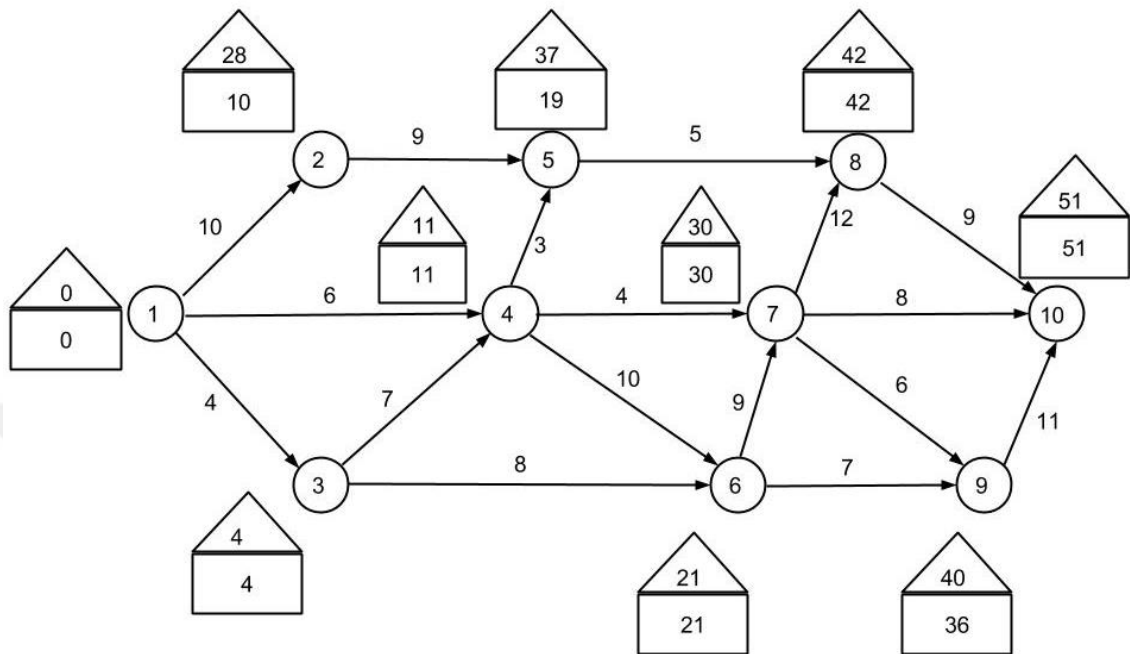


Figure 18: An example of a network diagram

Source: Operations research is understood and applied, p334.

The process of calculating the early times of all the activities is as below:

$$ES_1 = 0$$

$$ES_2 = ES_1 + d_{12} = 0 + 10 = 10$$

$$ES_3 = ES_1 + d_{13} = 0 + 4 = 4$$

$$ES_4 = \text{Max.} \begin{cases} ES_3 + d_{34} \\ ES_1 + d_{14} \end{cases} = \text{Max.} \begin{cases} 4 + 7 \\ 0 + 6 \end{cases} = 11$$

$$ES_5 = \text{Max.} \begin{cases} ES_2 + d_{25} \\ ES_4 + d_{45} \end{cases} = \text{Max.} \begin{cases} 10 + 9 \\ 11 + 3 \end{cases} = 19$$

$$ES_6 = \text{Max.} \begin{cases} ES_4 + d_{46} \\ ES_3 + d_{36} \end{cases} = \text{Max.} \begin{cases} 11 + 10 \\ 4 + 8 \end{cases} = 21$$

$$ES_7 = \text{Max.} \begin{cases} ES_4 + d_{47} \\ ES_6 + d_{67} \end{cases} = \text{Max.} \begin{cases} 11 + 4 \\ 21 + 9 \end{cases} = 30$$

$$Es_8 = \text{Max.} \begin{cases} Es_5 + d_{58} \\ Es_5 + d_{78} \end{cases} = \text{Max.} \begin{cases} 19 + 5 \\ 30 + 12 \end{cases} = 42$$

$$Es_9 = \text{Max.} \begin{cases} Es_6 + d_{69} \\ Es_7 + d_{79} \end{cases} = \text{Max.} \begin{cases} 21 + 7 \\ 30 + 6 \end{cases} = 36$$

$$Es_9 = \text{Max.} \begin{cases} Es_8 + d_{8,10} \\ Es_9 + d_{9,10} \\ Es_7 + d_{7,10} \end{cases} = \text{Max.} \begin{cases} 42 + 9 \\ 36 + 11 \\ 30 + 8 \end{cases} = 51$$

While calculating late times is from the beginning of each event as below:

$$Lc_{10} = Es_{10} = 51$$

$$Lc_9 = Lc_{10} - d_{9,10} = 51 - 11 = 40$$

$$Lc_8 = Lc_{10} - d_{8,10} = 51 - 9 = 42$$

$$Lc_7 = \text{Min.} \begin{cases} Lc_{10} - d_{7,10} \\ Lc_9 - d_{7,9} \\ Lc_8 - d_{7,8} \end{cases} = \text{Min.} \begin{cases} 51 - 8 \\ 40 - 6 \\ 42 - 12 \end{cases} = 30$$

$$Lc_6 = \text{Min.} \begin{cases} Lc_9 - d_{6,9} \\ Lc_7 - d_{6,7} \end{cases} = \text{Min.} \begin{cases} 40 - 7 \\ 30 - 9 \end{cases} = 21$$

$$Lc_5 = Lc_8 - d_{5,8} = 42 - 5 = 37$$

$$Lc_4 = \text{Min.} \begin{cases} Lc_5 - d_{4,5} \\ Lc_7 - d_{4,7} \\ Lc_6 - d_{4,6} \end{cases} = \text{Min.} \begin{cases} 37 - 3 \\ 30 - 4 \\ 21 - 10 \end{cases} = 11$$

$$Lc_3 = \text{Min.} \begin{cases} Lc_4 - d_{3,4} \\ Lc_6 - d_{3,6} \end{cases} = \text{Min.} \begin{cases} 11 - 7 \\ 21 - 8 \end{cases} = 4$$

$$Lc_1 = \text{Min.} \begin{cases} Lc_3 - d_{1,3} \\ Lc_4 - d_{1,4} \\ Lc_2 - d_{1,2} \end{cases} = \text{Min.} \begin{cases} 4 - 4 \\ 11 - 6 \\ 28 - 10 \end{cases} = 0$$

Table 2 gives a summary of the early and late times, which was mentioned above, in addition to the surplus time:

Table 2: The early, late and surplus times of activities

Activity	Required time of achievement d_{ij}	Early time Es_i	Late time Le_i	Surplus time S_{ij}
1-2	10	0	28	18
1-4	6	0	11	5
1-3	4	0	4	0
2-5	9	10	37	18
4-5	3	11	37	23
3-4	7	4	11	0
4-6	10	11	21	0
3-6	8	4	21	9
4-7	4	11	30	15
6-7	9	21	30	0
5-8	5	19	42	18
6-9	7	21	40	12
7-9	6	30	40	4
7-8	12	30	42	0
8-10	9	42	51	0
7-10	8	30	51	13
9-10	11	36	51	4

Whereas the surprise time of each critical path (each activity of a critical activity) equals zero, so the critical path can be determined as below:

(1-3) (3-4) (4-6) (6-7) (7-8) (8-10)

What has been determined are the critical activities, and the critical path is as below:

(1-3-4-6-7-8-10)

2.3.2. Compression methods in -CPM-

The most important objective of this method is the tradeoff between time and cost to reduce the project duration by increasing various types of resources and knowing the additional costs. It makes the manager in a position of distinguishing and choosing between completing the project in a normal time and avoiding the additional cost or completing the project in reduced time and bearing the additional cost by balancing between:

- Reducing fixed costs by reducing the project time.
- Increasing variable costs as a result of increasing the resources needed to reduce the project time.

The network analysis is reduced by reducing critical path times that affect the project completion date. This reduction has two aspects (Kasir, 2000):

- The first engineering: is to identify and determine the possibility of reducing activity time technically. There are activities whose time cannot be pressed for technical reasons. The effect of technical, organizational and human variables processes during the compression process should be taken into account.
- The second is economic: it represents the additional burden of the project resulting from the reduction of critical path time. The required resources to carry out the reduction are often not available, or the reduction costs are greater than the savings of fixed costs.

All pressure methods assume that the relationship between direct costs and time is linear, and that the reduction begins with critical activities with a lower slope of cost curve. They also assume that the available resources are sufficient to carry out the pressure. The pressure is minimized in direct costs as technically as possible. One of the most important pressure methods for networks in CPM is, step-by-step compression of critical path activities: Network compression in this manner requires the following points:

- Identify project activities and logical relationships between these activities.

- Estimate the following indicators for each activity in the project:
 - D_{ij} : Normal time to complete activity ij .
 - d_{ij} : Reduced time to complete activity ij .
 - C_{ij} : The normal cost of completing the activity ij .
 - c_{ij} : The reduced cost of the activity ij .
- Identify critical activities based on natural times, and calculate all activities times in the network.
- Calculate the slope of the cost curve D_{ij} as below:

$$D_{ij} = \frac{c_{ij} - C_{ij}}{d_{ij} - D_{ij}} \quad (2)$$

- We choose the critical path with less tendency for the cost curve to reduce its time by one unit of time and also decrease the project by one unit of time.
- The reduction process activity time in the previous step results in additional costs. The reduction will continue, if these additional costs are less than the savings in fixed costs which are resulted from the reduction of the project time, that is, if the total project costs are lower than those are calculated according to the project time which is specified by using the normal times of its activities.
- We repeat the process until the total project costs become less than before the reduction. So the optimistic time (a) time plan gives us the lowest value for the total project costs.

In another hand, we can use the Benefit of this method of reduction using the free time reserve: This method is based on the use of free time reserve for non-critical activities in the process of reducing the time of the project. The reduction process is as below (Kasir, 2001):

- Calculate the reduction of time limits of each activity by one unit at each step, after the first steps in the reduction method.
- Prioritize the alternatives depending on the slope of the cost curve and the reduction of time limits of each activity.

- Modification time and cost, according to the previous arrangement.
- Calculate the free time reserve of non-critical activity, if one or more critical activities are obtained.
- Identify activities that have a positive free time reserve and determine the positive values of this time reserve.
- Determine the critical path that has the lowest tendency for the cost curve to reduce its time and determine the limits of reduction.
- Critical path time is reduced by the positive free time reserve or within the reduction period of critical activity.
- The next reduction process repeats itself until all network activities become critical.

2.4. Network Analysis by Progressive Evaluation Review Technique –PERT-

(PERT) is a networking model. It is used in scheduling, planning and controlling projects that contain some kind of uncertainty in the period of completion of some of its activities. This model handles the uncertainty in the foreseeable future. The reasons of this uncertainty are the factors and external variables that affect the process of achievement. It is difficult to count on one estimate of activity time. To limit this effect and to address deviations in activity times, the time of each random variable activity is subject to a given probability distribution rather than a fixed amount. Since the time of completion of each project activity is a continuous random variable, it is subject to a continuous probability distribution. There are some distributions that can be used to estimate the times of activities in (PERT), we will mention the following distributions as triangular (3) (Ang Alfredo,1975).

2.4.1. Triangular distribution

It is a continuous probability distribution used when actual data is missing or not collected, or when their collection is impossible. This distribution is defined on domain [A, B], it shall be as follows (Ang Alfredo H-S, 1975):

$$F(x) = \begin{cases} \frac{2}{d-a} \left(\frac{x-a}{u-a} \right) & a \leq x \leq u \\ \frac{2}{b-a} \left(\frac{b-x}{b-u} \right) & u \leq x \leq b \end{cases} \quad (3)$$

Where $f(x)$ Probability distribution achieves the condition

$$\int_a^b f(x) dx = 1 \quad (4)$$

a = minimum

u = The most likely value

b = The upper limit is so $a \leq u \leq b$.

2.4.2. Regular distribution

This distribution is used to estimate the required time to accomplish a task, after estimating the upper and lower limits of that variable. It is represented as below (Tang, 1975):

$$f(x) = \begin{cases} \frac{1}{b-a} & a \leq x \leq b \\ 0 & \text{other wise} \end{cases} \quad (5)$$

2.4.3. β -PERT distribution

β -PERT distribution is derived from a distribution of the general BETA distribution. It is limited to knowing the approximate time of activity in the BART network when the actual data is missing. This distribution is based on three estimates of the time of activity completion (Bakry, 1997):

- Optimistic Estimate (a): is the estimated time for completing the work of two events which are taken at minimum levels. All the activities should be

appropriate for the process without any hindrances in implementation. All the conditions for performance and necessary resources must be good. This represents the optimistic time (a) time to achieve the event. This period can only be reduced by increasing expenditures.

- The Pessimistic Estimate (b): It is the estimated time to complete the work under bad conditions. It means that the achievement of this activity faces the worst conditions.
- The Most Likely Estimate (m): It means the expected time for completing the activity under normal conditions which are the most realistic and possible time to complete the activity. It is usually determined technically or by reference to experience in estimating the most likely to achieve.

The average of these estimates is determined by using the following equation:

$$\bar{D}_{ij} = \frac{a + 4m + b}{6} \quad (6)$$

The discrepancy gives the following relationship:

$$\sigma^2 = (b - a)^2 / 36 \quad (7)$$

Thus, the standard deviation is as below:

$$\sigma = b - a/6 \quad (8)$$

The use of BETA distributions is to estimate the duration of project activities which are most commonly used in the PERT model. This is why we will also use it through our research.

When we determine the expected time to find the critical activity, we follow the same steps as in CPM. This helps the project planner to compress the network by reducing the activity time, which will inevitably be offset by an increase in cost and then leads to the trade-off between the elements of time and cost. We note that the methods used in CPM are the same as those used in PERT, in addition to other methods of reducing PERT network. One of these methods is the method of reducing the time of a project by using the free time reserve according to the PERT/COST method. This method is based on the

differentiation between the time reserve of the activity and its reduced time, whichever is less. And then trade off with the larger cost tendency. The compression process is as below:

- Estimate the following indicators for each activity: d_{ij} , c_{ij} , D_{ij} , C_{ij} .
- Drawing the network and analysed it according to reduce times and to identify the critical path which represents the least time in which the project can be implemented under technically possible compressed times.
- Determine the time reserve. That is the difference between the reduced start and end times of non-critical project activities. And determine which time units can reduce non-critical activity.
- Identify all non-critical network activities and their times. And also identify the time reserve for each activity.
- We identified non-critical activities that belong to only one non-critical activity. We then reduced the time of these activities, choosing the non-critical path that has the greatest slope to the cost curve. We reduce its time by its time reserve, or by units to which we must reduce the time of that activity. Then we reduce the non-critical path time thereafter and repeat the process of calculating the cost savings after each reduction for a non-critical path time by making the slope of the cost curve of the activity by a number of reduced time units.
- We identify non-critical activities that belong to more than one non-critical activity. Non-critical path selects the largest cost.
- We repeat the steps until we will be unable to press more.

Example¹:

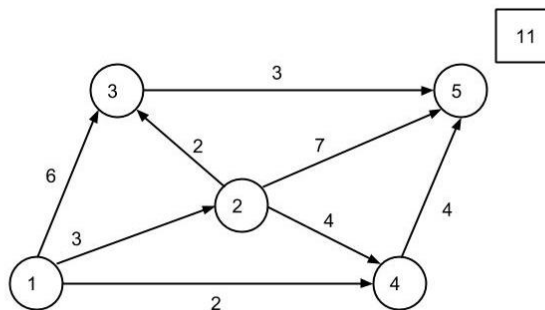
An industrial company has an investment opportunity to contribute to the completion of a specific project with a bid of (90000) dinars, but the project must be completed in

¹ See (Alshumarti, 2010)

eight weeks. Use the principle of barter between cost and time required for the achievement to schedule the lowest cost, and what recommendations do you recommend.

Activity	Time (duration)		Cost		slope
	normal	Crash	normal	crash	
1 - 4	2	1	8000	13000	5000
1 - 2	3	1	7000	19000	6000
1 - 3	6	5	11000	13500	2500
2 - 3	2	1	9000	10000	1000
2 - 4	4	3	6000	10000	4000
2 - 5	7	6	8500	11500	3000
3 - 5	3	2	5000	7000	2000
4 - 5	4	3	10500	16000	5500
			65000		

First: Network diagram must be drew.



Second: determine the critical activity.

6000 4000 5500

P₁: (1 - 2) (2 - 4) (4 - 5)

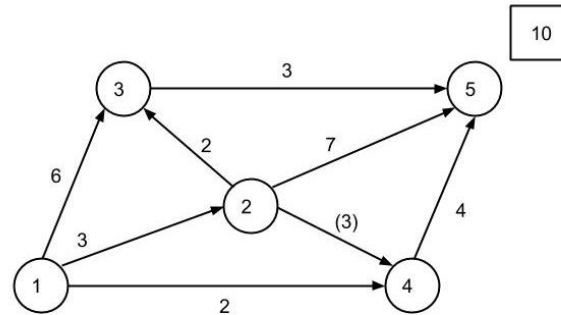
Which takes 11 weeks. In the above figure, each activity is known.

Here the activity that carries the lowest cost is completed. This activity is:

(2 – 4): 4000

The total cost is:

$$65000 + 4000 = 69000$$



In the second network diagram, two critical activities appear.

Two parallel lines should be put under the non-compressible activity.

$$P_1: \underline{\underline{(1 - 2) (2 - 4) (4 - 5)}} \\ 3000$$

$$P_2: (1 - 2) (2 - 5)$$

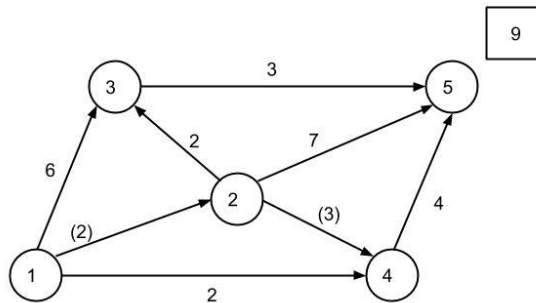
Here a combination of compressible activities must be selected and it is reduced by one unit of time, where the less cost is added to the total cost. If there is a joint activity which adds less cost, it also can be used. So (1 – 2) is selected because it is joint and when it is compressed it will add a cost of 6000 dinars which is the least addition of all combinations of the selected activity.

The added cost through the compression of (1 – 2) activity is:

(1 – 2): 6000

The total cost achieved by completing the project in nine weeks is:

$$69000 + 6000 = 75000$$



Through the network diagram, three critical activities appear. Here a combination of activities must be selected, in which these three activities participate. It must be added by compressing the least costs. If there is a joint activity which adds less cost, it also can be used.

$$6000 \quad 5500$$

$$P_1: \underline{\underline{(1 - 2) (2 - 4) (4 - 5)}}$$

$$3000$$

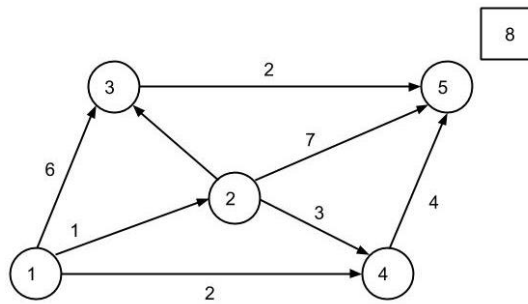
$$P_2: (1 - 2) (2 - 5)$$

$$2500 \quad 2000$$

$$P_3: (1 - 2) (3 - 5)$$

(1 - 2) (3 - 5) activities are selected. By compressing these activities, the three critical activities will be reduced by one unit of time. By compressing these two activities, 8000 dinars will be added to the total cost.

$$(1 - 2) (3 - 5): 8000 \text{ dinars}$$



So the total cost for completing the project in eight weeks is:

$$75000 + 8000 = 83000$$

The required time to achieve the project	Minimum cost
11	65000
10	69000
9	75000
8	83000

2.4.4. Comparison between -CPM- and -PERT-

According to what has been mentioned about traditional business networks we conclude that:

2.4.4.1. The similarities between CPM and PERT

- All project activities and events are certain to occur.
- They are used to schedule, plan and control projects; that is, to perform the same administrative functions.
- Many studies confirm that the results are proximate.
- They think that the activities of project are clear, that is, they have specific beginning and end and that they are separated.

2.4.4.2. Differences between CPM and PERT

- CPM considers the time as a fixed amount. While PERT considers it as a continuous random variable subjects to a specific probability distribution.
- CPM uses one estimate of time. While PERT uses three estimates to estimate the expected time for completion of each activity in uncertain conditions. PERT is therefore more realistic and appropriate for new projects, especially the projects which have a kind of uncertainty.
- CPM is used to manage construction and construction projects. These projects often use modular materials based on fixed technology that is not so exposed to change. While PERT is used in research and development, especially space-related industries. And the products of these modern industries are characterized by a high degree of change from time to time.

CPM and PERT consider that all project activities and events are certain. This makes their network architecture specific. They also consider that these activities are clear and independent. But this is a flaw because the theoretical estimates of the probability of time are uncertain due to their ignorance of the factors which affect the time. These factors include weather conditions, experience and practical skills of human resources, availability of raw materials ... etc. The completion of the activity is not certain, part of it may be accomplished or it may not be achieved at all and this is due to the nature of the work during the process of achievement. In order to make these estimates objective and good, there are other ways in the network planning process, which we will discuss later.

2.5. Modern Network Analysis Models

Traditional business models assume that project activities are specific and will be fully implemented. One activity cannot remain unfulfilled throughout the duration of the project. Activities, from the perspective of probability science, are certain events. They did not handle the uncertainty of the times of project activities. Although PERT relies on

information of a normal probabilistic, but the estimates of the probability theory of time variable are uncertain because they neglect qualitative factors affecting the time. For these reasons, new ways appeared to deal with these problems, such as the theory of Fuzzy set analysis and how to use it in the network planning.

2.5.1. Network planning and Fuzzy logic

This method deals with the time factor problem. It introduces the effect of qualitative factors (weather conditions, human resource efficiency, quality of other resources used in delivery such as machinery and equipment) on the time variable by using Fuzzy logic. Then we will clarify concepts about Fuzzy logic and review how they are used in network planning according to the analysis of PERT network and the scheduling of the project.

2.5.2. Fuzzy logic concepts

The selected group is defined as a set of elements and any element may or may not belong to the group (George J. Klir, 1995). The Fuzzy set analysis was defined by Zadeh in 1965 as follows: The Fuzzy set analysis is varieties of elements with a continuous level of belonging. This group was characterized by the importance of belonging distinctive, which assigned to each element a level of belonging range between zero and one. (Yuan, 1995) That is, when the element takes one degree of belonging (1) it means that the element belongs entirely to the Fuzzy set analysis, and when the degree of affiliation is zero (0), it means that the element does not belong at all to the Fuzzy set analysis. Other degrees vary from zero to one. When the degree of belonging is (0.5), it means that the element belongs to the Fuzzy set analysis by (0.5) and it does not belong to the group by the same rate. This element is called the balancing point. When the degree of belonging is (0.9), it means that the element belongs to the Fuzzy set analysis by (0.9), and does not belong to it by (0.1). It is closer to belonging than not belonging. The Fuzzy set analysis (A) is written as below (Kosko, 1997):

$$A = \{x_1|u_a(x_1), x_2|u_a(x_2), x_3|u_a(x_3) \dots x_n|u_a(x_n)\} \quad (9)$$

x_i : Fuzzy set analysis elements A, $i=1, 2, 3 \dots n$

$u_a(x_i)$: Random variable shows the degree of belonging (x_i) to the Group A, as below:

$$u_a(x_i) \in [0,1]$$

The random variable (x) is intermittent. The degrees of belonging of elements (x_i) to the Fuzzy set analysis (A) is also an intermittent random variable. A is described as a fractured Fuzzy set analysis. If (X) is a constant variable, the degrees of belonging is represented by a known variable as the continuous belonging variable of the Fuzzy set analysis. This belonging variable takes different forms. Fuzzy numbers, which are represented by a trapezoidal or triangular affiliation curve, are the most important linear approximations. The latter is widely distributed in the representation of the times of the project activities (SEN, 2001). The Fuzzy figure represents a quadrilateral trajectory of belonging. The symbols (a, b, c, d) represent the following (Moselhi, 1996):

a: The minimum domain which represents the left follower.

b: The minimum domain which represents the kernel of the follower.

c: The maximum domain which represents the kernel of the follower.

d: The maximum domain which represents the right follower.

(x) represents a random variable indicating a value between A and B . A . Its belonging follower is defined as below (Bojadziev, 2007):

$$U_x = \begin{cases} \frac{x-a}{b-a} & a < x < b \\ 1 & b < x < c \\ \frac{x-d}{c-d} & c < x < d \\ 0 & \text{otherwise} \end{cases} \quad (10)$$

The values of the left spread, the right spread, and the intermediate level reflect the degree of uncertainty. Each Fuzzy figure is represented by an affiliation curve in trapezoidal shape, which is graphically illustrated in [Figure 19](#).

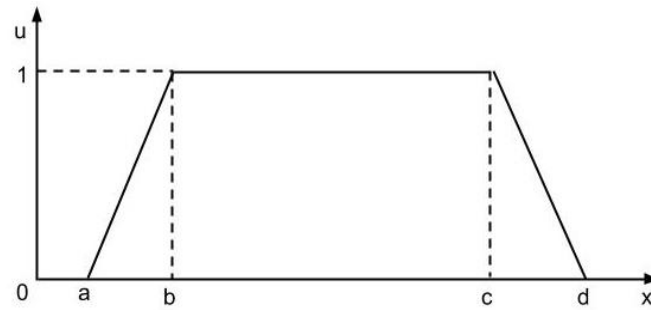


Figure 19: Fuzzy number represented by an affiliation curve in trapezoidal shape.

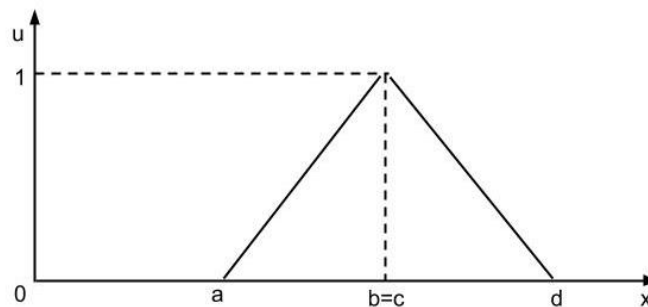
Source: George Bojadziev and Maria Bojadziev, *Fuzzy logic for business, finance and management*, 2nd, world scientific publishing, Singapore, 2007, p 25.

The Fuzzy figure, which is represented by a triangular affiliation curve, is a special case of a trapezoidal state. $B = C$ becomes the belonging follower of (x). It is graphically illustrated in Figure 20 and it takes the following formula:

$$U_x = \begin{cases} \frac{x-a}{b-a} & a < x < b \\ 1 & b = x = c \\ \frac{x-d}{c-d} & c < x < d \\ 0 & \text{otherwise} \end{cases} \quad (11)$$

Figure 20: Fuzzy number represented by an affiliation curve in triangle shape.

Source: George Bojadziev and Maria Bojadziev, *Fuzzy logic for business, finance and management*, 2nd, world scientific publishing, Singapore, 2007, p 25.



Also, the traditional collections can use the Fuzzy logic in performing their logical processes.

And we will explain it below:

1. Processes on intermittent Fuzzy logic:

- Intersection: The intersection of two Fuzzy set analysis (A) and (b) which are parts of the entire group (X). This entire group contains the elements (a) and (b) in terms of affiliation represented by the following relationship (Kosko, 1997):

$$U_{A \text{ and } B} = \min (U_{(A)}, U_{(b)}) \quad (12)$$

- Combination: it means combining two Fuzzy set analysis (a) and (b) which are two parts of the entire group. This entire group contains the elements (a) and (b) in terms of affiliation represented by the following relationship:

$$U_{A \text{ or } B} = \max (U_{(A)}, U_{(b)}) \quad (13)$$

- The group associated with a Fuzzy set analysis: is a Fuzzy set analysis which has the same elements of the basic group, but in different degrees of belonging which are calculated according to the following relationship (T.J.Ross, 2004):

$$u_{\bar{A}}(x) = 1 - u_A(x) \quad (14)$$

$(u_{\bar{A}}(x))$ represents the degree of belonging to the accompanying group (A).

2. Fuzzy relationship: if the Fuzzy set analysis (A) is a part of the total group (X) and the Fuzzy set analysis (B) is a part of the total group, the Fuzzy relationship (R) between (A) and (B) represent the result of the multiplication of them ($A * B$), which has a belonging of the following form (Asai, 1995):

$$U_{A \times B(X_i, X_j)} = U_{R(X_i, X_j)} = U_{a(X_i)} \wedge U_{b(y_j)} \quad (15)$$

$R(X_i, X_j)$ represents a Fuzzy relation between X and Y.

(\wedge) refers to the low value (MIN).

$i = 1, 2, 3, \dots, n$ and $j = 1, 2, 3, \dots, m$.

$U_{A \times B(X_i, X_j)}$ refers to the belonging degree of (X_i, X_j) to the Cartesian.

R is expressed in matrix form as below:

I		B				
		Y_1	....	Y_j	....	Y_m
A	X_1	$\text{Min} (U_{a(X_1)}, U_{b(y_1)})$	....	$\text{Min} (U_{a(X_1)}, U_{b(y_j)})$	....	$\text{Min} (U_{a(X_1)}, U_{b(y_m)})$
	\vdots	\vdots		\vdots		\vdots
	X_i	$\text{Min} (U_{a(X_i)}, U_{b(y_1)})$	....	$\text{Min} (U_{a(X_i)}, U_{b(y_j)})$	....	$\text{Min} (U_{a(X_i)}, U_{b(y_m)})$
	\vdots	\vdots		\vdots		\vdots
	X_n	$\text{Min} (U_{a(X_n)}, U_{b(y_1)})$	....	$\text{Min} (U_{a(X_n)}, U_{b(y_j)})$	....	$\text{Min} (U_{a(X_n)}, U_{b(y_m)})$

We can perform previous processes on the same Fuzzy relationships using the following formulas:

$$U_{k=1}^n R_k (X_i, Y_j) = V_{k=1}^n [R_k (X_i, Y_j)] \quad (16)$$

$U_{k=1}^n R_k (X_i, Y_j)$ refers to combining Fuzzy relations, the number of these relations is n between the elements Y and X.

$[R_k (X_i, Y_j)]$ is the belonging degree of (X_i, Y_j) to the Fuzzy relation K, where $K=1,2,3,\dots,n$

(V) refers to the maximum value.

$$\cap_{k=1}^n R_k (X_i, Y_j) = \wedge_{k=1}^n [R_k (X_i, Y_j)] \quad (17)$$

$\cap_{k=1}^n R_k (X_i, Y_j)$ refers to the intersection of Fuzzy relations, the number of these relations is n between the elements Y and X

(\wedge) refers to the low value (MIN).

- The relation which accompanies the Fuzzy relation is as below:

$$U_{\bar{R}} (X_i, Y_j) = 1 - U_R (X_i, Y_j) \quad (18)$$

3. Fuzzy structure: It is a Fuzzy relationship resulting from the installation of two Fuzzy relations, as below:

A: Fuzzy partial group of total group X.

B: Fuzzy partial group of total group Y.

C: Fuzzy partial group of total group Z.

R: The Fuzzy relationship between A&B.

T: The Fuzzy relationship between C&B.

Hence, the Fuzzy relationship between A&C is the Fuzzy structure of T&R, as expressed in the following affiliation

$$U_{TOR}(X_i, Z_k) = \max_{y_j} [\min U_R(X_i Y_j), U_T(X_i, Z_k)] \quad (19)$$

$U_{TOR}(X_i, Z_k)$ is the belonging degree of (X_i, Z_k) to the Fuzzy structure

4. Processes on Fuzzy numbers (L.Pasit, 1996): (M) and (N) are two virtual ambiguous numbers represented by an oblique affiliation, as below:

$$N = (a_1, b_1, c_1, d_1) \quad M = (a_2, b_2, c_2, d_2)$$

If $M \subseteq N$, so $U_{M(x)} \leq U_{N(x)}$ and the processes will be as below:

$$M \oplus N = (a_1 + a_2, b_1 + b_2, c_1 + c_2, d_1 + d_2) \quad (20)$$

$$M \ominus N = (a_1 - d_2, b_1 - c_2, c_1 - b_2, d_1 - a_2) \quad (21)$$

$$m\tilde{a}x(M, N) = [V(a_1, a_2), V(b_1, b_2), V(c_1, c_2), V(d_1, d_2)] \quad (22)$$

$$M\tilde{i}n(M, N) = [\Lambda(a_1, a_2), \Lambda(b_1, b_2), \Lambda(c_1, c_2), \Lambda(d_1, d_2)] \quad (23)$$

$$M \cap N = \{x, [u_{M(x)} \wedge u_{N(x)}]\} \quad (24)$$

Fuzzy addition process.

Fuzzy subtraction process.

$m\tilde{a}x(M, N)$ maximum Fuzzy number.

$M\tilde{i}n(M, N)$ minimum Fuzzy number.

2.5.1.2. Time as a Fuzzy concept

Dates and times are used to represent the time of achieving activities and project during setting the project time plan. History is used to indicate an important activity and foundation in the project as an end of a stage. While the time period according to (D_i) is the completion time of activity (i) in the project.

The uncertainty in the project is the summation of combining a number of degrees of uncertainty in the completion dates of the stages. The duration of implementation of activities affects the times of project activities, and then the project time. The Fuzzy times is used to deal with the uncertainty resulting from dates and time periods that are considered as specific times. Each one of these times will be shown below.

1. Specified times: The times which are expressed by moments or domains are specific times because the time variable takes a value within a range or specified value. That is, the degrees of belonging of these moments and each value of the time domain are equal one; otherwise, they will be non-existent.

The time zone, which is used in the time representation, is closed or open on one side. In many circumstances, the planner knows that a particular event will occur before or after a specific date, so he uses open fields on one side to express time (Moselhi, 1996). When circumstances do not help to determine the time value that will occur after or before the event, the closed time field will be used. So we have four kinds of different times (Moselhi, 1996).

- The specific time of one value (D_1) : that is, the activity will be carried out within the specified period (D_1) .
- A fixed time in a closed field $\{D_1, D_2\}$: that is, the activity will be performed in any value belonging to the previous field. It is impossible to do it before D_1 or after D_2 .
- A fixed time in an open field from the right. $\{D_1+\infty\}$: that is, the activity will be performed in any value belonging to the previous domain. It is impossible to do it before D_1 .

- A time specified in an open field from the left, that is, the activity will be performed at any value equal to or less than D_1 and impossible to exceed D_1 .
2. Fuzzy times: they are specific times indicate that the duration of the activity is possible or impossible. This is because the degree of time element belonging to the group according to these specified times is 1 or 0. These times become Fuzzy when the degree of belonging belongs to the domain $\{1,0\}$. In comparison with specific time, we find that (Palm, 1998):
- The time set at one value turns into a Fuzzy time with two Fuzzy edges. A triangle distribution indicates that the activity time can be between D_2 and D_3 . And the more likely value is D_1 .
 - The time specified in a closed field becomes Fuzzy by inserting two Fuzzy edges. It becomes a trapezoidal distribution indicating the most probable values. $\{D_1, D_2\}$. The less likely values are the values that belong to the domain $\{D_2-D_4\}$. The degrees of time values of $\{D_3-D_1\}$ are reduced to zero. Values are impossible before (D_3, D_4) and after (D_3, D_4) .
 - The time specified by an open field from the right becomes a Fuzzy time by introducing one Fuzzy boundary, which is the limit represented by field $\{D_1 - D_2\}$. Thus, time takes valuable values within this field. Time values are certainly possible within domain $\{D_1, +\infty\}$ and impossible within domain $\{-D_2, \infty\}$.
 - The time specified by an open field from the left becomes a Fuzzy time by introducing one Fuzzy boundary, which is the limit represented by field $\{D_1 - D_2\}$. Thus, time takes possible values within this field. Time values are certainly possible within field $\{0, D_1\}$ and impossible within other fields.

2.5.1.3. Analysis of the PERT network by using the estimation of the Fuzzy Logic

In traditional PERT technology, the duration of the activity is determined by the identification of indicators (a, b, m). The process of estimating these indicators is determined by experience in the field or by using similar project data. But these data are

often available because they are not comprehensive and do not contain all variables affecting the time of project completion. These variables may be descriptive (approximately, about, more ...) or quantity. So the theory of Fuzzy logic is used to deal with this problem and obtain accurate estimates of the time variable, by adjusting the values of probability distribution indicators that are subject to the project activity times according to the descriptive factors mentioned above. This leads to estimates of good faith, accurate calculations, and the results of a closer analysis of the reality and the circumstances that will surround the achievement.

The process of estimating probability distribution indicators (D, σ), which are subject to the times of project activities using the theory of Fuzzy logic, requires the following steps (Abdelhadi, 1999):

- Analyze the project structurally with a view to identifying activities and relationships of precedence between them to prepare a network diagram that illustrates these relationships.
- We estimate indicators (a, b, m) for each activity in the project.
- We determine the qualitative factors affecting the duration of each activity in the initiation. Each qualitative factor is classified in specific cases. We determine the frequency of each case and its negative impact on the duration of the activity by linguistic expressions. F is the occurrence of a negative group, C is the negative effect of a comprehensive set, and d is the length of time, all of these represent an interrupted Fuzzy set analysis.
- Converting the previous language expressions into Fuzzy set analysis using the following Fuzzy logic, which is one of the most popular groups:

Language expression	Expressed Fuzzy set analysis
very big	{0.8 / 0.25, 0.9 / 0.8, 1 / 1}
Big	{ 0.8 / 0.5 , 0.9 / 0.9 , 1 / 1 }
Medium	{ 0.3/0.2 , 0.4/0.8 , 0.5/1 , 0.6/0.8 ,0.7/0.2 }
Small	{ 0/1 , 0.1/ 0.9 , 0.2/ 0.5}

little small	{ 0/1 , 0.1/0.88, 0.2/0.42 }
very small	{0/1 , 0.1/ 0.81 , 0.2/ 0.25 }

- We find that the Cartesian deity, which is called the Fuzzy relationship between two partial Fuzzy set analyses, is the first partial of the total group F . And the second is the comprehensive group of negative impact C on a condition during the time of activity implementation and write it in matrix form as previously reported.
- After obtaining all the Fuzzy relationships and for all the conditions and qualitative variables, then we find the total effects of these qualitative factors which affect the time of activity implementation by combining the Fuzzy relationships with each other. The process of the combining finds the meeting of those relations by using the equations mentioned earlier. So we get the relationship T which contains all parts of the domain $[0, 1]$. Then we find the ambiguous Fuzzy relations between the negative results of the effects in the time of activity implementation and the time expressed in linguistic expressions which are turned into Fuzzy set analysis. The elements of the Fuzzy logic which represent the time are (a, b, m) .
- Finding the Fuzzy relations resulting from the previous step by using the previously mentioned combination relationship. Then we get a Fuzzy relationship (a) that contains all parts of the field $[0, 1]$.
- We have R a Fuzzy relationship between C and F . As well as T Fuzzy relationship between D and C . The Fuzzy relationship between F and D is obtained through the Fuzzy structure between R and T by using the relationship studied previously.
- In order to select the Fuzzy set analysis for the duration of the activity, taking into consideration the effect of all factors, we calculate the sum of the elements of each line in matrix (a) by the corresponding frequency (that is, the frequency of the corresponding occurrence). The belonging degrees of the Fuzzy set analysis elements which represent the period of activity implementation correspond to the highest value of the previous results values as follows:

$$\begin{aligned}
 & \sum_{j=1}^n TOR_{1j} \times F_1 \\
 & \sum_{j=1}^n TOR_{2j} \times F_2 \\
 & \vdots \\
 & \vdots \\
 & \sum_{j=1}^n TOR_{nj} \times F_n
 \end{aligned} \tag{25}$$

$$U_{x_i} = MAX_i \sum_{j=1}^n TOR_{ij} \times F_i \tag{26}$$

- We calculate the probability distribution indicators for the activity time based on that Fuzzy set analysis which is obtained by calculating the probability that makes the activity time equal to each element of this group as follows:

$$\begin{aligned}
 P(D = X_1) &= U_{x_1} / \sum_{i=1}^n U_{x_i} \\
 P(D = X_1) &= U_{x_1} / \sum_{i=1}^n U_{x_i} \\
 &\vdots
 \end{aligned}$$

$ P(D = X_n) = U_{x_n} / \sum_{i=1}^n U_{x_i} \tag{27} $
--

We get the following distribution:

X_i	X_1	X_2	.....	X_n	Σ
$U(X_i)$	$U(X_1)$	$U(X_2)$	.....	$U(X_n)$	/
$P(X_i)$	$P(X_1)$	$P(X_2)$	.....	$P(X_n)$	1

- Calculate the previous probability distribution indicators by using the following relationships:

$$\bar{D} = \sum_{i=1}^n x_i * P(X_i) \quad (28)$$

$$\sigma^2 = \sum_{i=1}^n x_i^2 * P(X_i) - (\bar{D})^2 \quad (29)$$

$$\sigma = \sqrt{\sum_{i=1}^n x_i^2 * P(X_i) - (\bar{D})^2} \quad (30)$$

New values (D, σ), which are obtained by applying the above steps to each project activity, are used to analyze the PERT network and to prepare a project plan as in the traditional PERT network, which determines the critical path and estimates the time required to complete the project.

2.5.1.4. The importance of using Fuzzy logic theory in network analysis:

Traditional network analysis models were not generally addressed. In particular, the PERT approach is a matter of uncertainty associated with the times of project activities. Although the PERT model relies on information of a probabilistic nature, however, the time required to complete the activity remains unknown or uncertain. This case of uncertainty necessitates the use of the probabilistic method, depending on the basis that represents the activity time as a continuous random variable subjects to a given probability distribution in two fields (expected value and standard deviation), allows to calculate difference coefficient which is a measure of uncertainty. The probability theory of the time variable is uncertain because it neglects the qualitative factors in the time factor (weather conditions which surround the completion process, work experience and skill, the quality of other resources used in the process of implementation, such as machinery and equipment and the efficiency of its performance). So that these estimates are objective and good. The effect of time-specific qualitative factors on the time variable is involved by using the Fuzzy logic theory.

The use of the Fuzzy logic theory is not limited to estimating probability distribution indicators. But rather to provide a reliable timetable for the implementation of the project plan. It can determine the time of the Fuzzy project. Time-based network analysis which, uses the Fuzzy logic theory, is called the Fuzzy network. It is clear and the relationships of precedence between its activities are known. But its activities are unclear. The activity

may be performed at all or a part of it may be performed or it may remain unfulfilled. There is ambiguity about each activity, making the activity time unclear and Fuzzy.

It is clear to us that network planning helps project implementers to deal with many problems, including delays in the completion of project activities due to the lack of timely management of project activities. As well as dealing with the problem of scarcity of resources through knowledge of critical activities and directing employment towards them in order to achieve them on time. This can be illustrated by following several models, the first of them is GERT, which is the first technique used in project management. But the lack of this scheme in detailing the activities of the project, and in clarifying the logical relations between them and also the appearance of large-scale projects, led to the appearance of new models in line with these changes.

Techniques (CPM) and (PERT) allowed for a comprehensive view of the project and its activities. Their use has thus become very broad. However, these models did not address the problem of uncertainty associated with project times. Although PERT relies on information of a potential nature. However, the time required to complete the activity remains unknown. This is due to the neglect of qualitative and influential factors in time factor (weather conditions, experience and skill of hand currency, quality of resources used in the delivery of machinery and equipment). In addition, it assumes that project activities are strictly defined and will be fully completed. Also, it does not allow the existence of reverse arrows. All these problems led to the appearance of new models trying to eliminate these difficulties.

The Fuzzy logic theory provided a reliable timeline for project implementation. By this technique, a Fuzzy time can be determined. Tracks in this technique are clear and relationships of precedence are known. But its activities are unclear that makes the time of completion unclear and Fuzzy. Therefore, belonging degrees of time variable are assigned to take decreased values from one to zero in such a way that time turns from one of the elements belonging to the group to an element that does not belong to the group. And using this technique eliminates all the qualitative factors affecting the estimation of the time of each activity.

CHAPTER THREE

ANALYSIS AND RESULTS

Projects have an important place in the economy. The development of projects affects the development and growth of countries. The identification of projects varies by purpose and objective. Projects are divided into two main axes; the first is a profit axis and the other is a service axis. These two axes are very similar and sometimes it is difficult to distinguish between them. Developed countries adopt an economic system that supports public projects that provide services to society and achieve profitability goals

It is no longer strange that developing countries pursue realistic economic policies; which are more committed to the general national interest and far from ideological bias. In the light of these policies, public enterprises have become a leading role in the economic development process in many countries of the world. A public project is a crucial instrument by which the developing country can mobilize and direct the necessary and sufficient production elements to the requirements of modern production. Such productions require a large economic size, technical and administrative progress, and business skill to be able to interact positively with the global market.

From this point of view, a general project is chosen to complete the buildings of the Ministry of Electricity - Research and Development Department in the Republic of Iraq Babylon city in order to apply the above techniques to this project. So that PERT is taken as a model of traditional networks models. For modern networks, the network planning is used by using the theory of Fuzzy Logic. In this chapter, the various aspects of network analysis are analysed as the cornerstone of this thesis.

The following points will be addressed:

- Definition of the project to be studied and the Stages of construction projects.
- Estimation of project time using CPM technique.
- Estimation of project time using PERT technique.

- Estimation of project time using Fuzzy set analysis.

3.1. Definition of the Project to be Studied

The exposure to the definition of the project to be studied requires at first exposure to the stages of construction projects and contracting methods in this type of projects that will address the stages of construction projects. Then, the entire project to be studied will be described.

3.1.1. Stages of construction projects

Construction projects usually go through a series of stages:

- A. Decision stage: At this stage, the employer will study the need to obtain the project, determine the requirements related to the project, and select consultants to assist in the completion of preliminary evaluation of the project and the feasibility study of the project and the impact of its presence in the economic and social aspects. At this stage, the project owner should make several arrangements, especially the identification of a project manager who is authorized by him and a project team. The project will also be described in terms of function and connection with the environment.
- B. The study and design stage: It is to transform the employee's aspirations, ideas and requirements related to the project into specific proposals through the following:
 1. The completion of an initial project design specifying the requirements of the legal and regulatory bodies related to the project (such as the foundations of the building and its systems) as well as the specifications and conditions of the used materials and the main construction methods in accordance with the project function and its nature. The stage consists of two main tasks for the researcher:
 - Initial Fee: The employer is required to submit the following points in the contractual period to the owner of the project:
 - ✓ Site map with all specifications related to the project and the environment surrounding the project.

- ✓ A report on the proposed architecture.
 - ✓ The block schema project which contains the port lets including the external configuration around the construction implant.
 - ✓ A representative diagram of each building type.
 - ✓ Unauthorized approval of the above-mentioned file by the project owner in the case and duration of the contract.
- Preliminary Project: It is a summary study based on figures for a comprehensive solution that allows the completion of the established program. This study includes the following points:
- ✓ Initialization scheme above the lifting Topographic.
 - ✓ Project Construction Plan.
 - ✓ Block scheme.
 - ✓ The height of the main facades.
 - ✓ Cross sections of different floors.
 - ✓ The longitudinal sections that necessary to understand the project.
 - ✓ Theoretical Drawing.
 - ✓ Specific variables for various possible technical solutions for the construction and justification of the solution or expected solutions.
 - ✓ Explanatory report with technical card.

As well as all the information that falls within the scope of this task and necessary to further appreciate the design of the project and its progress. The preliminary project task ends with the submission of the corresponding file to the project owner for approval. On the other hand, after the approval of the project owner of the preliminary project, the employer shall do the following:

- He decides to contact the reporter who is appointed by the project owner with the participation of the technical inspection authority for the building on the basis of the cluster plan presented in the preliminary project and the program of experiments and the procedure to be followed to study the soil.
- He monitors and interprets the geotechnical results of this study.

2. Prepare a cost plan by the quantities engineer in coordination with the design team.
3. Completion of the final design which is started after the completion of the initial design and the cost plan is similar to the initial design, but more detailed, which is through developing all the plans, specifications and conditions to guide the port to how to implement. This stage contains the following:
 - Documents were written are:
 - ✓ Technical specification books.
 - ✓ A comprehensive descriptive description for each share.
 - ✓ A quantitative and comprehensive assessment of each share with a summary table.
 - ✓ Plan of achieving the works of each section of the project.
 - Documents were drawn: they include the following:
 - ✓ Site plan.
 - ✓ Topographic plans for the floor.
 - ✓ Outline scaling chart with cross sections.
 - ✓ Cluster and external configurations.
 - ✓ The plan of the establishing the project and identify the different levels with the dimensions of the alleged foundations and the line of extensions and various connections, roads, footnotes and plantations.
 - ✓ Schemes of each level with identify blanks and different extensions for supply or drainage, as well as various equipment scheduled and put the passage.
 - ✓ Foundation Charts.
 - ✓ Surface charts with curves.
 - ✓ The height of the facades.
 - ✓ Longitudinal and transverse sections.
 - ✓ Schemes of traffic areas and barn.

- ✓ Outline plans, supporting walls, pedestrians, roofs, gardens, fences and other urban planners.
- ✓ Diagrams and forms of rain water and dirty water with channels.
- ✓ Plans for the establishment of green spaces with identify plant species.
- ✓ Sewage schemes and connections.
- ✓ Each other document falls within the scope of this task and is necessary to assess the design of the project and how it works better.
- ✓ Civil Engineering schemes with the calculation note

The implementation file shall be submitted for the approval of the owner of the project according to a plan prepared for this purpose.

- C. Contract stage or contractor selection: This means the way or method by which the contractor who implements the project will be selected. If the appointment of the Contractor is by consensual or direct appointment, it is preferable to appoint him after the completion of the initial design and cost plan, because when the contractor is appointed early, he will contribute effectively in the progress of the project quality.
- D. Implementation of the project: the stage of completion of the project in which the contractor takes the project site to complete the work of the project which is planned in the previous stages. This field of work includes three main elements:
- Prepare control information and documents to be relied upon during implementation.
 - Materials that used to complete the work of the project and conform to the specifications.
 - Comply with the special requirements which include:
 - ✓ Manufacturing quality; that is, the quality of project works.
 - ✓ The schedule, which ensures the coordination of the project activities and works, and helps in monitoring the completion of these works in a suitable time in order to complete the project on the determined time.

- ✓ Cost: Cost should be monitored according to the employer's requirements and compared to the cost plan So that the total cost of the project remains constant.

E. The contractor completes the work of the project sufficiently to allow the project owner to receive it. The project owner will inspect the work of the project and issue a list of defects that the contractor must fix in order to obtain the practical completion certificate (temporary receipt) The warranty period is one year old and the its amount is determined according to the contract and within the contract instructions.

F. Stage of operation, investment and project management:

The average time represents the expected value of time with a degree of belonging greater than the minimum and maximum times.

Through these methods, the project manager can manage his project in a way that is better than relying on the traditional method by specifying the timeframe in which the project is being completed. Therefore, he has a somewhat clear future vision makes him able to achieve his goal.

The projects vary in terms of purpose. The projects are divided into two main axes: the first is the profit axis and the second is the service axis. These two axes are very similar and it is difficult to distinguish between them sometimes. Developed countries adopt an economic system that supports public projects which provide services to society and achieve profitability goals.

3.1.2. Project of Babylon Training Center

The project of building a training centre for electricity Babylon / Training and Development Department / Ministry of Electricity / Republic of Iraq. According to the plans attached in Appendix (A).

The Babylon training centre is important for the employees working in the Ministry of Electricity. In cities within the Middle Euphrates region where they will be trained and developed in this scientific centre. The project contains the activities listed in Table 3 We

note that a team has been established to conduct engineering consultations, effects and time estimates that will help analyse the network of this project. The project contract was concluded under the Iraqi Investment Budget Implementation Law, which is summarized in Appendix (B).

3.1.3. Law and regulations of contracting

Implementation contract of Babylon Electricity Training Center

First Party / Ministry of Electricity - Training and Development Department

Second Party / Middle Euphrates Company and Delta Alrafedin Company

First party of contract

The establishment of an electricity training center in the province of Babylon on the plot No. 24/19573 District 11 and an area of 7751 m, owned by the first party and under the schedules of quantities, plans and designs attached to the contract, which is an integral part of the contract and under the supervision of a resident engineer, who is appointed by the first party.

The period of executing the contract should be 500 days starting from the date of receipt of the parcel of land which is described in the first item of the contract to the second party under a register organized for connecting the parties.

The contract amount and method of payment:

1. The amount of the contract (5,897,472,250) dinars only added to the general reserve amount of the contract by 7% (412,800300) dinars only.
2. The second party undertakes to submit a message from the strike department, which supports the discharge of his duty. (3.3%) of the value of the second party of contract should be deducted as insurance issued upon the submission of a message from the General Authority for Taxation, the companies section, by the entitlement to these guarantees, the issuance of the final acceptance certificate and the final settlement of accounts.

3. This contract shall be subject to increase and decrease by no more than (7%) (the reserve amount of the contractor) provided that a spare order is issued according to the controls.
4. If the contractor is unable to perform the contracting works in full, the first party may complete the work and return to the contractor with the payment of amounts.
5. The second party does not have the right to sub-contract with others in respect of the execution of part or all of the Contract without the formal consent of the first party.
6. This contract should be subject to the laws of Iraq upon the occurrence of any dispute between the parties and should be settled by the courts of Baghdad.
7. The following documents should be documents of the Contractor and the work should be performed in accordance with the provisions of the agency's regulations:
 - ❖ Contract.
 - ❖ Bills of quantities.
 - ❖ Submission form.
 - ❖ Paper assignment.
 - ❖ Contractor's bid.
 - ❖ Letter of Guarantee (5%) of the contract amount.
 - ❖ Clearance of the strike, no objection to participate in the tender.
 - ❖ General conditions for engineering contracting and the first two sections of civil and second electrical and mechanical engineering.
 - ❖ Iraqi laws and regulations. Written in Baghdad on 16/4/2008

3.1.4. Real implementation of the project

Administrative Law No. (14/6938) on 27/9/2012 and Administrative Order No. 15/7822 the initial receipt of the project was received by the executing company on 4/10/2011. The project was completed and the final receipt was received on 3/9/2012. Completion of the entire project is **340** days.

The work to be accomplished according to the conditions of the supervisor of the project, which must meet all the technical specifications required and specified in the contract are shown in Table 3.

Table 3: The activities that comprise the project according to the contract between the executing company and the Ministry of Electricity

Event	Details	Unit	Quantity	Predecessor Activity	Time (day)
A	A) The earthworks shall be drilled according to the drawings, dimensions and depth of the indicator in the drawings. The drilling shall be vertical and straight, leading to good soil suitable for foundation or according to the drawings. The price includes the withdrawal of groundwater if it appears.	m ³	16857	----	20
B	(B) Equipping materials, brushes and layers of gravel. The thickness of each layer 25 cm with the burial to reach the required levels with all that is necessary to achieve a good and integrated work.	m ³	15326	----	40
C	Ordinary and reinforced concrete works for foundations, under the foundations and walkways, according to the project plans and required specifications by using resistant cement.	m ²	5459	A, B	60
D	Green spaces, landscaping, paving roads in asphalt with parking lots, 15 cm concrete	m ² m L	5632 575	A, B	50

	walkways, concrete and stone fence, Park fence for parking lots and playgrounds according to the project plans and technical specifications.				
E	The construction of the bricks above the 24 cm thickness and all the floors according to the dimensions that indicated in the drawings by using ordinary cement.	m ³	1528	A, B	90
F	Electricity: Processing and connecting the main and internal electrical systems according to the electrical plans and schedules of the project.	m L	2265	A, B	20
G	Concrete works for columns, ceilings, tiers, trenches, stairs, over rails, curtains, water pipes, according to project plans and required technical specifications.	m ³	866	C, E	36
H	Preparation and establishment of water and sewage network according to project plans and health tables.	m L	2000	A, B	15
I	Whitening with plaster, cementing, plastering works by cementing the packaging works in kashi, marble and ceramics for	m ²	15140	G	120

	floors and facades and flat works according to the project drawings and the required technical specifications.				
J	Installation of roofing, iron and wooden doors, windows and quarry of stairs and all that is required for metal and wooden work and paint according to the project drawings and required technical specifications.	m ² m ² m L NUMBER	3895 70 51 83 114	I	60
K	Providing and installation all electrical accessories and not limited to Pulp lights, fans, electrical switches ...etc. According to the project electrical plans and schedules.	NUMBER	1975	L	20
L	Providing and installation all sanitary accessories according to the project plans and sanitary manuals.	NUMBER	330	J, H	15

In accordance to the meeting with the team work which has considerable technical experience in Babylon city, we have identified each of the three times and then we calculated the expected time and variance of each activity as it is shown in CPM technique, PERT technique and Fuzzy Logic which expressed by (day) unit.

3.2. Estimation of Project Time Using CPM Technique Calculation Times of Activities

CPM technique depends on calculating the time of project activities and defining the critical activities and critical paths by drawing the network analysis of the project.

Drawing Network Analysis Figure 21 shows the sequence of events and times. As illustrated by the Extract Time (E.T), the Earliest Start Time (E.S), the Earliest Finish Time (E.F), the Latest Completion (L.C), Earliest Completion (E. C), and Float of Time (T.F) of each activity. It is also illustrate critical paths and critical events.

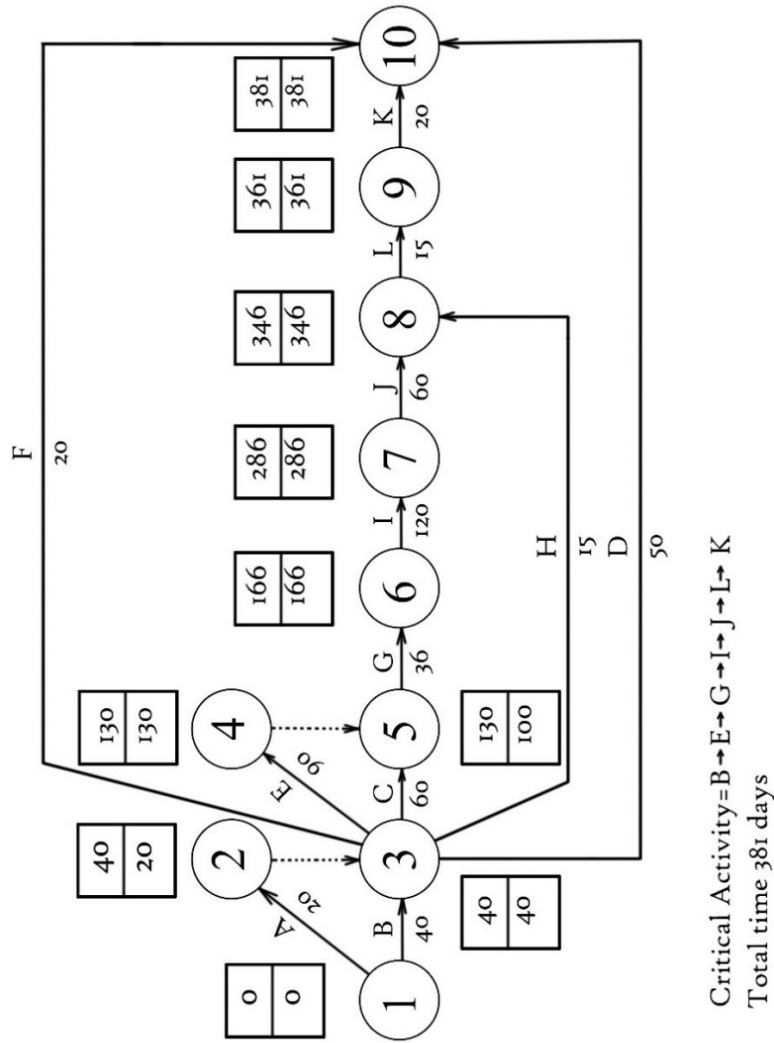


Figure 21: Drawing network by using the method of CPM

Table 4 shows the sequence of the project events, previous events, estimated time, float of time and critical activity.

Table 4 : Estimating project time by using the CPM technique

Event	Previous Activity	Time	Earliest start time (E.S)	Earliest finish time (E.F)	Latest Completion (L.C)	Earliest Completion (E.C)	Float of time (T.F)	Critical Activity (C.A)
A	---	20	0	20	0	20	20	
B	---	40	0	40	0	40	0	C.A
C	A-B	60	40	100	60	130	30	
D	A-B	50	40	90	50	381	291	
E	A-B	90	40	130	90	130	0	C.A
F	A-B	20	40	60	20	381	321	
H	A-B	15	40	55	15	346	291	
G	C-E	36	130	166	36	166	0	C.A
I	G	120	166	286	120	286	0	C.A
J	I	60	286	346	60	346	0	C.A
L	J-H	15	346	361	15	361	0	C.A
K	L	20	361	381	20	381	0	C.A

C.A= B →E →G →I →J →L →K, C.P=1 →3 →4 →6 →7 →8 →9 →10

Total time of project complication is 381 days.

3.3. Estimation of Project Time Using PERT Technique Calculation of Expected Times of Activities

The PERT technique, as mentioned in chapter 3, is based on three times, the optimistic time (a), the pessimistic time and the most likely time. The expected time (\bar{D}_{ij}) and variance(σ^2) are calculated from equation (6) and (7) as follows:

$$\bar{D}_{ij} = \frac{a + 4m + b}{6}$$

$$\sigma^2 = (b - a)^2/36$$

In accordance with our meeting with the engineering office which has considerable experience in the achievement, the studies office, and the technical interest in Babylon city, we have identified each of the three times and then we calculated the expected time and variance of each activity as it is shown in Table 5, the used unit is one day.

Table 5, shows the sequence of the project events, predecessor activity, expected time and variance.

Table 5: Calculation of the projected times of project activities

Event	Predecessor Activity	Optimistic Time (a)	Most Likely Time (m)	Pessimistic Time (b)	Expected Time (\bar{D}_{ij})	Variance (σ^2)
A	-----	15	20	50	24.1	34
B	-----	30	40	70	43.3	44.4
C	A, B	50	60	100	65	69.4
D	B A	45	50	75	53.3	25
E	A, B	70	90	150	96.7	177.8
F	B A	18	20	30	21.3	4
H	B A	12	15	25	16.2	4.7
G	C, E	30	36	50	37.3	11.1
I	E	100	120	175	125.8	156.3
J	I	50	60	100	65	69.4
L	S, H	12	15	25	16.2	4.7
K	L, F	18	20	35	22.2	8

After drawing Network Analysis as we can see in Figure 22 the Drawing of the network by using method of PERT shows that the sequence of events and times.. As

illustrated by the Extract Time (E.T), the Earliest Start Time (E.S), the Earliest Finish Time (E.F), the Latest Completion (L.C), Earliest Completion (E. C), and Float of Time (T.F) of each activity. It is also illustrate critical paths and critical events.

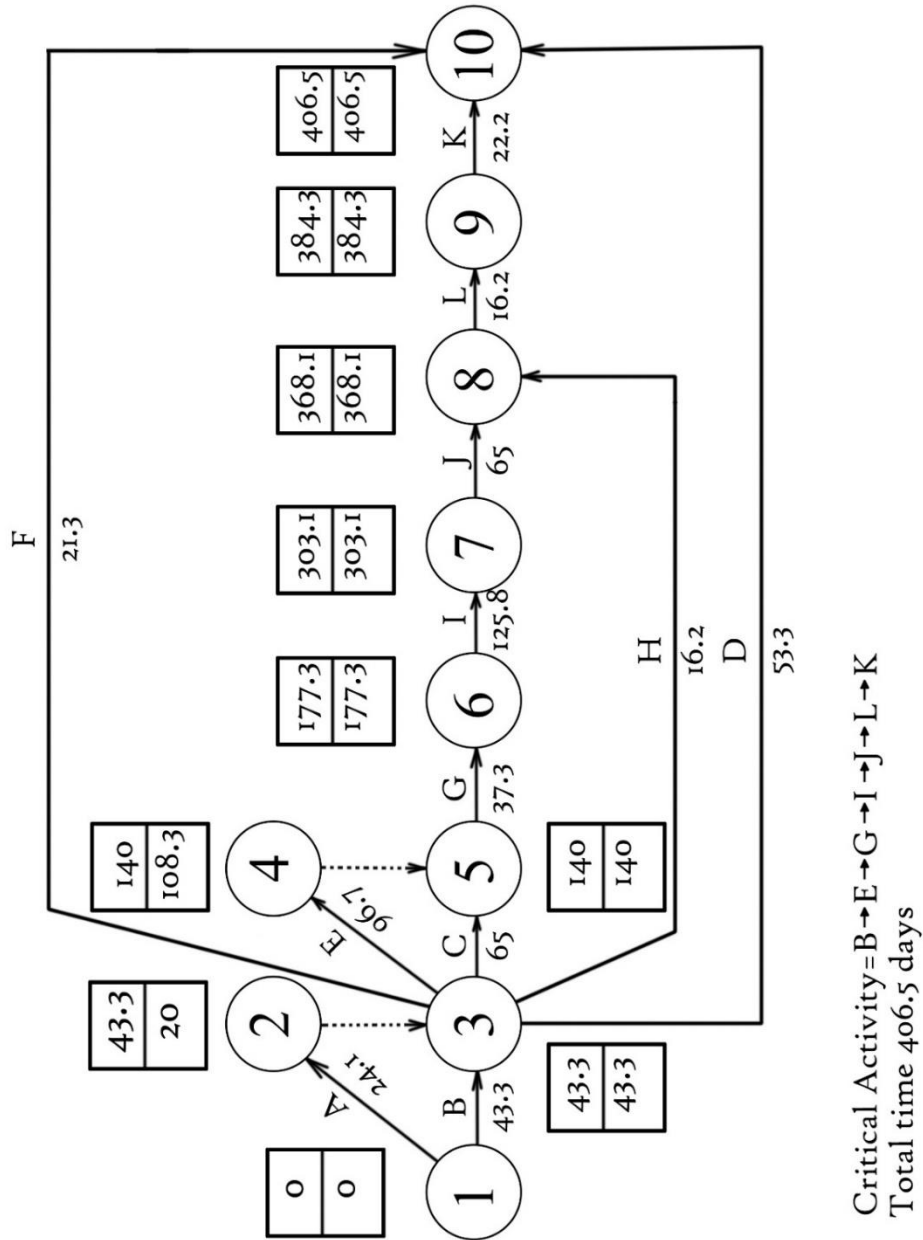


Figure 22 Drawing network by using the method of PERT

❖ Calculation of start and end times of activities

Table 6, shows the sequence of the project events, previous events, estimated time, float of time and critical activity.

Table 6: Calculation of start and end times of activities

Event	Expected Time (\bar{D})	Earliest Start Time (E.S)	Earliest Finish Time (E.F)	Latest Completion (L.C)	Earliest Completion (E.C)	Float of Time (T.F)	Critical Activity
A	24.1	0	24.1	0	43.3	19.2	
B	43.3	0	43.3	0	43.3	0	C.A
C	65	43.3	108.3	43.3	140	31.7	
D	53.3	43.3	96.6	43.3	406.5	309.9	
E	96.7	43.3	140	43.3	140	0	C.A
F	21.3	43.3	64.6	43.3	384.3	319.7	
H	16.2	43.3	59.5	43.3	368.1	308.6	
G	37.3	140	177.3	140	177.3	0	C.A
I	125.8	177.3	303.1	177.3	303.1	0	C.A
J	65	303.1	368.1	303.1	368.1	0	C.A
L	16.2	368.1	384.3	368.1	384.3	0	C.A
K	22.2	384.3	406.5	384.3	406.5	0	C.A

Through the previous network analysis it is clear that the critical activities which must be given great importance are:

C.A= B →E →G →I →J →L →K

C.P=1 →3 →4 →6 →7 →8 →9 →10

So the project minimum completion time is 406.5. The following points should be taken into consideration:

- ❖ The presence of critical activities: The contractor should pay attention to this point and it should be given a special supervision by the project manager.
- ❖ The existence of non-critical activities: it has a total time reserve that can be exploited during the delivery process, particularly with regard to human, machinery and equipment resource allocation, and with regard to external design activities and the construction of the protective wall, which is considered as a subproject of the project as a whole.

Despite this, but this method neglected several aspects in the process of achievement, especially with regard to the adverse weather conditions in the winter (which is characteristic of the region). As well as the efficiency of labor, that considered as an important factor in some activities, especially the field of construction, which is the subject of the study.

3.4 Estimating the Project Time Using Fuzzy Set Analysis

During this stage, it is attempted to show the impact of qualitative factors in the duration of activities completion of the project under study. Then the Fuzzy analysis of the project under study will be done and the time of activities completion will be estimated taking into account the qualitative factors affecting them.

3.4.1. The Fuzzy analysis of the project under study

The Fuzzy analysis is assumed that all project activities are correlated with a logical relationship of the end to beginning type. That is, it is impossible to start an activity until finishing the previous activity. It is also assumed that the activity times have a triangular distribution (a, b, c, d) where $b = c$ in Figure 23.

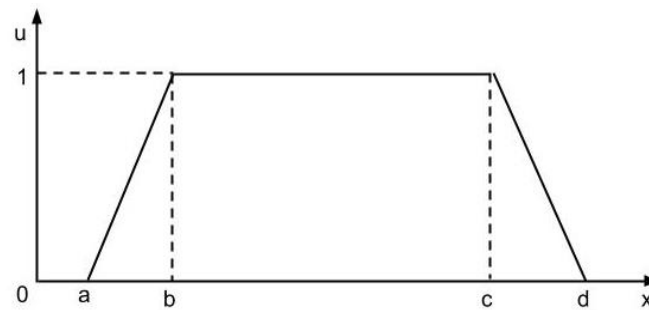


Figure 23: Fuzzy number represented by an affiliation curve in trapezoidal shape.

Source: George Bojadziev and Maria Bojadziev, *Fuzzy logic for business, finance and management*, 2nd, world scientific publishing, Singapore, 2007, p 25.

Where:

a: Expresses the minimum time of completion of the project and it is obtained through the optimistic time (a).

d: Expresses the maximum time of completion of the project and it is obtained through pessimistic time.

b, c: Express the average time limit of the completion of the project and they are obtained by the most probable time. So the used term is that the expected time to complete the project is the most likely time.

1. The completion time of the project is determined, taking into account the three project times.

When using the optimistic time (a), which is the least time to complete the activity, the estimated time to complete the project is 310 days. The critical activities for the critical path are: C.A= B →E →G →I →J →L →K Comparing this analysis with PERT analysis, the activities of the critical path are the same.

When using the most likely time, which is the moderate time to complete the activity, the estimated time to complete the project is 381days and the Critical activities for the Critical

path are: C.A= B →E →G →I →J →L →K. When comparing this analysis with PERT analysis, the activities of the critical path are the same.

When using the pessimistic time, which is the largest time to complete the activity, the estimated time to complete the project is 605 days and the critical activities for the critical path are: C.A= B →E →G →I →J →L →K. When comparing this analysis with PERT analysis, the activities of the critical path are the same.

It is calculated that the distribution of the activities of the project under study is a triangular distribution (310,381,381,605). The maximum duration is 605 days, the minimum duration is 310 days and the most likely period is 381 days. It is accepted to complete this project on PERT analysis with a difference time 25.5 days.

It is noted that in all previous cases there is an excess for non-critical activities, particularly with respect to external design and construction of the protective wall, which can be invested in the distribution of resources, whether human or equipment.

By comparing the Fuzzy analysis with the PERT technique, the expected time according to the Fuzzy model is more logical than the PERT model

Because it gives the following three indicators of time:

- ❖ A Minimal time period: when unexpected positive events positively affect the implementation of the activity, or when a part of the activity is carried out and not the whole activity.
- ❖ A maximum time period indicates that the expected time of completion of the activity when it adversely affects the implementation process is unpredictable (for example natural disasters).
- ❖ The average time refers to the expected value of time with a degree of belonging greater than the minimum and maximum times.

2. Factors affecting project activities

In order to analyze the project in time according to the method of estimating the Fuzzy logic of probability distribution indicators, the qualitative factors that affecting the

time of completion of each project activity, the cases of these factors and the stress of occurrence of each case and their negative impact should be determined as shown in.

Table 7.

Table 7: Factors affecting project activities

Event	Optimistic Time (a)	Most Likely Time (m)	Time pessimistic (b)	The qualitative factor studied	the condition	Frequency (F)	negative impact (C)
A	15	20	50	weather	Moderate to sunny	Small	Very small
					Moderate to rainy	average	Small
					bad	very big	big
B	30	40	70	weather	Moderate to sunny	Small	Very Small
					Moderate to rainy	average	Small
					bad	very big	big
C	50	60	100	Labor experience	High	very big	Very Small
					Medium	Small	little small
					Poor	Very Small	big
E	70	90	150	Labor experience	High	very big	Very Small
					Medium	Small	little small
					Poor	Very Small	big

G	30	36	50	weather	Moderate to sunny	Small	Very Small
					Moderate to rainy	average	Small
					bad	very big	big
I	100	120	175	Labor experience	High	very big	Very Small
					Medium	Small	little small
					Poor	Very Small	big
J	50	60	100	Labor experience	High	very big	Very Small
					Medium	Small	little small
					Poor	Very Small	big
L	12	15	25	Labor experience	High	very big	Very Small
					Medium	Small	little small
					Poor	Very Small	big
K	18	20	35	Labor experience	High	very big	Very Small
					Medium	Small	little small
					Poor	Very Small	big
F	18	20	30	Labor experience	High	very big	Very Small
					Medium	Small	little small

					Poor	Very Small	big
H	12	15	25	Labor experience	High	very big	Very Small
					Medium	Small	Little small
					Poor	Very Small	big
D	45	50	75	weather	Moderate to sunny	Small	Very Small
					Moderate to rainy	average	Small
					bad	very big	big

In this analysis, we have relied on two main factors that greatly affect the project completion time: labour experience and weather conditions, which play an important role in the completion of construction projects.

The Fuzzy relationships between the negative effects of the qualitative factors and the time period are shown in [Table 8](#)

Table 8: The Fuzzy relationships between the negative effects of the qualitative factors and the time period

Source: Mohamed Abdel-Hadi and fall into the foggy logic in making administrative decisions. Kuwait University. The second issue, 1999.

Time period	Negative impact results C	Linguistic expression used
medium	big	$D=\{a/0,m/1,b/0.2\}$
Small	Medium	$D=\{a/1,m/0.5,b/0\}$
very small	Small	$D=\{a/1,m/0.1,b/0\}$

3. Estimating the time of the project under study:

At this stage, we will take two factors. The case of the experience is the qualitative factor affecting the situation and the other weather conditions are the influential factor. The calculation of each one is shown as below:

- ❖ Taking the activity (A) in which weather conditions are the most important qualitative factors affecting it because it needs a certain period both for the preparation and the duration of the survival of the concrete to be solid and usable, then the Fuzzy time is calculated.

1. Convert previous expressions into Fuzzy sets. And find the relationship between them by using equation (16):

$F_1 * C_1$		C_1 Very Small		
		0	0.1	0.2
F ₁ Small	0	1	0.81	0.25
	0.1	0.9	0.81	0.25
	0.2	0.5	0.5	0.25

$F_2 * C_2$		C_2 Small		
		0	0.1	0.2
F ₂ medium	0.3	0.2	0.2	0.2
	0.4	0.8	0.8	0.5
	0.5	1	0.9	0.5
	0.6	0.8	0.8	0.5
	0.7	0.2	0.2	0.2

$F_3 * C_3$		C_3 Very big		
		0.8	0.9	1
F ₃ big	0.8	0.25	0.5	0.5
	0.9	0.25	0.8	0.9
	1	0.25	0.8	1

2. $T = (F_1 * C_1) \cup (F_2 * C_2) \cup (F_3 * C_3)$ by using equation (17).

T	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
0	1	0.81	0.25	0	0	0	0	0	0	0	0
0.1	0.9	0.81	0.25	0	0	0	0	0	0	0	0
0.2	0.5	0.5	0.25	0	0	0	0	0	0	0	0
0.3	0.2	0.2	0.2	0	0	0	0	0	0	0	0
0.4	0.8	0.8	0.5	0	0	0	0	0	0	0	0
0.5	1	0.9	0.5	0	0	0	0	0	0	0	0
0.6	0.8	0.8	0.5	0	0	0	0	0	0	0	0
0.7	0.2	0.2	0.2	0	0	0	0	0	0	0	0
0.8	0	0	0	0	0	0	0	0	0.25	0.5	0.5
0.9	0	0	0	0	0	0	0	0	0.25	0.8	0.9
1	0	0	0	0	0	0	0	0	0.25	0.8	1

3- Convert time expressions into Fuzzy set analysis and to find the relationship between them by using equation (16):

R_1		D_1 medium		
		15	20	50
C ₁ big	0.8	0	0.5	0.2
	0.9	0	0.9	0.2
	1	0	1	0.2

R_2		D_2 Small		
		15	20	50
C_2 medium	0.3	0.2	0.2	0
	0.4	0.8	0.5	0
	0.5	1	0.5	0
	0.6	0.8	0.5	0
	0.7	0.2	0.2	0
R_3		D_3 Very Small		
		15	20	50
C_3 Small	0	1	0.1	0
	0.1	0.9	0.1	0
	0.2	0.5	0.1	0

4- $T = (R_1) \cup (R_2) \cup (R_3)$ by using equation (25):

R_2		D_2 Small		
		15	20	50
C_2 medium	0	1	0.1	0
	0.1	0.9	0.1	0
	0.2	0.5	0.1	0
	0.3	0.2	0.2	0
	0.4	0.8	0.5	0
	0.5	1	0.5	0
	0.6	0.8	0.5	0
	0.7	0.2	0.2	0
	0.8	0	0.5	0.2
	0.9	0	0.9	0.2
	1	0	1	0.2

5- Find the Fuzzy set analysis for activity time by using equation (19):

T		D			$\sum TOR_{ij}$	$\sum TOR_{ij} * F_i$
		15	20	50		
C ₂ medium	0	1	0.1	0	1.1	0
	0.1	0.9	0.1	0	1	0.1
	0.2	0.5	0.1	0	0.6	0.12
	0.3	0.2	0.1	0	0.3	0.09
	0.4	0.8	0.1	0	0.9	0.36
	0.5	1	0.1	0	1.1	0.55
	0.6	0.8	0.1	0	0.9	0.63
	0.7	0.2	0.1	0	0.3	0.21
	0.8	0	0.5	0.2	0.7	0.56
	0.9	0	0.9	0.2	1.1	0.99
1	0	1	0.2	1.2	1.2	

The Fuzzy set analysis of the activity (A) time: [15/0 20/1 50/0.2]

Probability distribution of activity time (A) which calculated by using equation (27) is:

$$P(D_A=15) = 0 \div 1.2 = 0$$

$$P(D_A=20) = 1 \div 1.2 = 0.833$$

$$P(D_A=50) = 0.2 \div 1.2 = 0.167$$

And, by using equations (28) and (29) respectively values of \bar{D}_A and σ^2 can be calculated as follow:

$$\bar{D}_A = (15*0) + (20*0.833) + (50*0.167) = 26$$

$$\sigma^2 = ((15)^2 * 0) + ((20)^2 * 0.833) + ((50)^2 * 0.167) - (26)^2 = 125.2$$

The Fuzzy set analysis of the activity (B) time: [30/0 40/1 70/0.2]

Probability distribution of activity time (B) is:

$$P(D_B = 30) = 0 \div 1.2 = 0$$

$$P(D_B = 40) = 1 \div 1.2 = 0.833$$

$$P(D_B = 70) = 0.2 \div 1.2 = 0.167$$

$$\bar{D}_A = (30*0) + (40*0.833) + (70*0.167) = 45$$

$$\sigma^2 = ((30)^2 * 0) + ((40)^2 * 0.833) + ((70)^2 * 0.167) - (45)^2 = 126.1$$

The Fuzzy set analysis of the activity (G) time: [30/0 36/1 50/0.2]

Probability distribution of activity time (G) is:

$$P(D_G = 30) = 0 \div 1.2 = 0$$

$$P(D_G = 36) = 1 \div 1.2 = 0.833$$

$$P(D_G = 50) = 0.2 \div 1.2 = 0.167$$

$$\bar{D}_G = (30*0) + (36*0.833) + (50*0.167) = 38$$

$$\sigma^2 = ((30)^2 * 0) + ((36)^2 * 0.833) + ((50)^2 * 0.167) - (38)^2 = 53.1$$

The Fuzzy set analysis of the activity (D) time: [45/0 50/1 75/0.2]

Probability distribution of activity time (D) is:

$$P(D_D = 45) = 0 \div 1.2 = 0$$

$$P(D_D = 50) = 1 \div 1.2 = 0.833$$

$$P(D_D = 75) = 0.2 \div 1.2 = 0.167$$

$$\bar{D}_D = (45*0) + (50*0.833) + (75*0.167) = 54.2$$

$$\sigma^2 = ((45)^2 * 0) + ((50)^2 * 0.833) + ((75)^2 * 0.167) - (54.2)^2 = 84.3$$

- ❖ Taking the activity (C) Where the professional experience of the worker is the most important qualitative factors affecting it because it

needs certain technical specifications, then the Fuzzy time is calculated.

Convert previous expressions into Fuzzy sets. And find the relationship between them by using equation (16):

$F_1 * C_1$		C_1 Very Small		
		0	0.1	0.2
F ₁ Very big	0.8	0.25	0.25	0.25
	0.9	0.8	0.8	0.25
	1	1	0.81	0.25

$F_2 * C_2$		C_2 Somewhat small		
		0	0.1	0.2
F ₂ Small	0	1	0.88	0.42
	0.1	0.9	0.88	0.42
	0.2	0.5	0.5	0.42

$F_3 * C_3$		C_3 big		
		0.8	0.9	1
F ₃ Very Small	0	0.5	0.9	1
	0.1	0.5	0.81	0.81
	0.2	0.25	0.25	0.25

2- $T = (F_1 * C_1) \cup (F_2 * C_2) \cup (F_3 * C_3)$ by using equation (17):

T	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
0	1	0.88	0.42	0	0	0	0	0	0.5	0.9	1
0.1	0.9	0.88	0.42	0	0	0	0	0	0.5	0.81	0.81
0.2	0.5	0.5	0.42	0	0	0	0	0	0.25	0.25	0.25
0.3	0	0	0	0	0	0	0	0	0	0	0
0.4	0	0	0	0	0	0	0	0	0	0	0
0.5	0	0	0	0	0	0	0	0	0	0	0
0.6	0	0	0	0	0	0	0	0	0	0	0
0.7	0	0	0	0	0	0	0	0	0	0	0
0.8	0.25	0.25	0.25	0	0	0	0	0	0	0	0
0.9	0.8	0.8	0.25	0	0	0	0	0	0	0	0
1	1	0.81	0.25	0	0	0	0	0	0	0	0

3- Convert time expressions into Fuzzy set analysis and to find the relationship between them by using equation (16):

R_1		D_1 medium		
		50	60	100
C_1 big	0.8	0	0.5	0.2
	0.9	0	0.9	0.2
	1	0	1	0.2

R_2		D_2 Small		
		50	60	100
C_2 medium	0.3	0.2	0.2	0
	0.4	0.8	0.5	0
	0.5	1	0.5	0
	0.6	0.8	0.5	0
	0.7	0.2	0.2	0

R_3		D_3 Very Small		
		50	60	100
C_3 Small	0	1	0.1	0
	0.1	0.9	0.1	0
	0.2	0.5	0.1	0

4- $T = (R_1) \cup (R_2) \cup (R_3)$ by using equation (25):

R_2		D_2 Small		
		50	60	100
C_2 medium	0	1	0.1	0
	0.1	0.9	0.1	0
	0.2	0.5	0.1	0
	0.3	0.2	0.2	0
	0.4	0.8	0.5	0
	0.5	1	0.5	0
	0.6	0.8	0.5	0
	0.7	0.2	0.2	0
	0.8	0	0.5	0.2
	0.9	0	0.9	0.2
	1	0	1	0.2

5- Find the Fuzzy set analysis for activity time by using equation (19):

T		D			$\sum TOR_{ij}$	$\sum TOR_{ij} * F_i$
		50	60	100		
C ₂ medium	0	1	1	0.2	202	0
	0.1	0.9	0.81	0.2	1.91	0.191
	0.2	0.5	0.25	0.2	0.95	0.19
	0.3	0	0	0	0	0
	0.4	0	0	0	0	0
	0.5	0	0	0	0	0
	0.6	0	0	0	0	0
	0.7	0	0	0	0	0
	0.8	0.25	0.1	0	0.35	0.28
	0.9	0.8	0.1	0	0.9	0.81
	1	1	0.1	0	1.1	1.1

The Fuzzy set analysis of the activity (C) time: [50/1 60/0.1 100/0]

Probability distribution of activity time (C) by using equation (27) is:

$$P(D_C = 50) = 1 \div 1.1 = 0.909$$

$$P(D_C = 60) = 0.1 \div 1.1 = 0.091$$

$$P(D_C = 100) = 0 \div 1.1 = 0$$

And, by using equations (28) and (29) respectively values of \bar{D}_A and σ^2 can be calculated as follow:

$$\bar{D}_C = (50 * 0.909) + (60 * 0.091) + (100 * 0) = 50.91$$

$$\sigma^2 = ((50)^2 * 0.909) + ((60)^2 * 0.091) + ((100)^2 * 0) - (50.91)^2 = 8.3$$

The Fuzzy set analysis of the activity (E) time: [70/1 90/0.1 150/0]

$$P(D_E = 70) = 1 \div 1.1 = 0.909$$

$$P(D_E = 90) = 0.1 \div 1.1 = 0.091$$

$$P(D_E = 150) = 0 \div 1.1 = 0$$

$$\bar{D}_E = (70 * 0.909) + (90 * 0.091) + (150 * 0) = 71.8$$

$$\sigma^2 = ((70)^2 * 0.909) + ((90)^2 * 0.091) + ((150)^2 * 0) - (71.8)^2 = 36$$

The Fuzzy set analysis of the activity (I) time: [100/1 120/0.1 175/0]

$$P(D_I = 100) = 1 \div 1.1 = 0.909$$

$$P(D_I = 120) = 0.1 \div 1.1 = 0.091$$

$$P(D_I = 175) = 0 \div 1.1 = 0$$

$$\bar{D}_I = (100 * 0.909) + (120 * 0.091) + (175 * 0) = 101.8$$

$$\sigma^2 = ((100)^2 * 0.909) + ((120)^2 * 0.091) + ((175)^2 * 0) - (101.8)^2 = 37.2$$

The Fuzzy set analysis of the activity (J) time: [50/1 60/0.1 100/0]

$$P(D_J = 50) = 1 \div 1.1 = 0.909$$

$$P(D_J = 60) = 0.1 \div 1.1 = 0.091$$

$$P(D_J = 100) = 0 \div 1.1 = 0$$

$$\bar{D}_J = (50 * 0.909) + (60 * 0.091) + (100 * 0) = 50.91$$

$$\sigma^2 = ((50)^2 * 0.909) + ((60)^2 * 0.091) + ((100)^2 * 0) - (50.91)^2 = 8.3$$

The Fuzzy set analysis of the activity (L) time: [12/1 15/0.1 25/0]

$$P(D_L = 12) = 1 \div 1.1 = 0.909$$

$$P(D_L = 15) = 0.1 \div 1.1 = 0.091$$

$$P(D_L = 25) = 0 \div 1.1 = 0$$

$$\bar{D}_L = (12*0.909) + (15*0.091) + (25*0) = 12.3$$

$$\sigma^2 = ((12)^2 * 0.909) + ((15)^2 * 0.091) + ((25)^2 * 0) - (12.3)^2 = 0.1$$

The Fuzzy set analysis of the activity (K) time: [18/1 20/0.1 35/0]

$$P(D_K = 18) = 1 \div 1.1 = 0.909$$

$$P(D_K = 20) = 0.1 \div 1.1 = 0.091$$

$$P(D_K = 35) = 0 \div 1.1 = 0$$

$$\bar{D}_K = (18*0.909) + (20*0.091) + (35*0) = 18.18$$

$$\sigma^2 = ((18)^2 * 0.909) + ((20)^2 * 0.091) + ((35)^2 * 0) - (18.18)^2 = 0.4$$

The Fuzzy set analysis of the activity (F) time: [18/1 20/0.1 30/0]

$$P(D_F = 18) = 1 \div 1.1 = 0.909$$

$$P(D_F = 20) = 0.1 \div 1.1 = 0.091$$

$$P(D_F = 30) = 0 \div 1.1 = 0$$

$$\bar{D}_F = (18*0.909) + (20*0.091) + (35*0) = 18.18$$

$$\sigma^2 = ((18)^2 * 0.909) + ((20)^2 * 0.091) + ((35)^2 * 0) - (18.18)^2 = 0.4$$

The Fuzzy set analysis of the activity (H) time: [12/1 15/0.1 25/0]

$$P(D_H = 12) = 1 \div 1.1 = 0.909$$

$$P(D_H = 15) = 0.1 \div 1.1 = 0.091$$

$$P(D_H = 25) = 0 \div 1.1 = 0$$

$$\bar{D}_H = (12*0.909) + (15*0.091) + (25*0) = 12.3$$

$$\sigma^2 = ((12)^2 * 0.909) + ((15)^2 * 0.091) + ((25)^2 * 0) - (12.3)^2 = 0.1$$

Table 9 shows the sequence of the project events, predecessor activity, expected time and variance.

Table 9: Calculation of the projected times of project activities

Event	Predecessor Activity	Optimistic Time (a)	Most Likely Time(m)	Pessimistic Time (b)	Expected time (\bar{D})	Variance (σ^2)
A	-----	15	20	50	25	125.7
B	-----	30	40	70	45	126.1
C	A, B	50	60	100	50.91	8.3
D	A, B	45	50	75	54.2	84.3
E	A, B	70	90	150	71.8	36
F	A, B	18	20	30	18.18	0.4
H	A, B	12	15	25	12.3	0.1
G	C, E	30	36	50	38	53.1
I	G	100	120	175	101.8	37.2
J	I	50	60	100	50.91	8.3
L	J, H	12	15	25	12.3	0.1
K	L	18	20	35	18.18	0.4

6. Draw the project network by using the method of Fuzzy logic

We can see the sequence of events and times in [Figure 24](#). As illustrated by the Extract Time (E.T), the Earliest Start Time (E.S), the Earliest Finish Time (E.F), the Latest Completion (L.C), Earliest Completion (E. C), and Float of Time (T.F) of each activity. It is also illustrated critical paths and critical events.

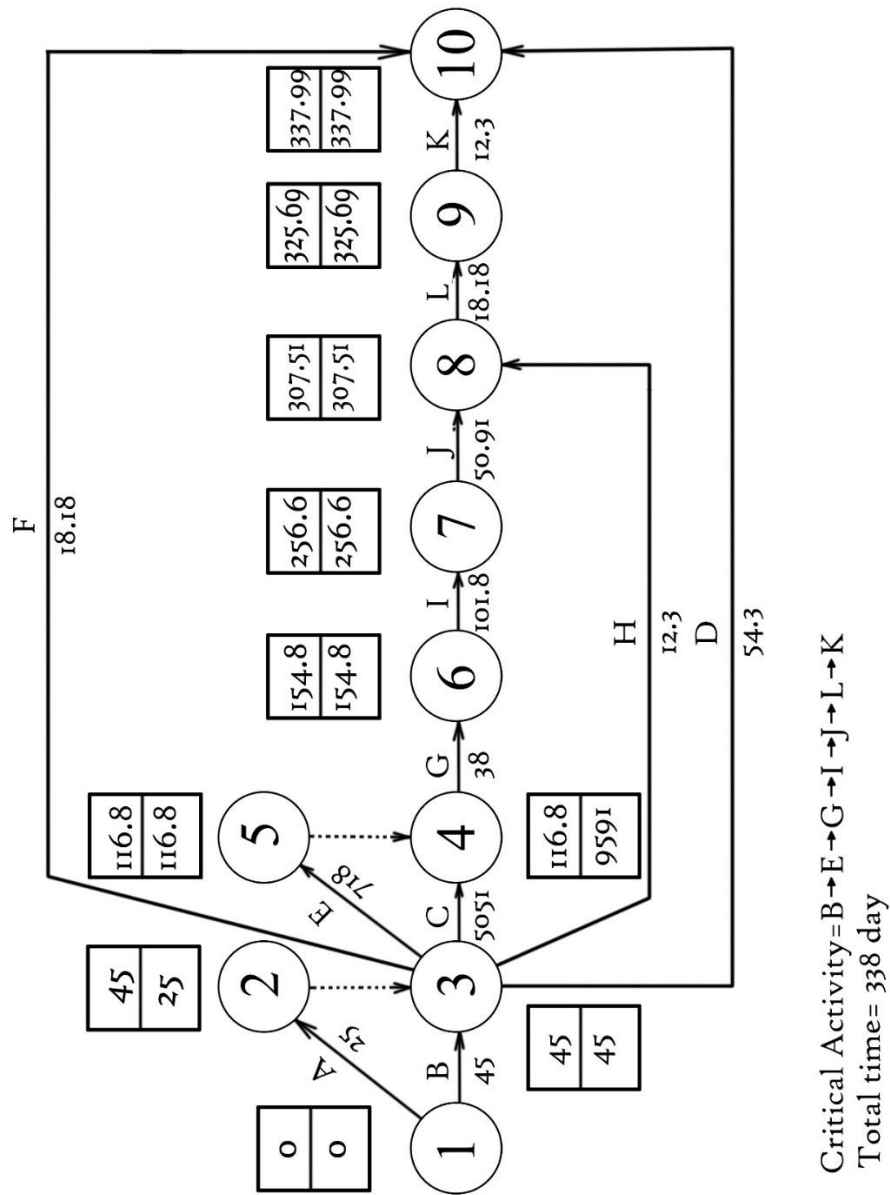


Figure 24: The project network by using the method of Fuzzy logic

7. Calculation of start and end times of activities by using Fuzzy PERT.

Table 10 shows the sequence of the project events, previous events, estimated time, float of time and critical activity.

Table 10: Calculation of start and end times of activities

Event	Expected Time (\bar{D})	Earliest Start Time (E.S)	Earliest Finish Time (E.F)	Latest Completion (L.C)	Earliest Completion (E.C)	Float of Time (T.F)	Critical Activity
A	25	0	25	0	45	20	
B	45	0	45	0	45	0	C.A
C	50.91	45	95.91	45	116.8	20.1	
D	54.2	45	99.3	45	337.99	238.69	
E	71.8	45	116.8	45	116.8	0	C.A
F	18.18	45	63.2	45	325.69	262.51	
H	12.3	45	57.3	45	307.51	250.2	
G	38	116.8	154.8	116.8	154.8	0	C.A
I	101.8	154.8	256.6	154.8	256.6	0	C.A
J	50.91	256.6	307.51	256.6	307.51	0	C.A
L	18.18	307.51	325.69	307.51	325.69	0	C.A
K	12.3	325.69	337.99	325.69	337.99	0	C.A

C.A= B → E → G → I → J → L → K

C.P=1 → 3 → 4 → 6 → 7 → 8 → 9 → 10

Through the previous network analysis and Table 10 shows the sequence of the project events, previous events, estimated time, float of time and critical activity.

Table 10 it is clear that the activities that the critical activities which must be given the most importance are:

Critical activities: B → E → G → I → J → L → K

Critical Paths: 1 → 3 → 4 → 6 → 7 → 8 → 9 → 10

The project minimum completion time is 338 day.

3.5. Comparing Between PERT Technique and Fuzzy Logic

After taking into account the factors affecting the completion of the activities of the project using the fuzzy set theory. Compare the results with the estimated time of the project activities using the PERT technique. Table 11 shows a comparison between the time estimates for each project activity.

Table 11: Potential distribution indicators for project activities

Event	PERT		Fuzzy PERT	
	Expected time (\bar{D})	Variance (σ^2)	Expected time (\bar{D})	Variance (σ^2)
A	24.1	34	25	125.7
B	43.3	44.4	45	126.1
C	65	69.4	50.91	8.3
D	53.3	25	54.2	84.3
E	96.7	177.8	71.8	36
F	21.3	4	18.18	0.4
H	16.2	4.7	12.3	0.1
G	37.3	11.1	38	53.1
I	125.8	156.3	101.8	37.2
J	65	69.4	50.91	8.3
L	16.2	8	18.18	0.4
K	22.2	4.7	12.3	0.1

In order to calculate the total time for the completion of the project using the fuzzy set theory is 338 days. Compared to the project completion time using the PERT technique it is 406.5 days. Now we can conclude the following conclusion:

So relying on this method gives a more accurate picture of the use of PERT technology. In this case, the institution must focus on the critical activities that are affected by the labor experience due to their influence on time. Any delay will affect the delivery date of the project. The organization should also use the days in which the weather is moderate and workable by adding work hours after the end of work time. If it felt that this might affect the mandate, it would be best to assign the work that needed to be done quickly to qualified persons through secondary processing.

The success of the projects is linked to each step of the process ranging from the idea to the implementation, improvement and development. It is necessary to contribute to meet the requirements of growth and development of projects through a system of integrated services, and through innovating diverse and sophisticated ways to deliver these services. This will be through effective management of these projects; an effective management means planning, organizing, scheduling and controlling.

This chapter clarifies the use of both PERT and Fuzzy set analysis theory in estimating the times of activities. It has become clear that PERT technique is effective and helps to find a certain way to manage project to the fullest. But this method has given a better vision than the way the enterprise of achievement has used it. But it neglected some of the things that significantly affect the duration of the completion of project, which is a factor of labour experience and the impact of weather conditions. This is what the theory of Fuzzy set analysis has worked on. It has estimated the time through the influence of these factors on the time of activities.

It has been noticed that the expected time according to the Fuzzy model is more logical than the expected time of PERT model, because it gives the following three indicators of time:

- Minimal time when there are unexpected things that positively affect the implementation of the activity, or when part of the activity, not the whole activity, is performed.

- The greatest time refers to the expected time of project completion and when there are unexpected things that adversely affect the implementation process.

- The average time which represents the expected value of time with a degree of belonging is greater than the minimum and maximum times.

Through these methods, the project manager can manage his project in a way that is better than relying on the traditional method by specifying the timeframe in which the project is being completed. Therefore, he has a somewhat clear future vision in order to achieve his goal.

CONCLUSION

The current time is the age of evolution, scientific progress and modern technology, so it is important to follow this cultural curve by using the available human and material resources, and this can only be achieved by the continuous pursuit of human ability and ambition in creativity and innovation which has left no room for stagnation or wait. Change is the nature of the times, and as a result of this successive development, many of the problems that guide society today appeared.

Project management is one of the important systems within the social and economic system at the same time, especially with respect to time, because the progress of nations and their cultural achievements is measured by the time spent in achieving their goals. Time is a unique commodity given equally to every person. If institutions carefully record their financial and human assets in statements. Without these statements covering the time factor, this work is considered incomplete. The corporation may incur countless losses that could even lead to bankruptcy. For these reasons, several methods have emerged for managing these projects and completing them on time, perhaps the most important one among them is the use of network planning; which provides management with a structured approach to managing the project. This method appears in the 1950s. There were several methods of network analysis such as: CPM and PERT. However, the weak points of these processes, as shown in the study, led to the emergence of modern methods that help to progress the project management to the fullest. It estimates the time of the project activities, taking into account all the qualitative factors affecting the activity, and thus it gives an estimate of the time of activity better than the estimate given by traditional methods. This research clarifies the role of these methods in the management of the project and the precise view that they give about the activities of the project. This leads to find an answer to the previously mentioned hypotheses, in addition to a set of results and suggestions.

Testing hypotheses

- The first hypothesis: Through the study, it is clear that there are differences between the average estimated time of the contract and the actual time of completion. This is indicated by the provisional receipt register. This may be due to the attempt of the company to avoid the delay in completion of the project, which leads to financial sanctions that adversely affect the contractor work, thus he proposes a longer period of actual completion in order to get a surplus time.
- The second hypothesis: this study shows that there are differences between the estimated time using the PERT method and the actual time of delivery by 66 days compared to the time provided by the completion contract. This is probably due to the exclusion of the impact of quality factors on the time of project activities.
- The third hypothesis: There are slight differences between the actual time of achievement and estimated time according to the Fuzzy logic network. This may be due to the optimistic time (a) utilization of labour experience and the use of overtime work, or to improve the weather situation, and thus leading to complete the project in the least expected time.

Results of the study

- Invalid research hypotheses. With differences between averages estimated time; contract, PERT, Fuzzy logic and average actual time of achievement.
- Network planning estimates are good because their value is closer to the actual time of project completion than the contract estimates.
- The impact of qualitative factors on the time of completion of the activities, especially related to weather conditions, which greatly affect the completion of project.
- The analysis of the PERT network by using the estimates of the theory of Fuzzy set analysis can be considered as one of the compression methods of traditional PERT network. The Fuzzy set analysis theory enables to reduce the project time by influencing the qualitative factors over the time of critical activities, especially those relating to resources, not by increasing a number of

resources or time allotted to the activity. This theory is not only useful in reducing time but also in creating resources, especially human resources. Entrepreneurs tend to attract less labour and experience to carry out the activity rather than relying on large scale labour and poor experience.

Suggestions

The following suggestions are based on what has been mentioned above:

- Follow the method of network planning to estimate the time of project activities, taking into account all the qualitative factors affecting the completion of activities, and follow the sequence of activities as presented in the research in order to eliminate chaos during the process of achievement.
- Relying on a steady employment experience and skill gained over time; especially when the labour experience is one of the most important factors affecting the work.
- Use secondary handling for certain activities that need certain techniques, to save time on hand and to ensure quality on the other hand.
- Follow the model of fuzzy logic in estimating the time of project activities and results indicators, and conduct research and seminars on this method to clarify and expand its use in scientific institutions.
- To oblige the technical departments responsible for monitoring and monitoring the implementation of the project to collect metadata and digital data in order to create a reliable information system for developing the future plan.
- The establishment of a scientific research institution in public institutions whose task is to study the problems that face the progress of work in construction projects and to carry out scientific and applied research and workshops in the fields of project completion and give a close look at how to use modern scientific methods in completing projects.

Prospects for study

During the treatment of the subject, several problems are encountered which could not be addressed. So they are provided as prospects for research. The most important among these prospects are:

- Studies in the theory of Fuzzy set analysis related to mathematics specialization.
- Studying the relationship between Fuzzy set analysis and time as a Fuzzy concept.
- The impact of qualitative factors; weather conditions surrounding the completion process, labour experience and skill, quality of other resources used in the process of implementation, such as machinery and equipment and efficiency of performance on the completion of projects which use the Fuzzy set analysis theory.

REFERENCES

- Abdelhadi, Muhammed. 1999. Fuzzy logic in making administrative decisions. 1999. pp. 210. second edition.
- AbuKahf, AbdulGhaffar Hanefy And Abdulsalam. 1994. Organization and Business Management. Alexandria, Egypt, : the modern Arab Bureau,, 1994. p. 80.
- Ackoff, Russell Lincoln. Corporate Planning Methods, Organizational Edition. Paris, 1973. Vols. PP15 – 16.
- Ahmed, Ammar. Importance a review of techniques for risk management in projects. www.emeraldinsight.com/reprints. 2005.
- Alaqaq, Midhet Muhammed. Introduction to Development and Planning. *Alnahdha for printing and distribution*. Lebanon, 1980. p 194.
- Albert, Battersby. Network Analysis For planning and Scheduling. MACMILLAN, London, England, 1970. Vols. P268-269. 3 ed.
- Alfadhil, Muaid Abdulhusain. Accounting processes researches. Jordan, : Ithraa for publish and distribution,, 2008. p 302.
- Al-Harbi, Kamal M. Al-Subhi. Application of the AHP in project management. www.elsevier.com/locate/ijproman. 1999.
- Almansoory, Alhakeem Latif And Abdulgaleel A. Introduction to Operations Research. Benghazi, Libya, University of QarYounis, 1987. p 182.
- Alselmi, Ali. Planning and follow-up. Egypt, Cairo, : Ghareeb for printing and distribution,, 1978. p151.
- Alshareef, Ali. Management and Contemporary. Egypt, Alexandria, 2003. p 374.
- Al-Sheikh, Abu Al-Qasim Saud. *Operations Research*. 2009.
- Alshumary, Hamed Saad Nour. Operations Research is Understood and Applied. 2010. p316.
- Ang Alfredo H-S, W.H.Tang, J.Wiley& Sons,. Probability concepts in Engineering planning and Design, volume 1, p224. Singapore, 1975.
- Arab, Hani. *Operations Research*. 2009.
- Article in International Journal of Project, February 2003.
Management.<https://www.researchgate.net/publication/223746814>.

Article in International Journal of Project Management. February 2013
<https://www.researchgate.net/publication/257094667>.

Article in Journal of Construction Engineering and Management, April 2010.
<https://www.researchgate.net/publication/253833741>.

Article in Organization Studies, November . 2004.
<http://oss.sagepub.com/cgi/content/abstract/25/9/1491>.

Asai, K. Fuzzy Systems for Management, IOS Press. Netheland, 1995. pp.192.

Association francophone de management de project, La gestation de project, 2011.

Atoum, Shafiq Al. *Operations Research*. 2011.

Awad, Mohammed Ahmed. Strategic Management. Alexandria, Egypt : Dar Aljameya, 2000. p 16.

Baccarini, David Baccarini. The Concept of Project Complexity Overview. International Journal of Project Management, 1996.

Baccarini, David. The concept of project complexity
<http://www.sciencedirect.com/science/article/pii/0263786395000933>. 1996.

Backendorff, Johann. Inquiring Into the Temporary Organization: New Direction for Project Management Research. Pergamon Journal, 1995.

Bakry, Sonya Mohamed El. Quantitative Studies and Decision Making, . Alexandria, Egypt, : University House, 1997. p. 180.

Ballout, Hassan Ibrahim. Project Management and Economic Feasibility Study,. Lebanon : Arab Renaissance Publishing House, 2002. p 20.

Baloot, Husain Ibrahim. Project Management and Study of Economic Feasibility. Lebanon : Arab nahdha, 2002. p 23.

Bojadziev, George Bojadziev and Maria. Fuzzy logic for business, finance and management. Singapore, : world scientific publishing, 2007. p24. 2ed.

Bokara, Rabah. Processes researches. Alexandria, Egypt,, University student youth organization, 2004. pp. 275.

Brucker, Andreas Drexl and Rolf M ohring and Klaus Neumann and Erwin Pesch and Peter. Resource-constrained project scheduling: Notation, class cation, models, and methods. *European Journal of Operational Research*..e-mail: drexl@bwl.uni.kiel.de. 1999.

Calvert, Calvert ReD Coles and G Bailey and RE. Introduction to Building Management. 1995. pp.242. 6 edition.

Chinowsky, James Diekmann and John O'Brien and Paul S. Project Organizations as Social Networks. *Journal of Construction Engineering and Management*. 2010.

Cicmil, Svetlana. New Possibilities for Project Management Theory. *project management Journal*, 2006.

Clet, Henri-pierre MADERS and Etienne. Le management d'un project. Paris, 1997. pp. 8.

Consultants, Cambridge. A programmed Introduction to critical path Methods. England,, Cambridge consultants (training), 1967. pp.43.

Cornelis, Glad Deschrijver and Etienne E. Kerre and Chris. Implication in intuitionistic fuzzy and interval-valued fuzzy set theory, construction, classification, application. *International Journal of Approximate Reasoning* 35 55–95. www.elsevier.com/locate/ijar. 2004.

Crawford, Julien Pollack and David England and Lynn. Uncovering the trends in project management. *International Journal of Project Management* Vol, 24 , pp. 175–184. - www.elsevier.com/locate/ijproman. 2006.

D.Baccarini. The concept of project complexity-a review, 1996, pp. 201-204, <http://www.sciencedirect.com/science/article/pii/0263786395000933> .

D.L.FISHER, & W.M.GOLDSTEIN. [https://doi.org/10.1016/0022-2496\(83\)90040-8](https://doi.org/10.1016/0022-2496(83)90040-8) .

Dalton, MC Farland and Melville. Management-Principles and Practice. London, Macmillan, 1970. pp. 14- 20.

Danial, Paul. *Theory and Practice in Strategic Management -Five years of Apprenticeship in Large French Companies-*, State Thesis in Management Sciences. Paris, 1979. 15.

Davies, Terry Cooke. The “real” success factors on projects www.elsevier.com/locate/ijproman. *International Journal of Project Management* 20 185–190. 2002.

Decarlo, Doug. *Extreme Project Management* . 2004.

Delal, Sadiq Aljewad. *Operations Researches*. 2008. p207.

Duncan, William R. A guide to the Project Management Body of Knowledge. <http://www.softwareresearch.net/fileadmi>, 1996. p54.

Dvira, Tzvi Razb and Aaron J Shenhar and Dov. 2003. An empirical analysis of the relationship between project planning and project success. *International Journal of Project Management*. <https://www.researchgate.net/publication/223746814>. February 2003.

Equilbey, Luc BOYER and Noël. Organisation-Théories et applications. Paris, 2003. P203. 2nd edition.

Fisher, WILLIAM M GOLDSTEIN and DONALD L. Stochastic PERT Networks as Models of Cognition. *Journal of Mathematical Psychology* 27, 121-151. 1983 by Academic Press. Inc. 1983.

Garc az, Yohn E. Fuzzy Logic in Process Control,. 2006. p1.

Garold, D. Oberlemder. Project Management for Engineering and Construction. 2000. P 139. 2nd ed. .

George J. Klir, Bo Yuan. Fuzzy Sets and Fuzzy Logic Theory and applications, p58. New Jersey, USA, : Prentice Hall PTR,, 1995.

Ghenim, Othman Muhammed. Planning basics and general principles. Jordan : Alsafa for printing and distribution, 1999. p 35.

Grabher, Gernot. Temporary Architectures of Learning: Knowledge Governance in Project Ecologies. *Project Management Journal* - <http://oss.sagepub.com/cgi/content/abstract/25/9/1491>. 2004.

Gray, Erik W. Larson and Clifford F. *Project Management the Managerial Process*. 2011. Fifth Additionl.

Guide to the Project Management Body of Knowledge. Institute, American National. 2008. USA : The Project Management Institute, 2008. p6. 5rd.

Guide to the Project Management Body of Knowledge,. Insitute, American Netional.2008. pp. 5. fifth edition.

Guide to the project management body of knowledge. Institute, American National. USA, 2004. pp. 28. 3rd ed.

Guide to the Project Management Body of Knowledge. Institute, American National. USA, 2008. pp. 274. 5rd.

H.A.Alsamarray. Quantitative Methods of Administrative Decision Making, dar al hilal, 1997. pp. 387.

H.S.Alshumary. Operations research is understood and applied, pp. 366. 2010.

Hafez, Abdul Aziz Abdul Rashid. *The method of network analysis*. 2003.

Haifa. Faculty of Industrial Engineering and Management,
e-mail:amirash@techunix.technion.ac.il; deweck@mit.edu; dori@ie.technion.ac.il).
Israel, Technion, Israel Institute of Technology.

Hanefy, Abdulghaffar. Basics of Organizations Management. 2000. pp. 399.

- Hanefy, AbdulGhaffar. *The Basics of Managing Organizations*. University House, the modern Arab Bureau, Alexandria, Egypt, 2000. pp. 393.
- Harold, R Kerzner. *Project Management a System Approach to Planning-Scheduling and controlling*. 2013.
- Herroelen, Erik DEMEULEMEESTER and Pert DE REYCK and Willy. 1997. A CLASSIFICATION SCHEME FOR PROJECT SCHEDULING PROBLEMS. <http://econ.kuleuven.ac.be/tew/academic/prodbel>. 1997.
- Herroelen, Willy. PROJECT SCHEDULING UNDER UNCERTAINTY SURVEY AND RESEARCH POTENTIALS. *International Journal of Project Management*. 2002.
- Hillwa, Muhammed Fawzi. *Principles of Administration*. 2007. P9.
- Huang, Sue Newell and Carole Tansley and Jimmy. A simulation approach to the PERT/CPM time-cost trade-off problem. *Project Management Journal*, 35(2), 31–37. www.pmi.org/learning/library/simulation-approach-project-evaluation-review-technique-2532. 2004.
- Hugues, Marchat. *KIT de Conduit de Project Editions d'organisatio*. Paris, 2001. P22.
- Hwang, Wei Jian Ng and Bon-Gang. Project management knowledge and skills for green construction. *International Journal of Project Management* • February 2013. <https://www.researchgate.net/publication/257094667>. 2012.
- Imagining of Project Management. translation of Muhammed Alshareef, 2005. pp. 119-124.
- Imagining of Project Management . translation of Muhammed Alshareef, 2005. pp.115.
- Institute, American National. USA, 2004. pp. 30. 3rd ed.
- Institute, American National. USA, 2004. pp. 31. 3rd ed.
- Institute, American National. USA 2008. pp. 8. 3rd ed.
- Introduction to development and planning, pp. 194. Lebanon, : Alnahdha for printing and distribution,, 1980.
- Instructions for the implementation of government contracts No. (1), article nine. 2014.
- Instructions for the implementation of government contracts No. (1), chapter one, article one. 2014.
- Instructions for the implementation of government contracts No. (1), chapter seven, article seven and eight. 2014.

Instructions for the implementation of government contracts No. (1), chapter three, article three. 2014.

Instructions for the implementation of government contracts No. (1), chapter two, article two. 2014.

Jin, Raymond E Levitt and Yan. 1996. The Virtual Design Team: A Computational Model of Project Organizations. *jin@ce.stanford.edu, levitt@ce.stanford.edu*. March 15, , 1996.

Kalika, Michel. Management-strategy and organization, <https://frsecure.oboulo.com/showcart/exchange.>, 2010.

Kanapeckiene, A Kaklauskas and E K Zavadskas and M Seniut and L. Integrated knowledge management model and system for construction projects. *Engineering Applications of Artificial Intelligence*. Journal home page: www.elsevier.com/locate/engappai. 2010.

Kasir, Mansour. Accelerate the project completion time using the time-to-end activity in pert and cost method. 2001. p 195. 8th edition.

Kasir, Mansour. Management decision theory, Concepts and methods of development., 2000. p686.

Kaven, Frosbreg. Imagining of Project Management. translation of Muhammed Alshareef, 2005.

Kit de conduit projet. Paris, 2001. P 18.

Kloppenborg, Timothy J. Leadership in Project Life Cycle and Team Character Development. <https://www.pmi.org/learning/library/leadership-project-life-cycle-team-character-development-5303>. [Online] Project Management Journal, 1999.

Kosko, B. Fuzzy Engineering, Prentice- Hall. U.S.A, 1997. pp. 9.

L. Mikhailov, P. Tsvetinov. [https://doi.org/10.1016/S0165-0114\(02\)00383-4](https://doi.org/10.1016/S0165-0114(02)00383-4). 2003.

Leadership; emotional intelligence; literature; project success factors by the Project Management Institute. 2005.

Lozi, Mousa Al. Management Development - Concepts, Principles and Applications. 2000. P 120. Arabic. Cit.

M.M.Alaqad. Introduction to development and planning, p 194. Lebanon, : Alnahdha for printing and distribution, 1980,.

Maders, Henri Pierre. Association Francophone de Management de Projet. Paris , 1997. P 8.

- Maher, Ahmed. Human Resources Management. University House, Alexandria, Egypt , 2005. p 566.
- Mansour, Ali Muhammed. Management Principles,. Egypt, : the Group of Arab Nile, Cairo,, 1999. p 239.
- Mazi, Muhammed Tawfeeq. Manage and Schedule Projects. Egypt, : Aljameya for printing and distribution,, 2000. Vols. p 61-62.
- Mazi, Muhammed Tawfiq. Manage and Schedule Projects. Egypt : Aljameya for printing and distribution, 2000. p17.
- Mikhailov, P.Tsvetinov and L. Evaluation of Services using a Fuzzy Analytic Hierarchy Process. *School of Information Systems, l.mikhailov@co.umist.ac.uk*. George Street,GPO Box 2434, Brisbane, Q 4001, Australia., Queensland University of Technology, 2003.
- Mintzberg, Henry. *The Structuring of Organization Englewood Cliffs*. New York, USA , 1979.
- Moder, CR Phillips and EW Davis and J J. Project Management with CPM , PERT and Precedence Diagramming. New York, USA,, VANN ostrand Rinhold Company, 1983. P 23. 3rd edition.
- Moder, CR Phillips and EW Davis and JJ. Project Management With CPM-PERT and Precedence Diagramming. New York' USA, 1983. p256. 3rd ed.
- Morgan, Salman Mohammed. *Operations Research*. 2012.
- Moselhi, Osama (1996). Project - Network Analysis Using Fuzzy Sets Theory, op-cit. *Journal of Constraction Engineering And Management*. pp. 309. 311. 313
- Nah, Fiona Fu Hoon. Critical Factors for Successful Implementation of Interpersonal Systems. *Business Project Management Journal*, 2001.
- Najim, Najim Abboud. *Introduction to Operations Management*. 2008.
- Newell, Carole Tansley and Jimmy Huang and Sue. Social Capital and Knowledge Integration in an ERP Project Team: The Importance of Bridging AND Bonding. <https://www.researchgate.net/publication/227817808>. 2004.
- Newell, Michael W., (2005). Preparing for the Project Management Professional (PMP) Certification Exam. pp. 2. 3th edition.
- Nigel, Smith. *Engineering Project Management*. USA, 2002. P 10. 2nd ed.
- O.M.Ghenim, Planning basics and general principles, p 29. Jordan, : Alsafa for printing and distribution,, 1999.
- Operations Management Group.e-mail: info@econ.kuleuven.ac.be. May 2002.

- Operations research is understood and applied. 2010. pp. 334.
- Organizational Behavior and Personnel Management. Egypt, Alexandria, 1993. pp. 93.
- Othman, Hussain Othamn Muhammed. Principles of Public Administration. 2007. P21.
- Palm, R. & D. Driakov. advances in fuzzy control, aspringer-verlang company, vol,16, pp. 33. Germany, 1998.
- Pellegrinll, Sergio. Program Management Organizing Project Based Change. International Journal of Project Management, 1997.
- Pant, Bassam Baroudi and Ira. Project management education: The human skills imperative. *Article in International Journal of Project Management* , <https://www.researchgate.net/publication/223616504>. February 2008.
- Planning Basics and General Principles. *Alsafa for printing and distribution*. Jordan, 1999. pp. 29.
- Project Management and Study of Economic Feasibility. Lebanon, : Arab nahdha,, 2002. pp. 74-75.
- Project Management and Study of Economic Feasibility,. Lebanon, : Arab nahdha, 2002. pp 176.
- Project Management and Study of Economic Feasibility,. Lebanon : Arab nahdha, 2002. pp. 20.
- Project Management The Managerial Process . 2011. pp. 10. 5th edition.
- Project Management, the Managerial Process. 2011. pp. 5. fifth edition.
- Projects Management, Translation of Bahaa Shahin. Egypt, Cairo : Arab Nile group, 2005. pp. 36.
- Project Management vs. Systems Engineering Management: A Practitioners' View on Integrating the Project and Product Domains. *Faculty of Industrial Engineering and Management*, e-mail:amirash@technion.ac.il; deweck@mit.edu; dori@ie.technion.ac.il). 2010.
- Poulin, Yves. Définition de la notion de projet: La gestion de projet. <http://www.enap.quebec.ca/didactheque/html-fra/outils/informateur/gestion-projet/gp-def-gestion.htm>, 2011.
- Prabhakar, Guru Prakash. Switch Leadership in Projects . *Project Management Journal*, January 2005, <https://www.researchgate.net/publication/241897793>. 2005.
- Preparing for PMP project management protection, 3rd edition, p 160.

Project Management Institute, Guide to the project management body of knowledge, 5rd, pp. 274. 2008.

Project Management Journal , <https://www.researchgate.net/publication/241897793>. January 2005.

R.TURNER, &R.MULLER. www.elsevier.com/locate/ijproman.

Rory, John Wiley And Sons chichester and Burke. project Management planning and control. New York, USA, 1992. p16. 2 ed.

S.CHANASA, & P.ZIELINSKIB. RWTH Aachen, Korneliusstr. 5, 52076 Aachen, Germany.zi@or.rwth-aachen.de. 2000.

School of Architecture, Construction and Planning, Curtin University of Technology, GPO Box U Perth 6001, Western Australia, 1987.

SEN, Leu SOU. AGA-based Fuzzy Optimal model for construction time cost tradeoff. International journal of project Management,, 2001. p49.

Shamarti, Hamed Saad Nour Al. Operations Research. 2009. P318.

Shenhar, Dov Dvir and Ofer Levy and Alan C. Maltz and Aaron J. Project Success: A Multidimensional Strategic Concept. *Long Range Planning* 34, 699–725.www.lrpjournal.com. 2001.

Smith, Henry Antoine. *Engineering Project Management Engineering & Contracting*. Arabization of Alaa Ahmed Samour, 2013.

Soderlund, Jonas. Building theories of project management: past research, questions for the future - www.elsevier.com/locate/ijproman. 2003.

T.J.Ross, J.Wiley, & sons. Fuzzy Logic with Engineering Application, 2 editon, P35. Inc, USA, 2004.

T.Yong. projects management, translation of Bahaa' Shahin, p 36. Egypt, Cairo, : Arab Nile group, 2005.

Taha, Hamdi. *Operations Research*. 2008.

Tang, Ang Alfrefo and Wilson H. Probability of Concepts in Engineering Planning and Decision. 1975. p225.

Turner, J Rodney. Creating value by delivering integrated solutions. *Article in International Journal of Project Management* ,<https://www.researchgate.net/publication/222412051>. July 2005.

The Project Manager's Leadership Styleas A Success Factor On Projects. www.elsevier.com/locate/ijproman. 2009.

The Theory of Administrative Decisions - Concepts and Quantitative methods. Amman, Jordan : Dar Hamid, 2000. Vols. p 80-81. the first edition.

The Project Management A-Z . *Gower Publishing Limited*. England, 2003. pp.1. www.emeraldinsight.com/reprints.

Turnera, Ralf Mu"llerb and J. Rodney. On the nature of the project as a temporary organization. *International Journal of Project Management*. <https://www.researchgate.net/publication/222402297>. January 2003.

Winston, Wayne L. *Operation Research Applications and Algorithms*. 2004.

Wren, Alan. *The Project Mamagement A-Z*. 2003.

Yong, Triqorl. Projects Management Translation of Bahaa Shahi. Egypt, Cairo : Arab Nile group, 2005. pp. 36.

Yuan, George J. Klir and Bo. Fuzzy Sets and Fuzzy Logic Theory and applications , pp. 59. New Jersey, USA, : Prentice Hall PTR, 1995.

Zhi, He. Risk management for overseas construction projects. *International Journal of Project Management* 13, No. 4, pp. 231-237, . Singapore, School of Civil and Structural Engineering, Nanyang Technological University, 1995.

Zielinskib., Stefan Chanasa and Pawel. Critical path analysis in the network with fuzzy activity times. *Fuzzy Sets and Systems*.www.elsevier.com/locate/fss. 2000.

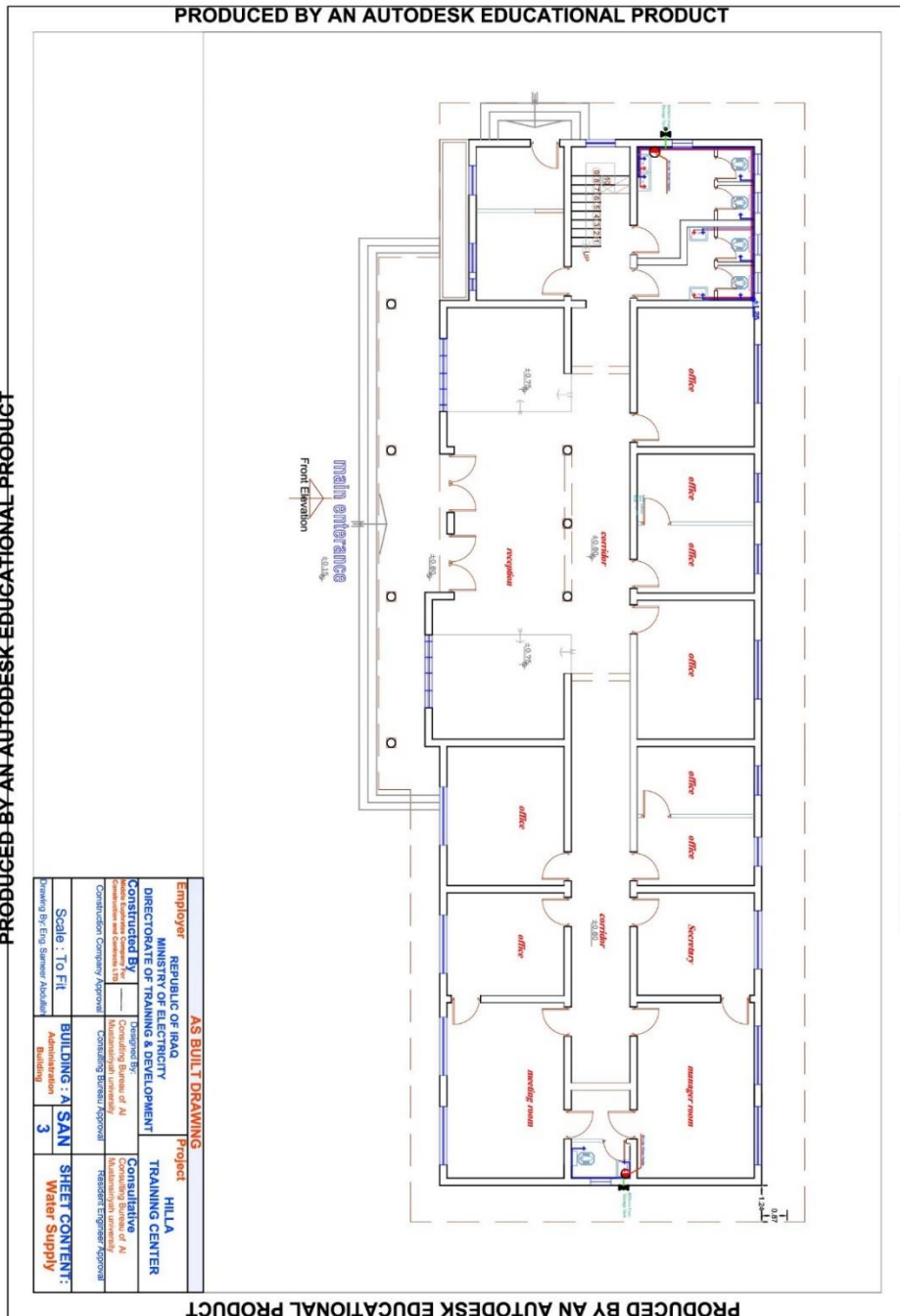
Zielinskib, & Chanasa, zi@or.rwth-aachen.de . 2000.

Zimmermann, H. J. Fuzzy set theory. 2010.

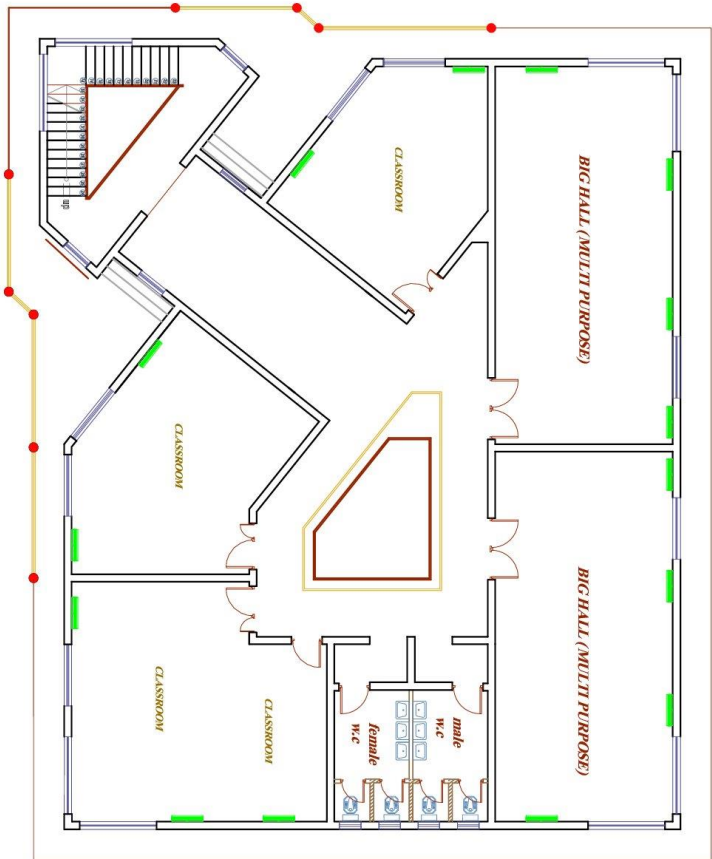
APPENDICES

Appendix (A)

Buildings Layouts



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First Floor Plan

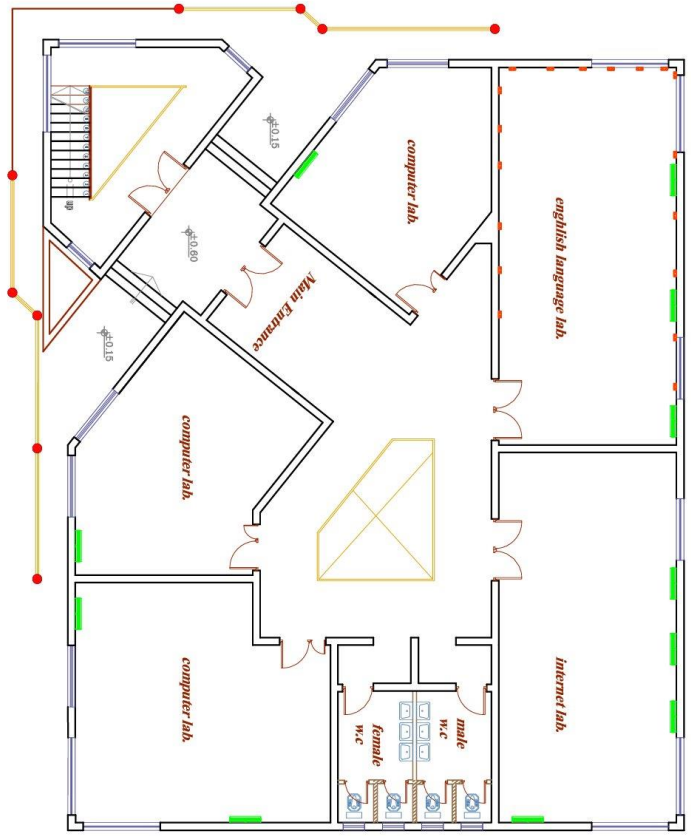
No.	REVISION	INITIAL	DATE	PROJ.	BUILDING	SHEET COMMENT	NO.
1	Consulting Bureau of Iraqi Engineering Union		Sep. 2007	HILLA TRAINING CENTER	LECTURE BUILDING	First FLOOR Power	B
				EMPLOYER REPUBLIC OF IRAQ / MINISTRY OF ELECTRICITY DIRECTORATE OF TRAINING & DEVELOPMENT		DESIGNED BY Consulting Bureau of Al-Mustathina University Checked by Consulting Bureau of Iraqi Engineering Union Approved by Consulting Bureau of Iraqi Engineering Union Scale: 1/50 Drawing No: 02	
				CLIENT Ministry of Education Directorate of Training & Development Hilla Training Center		DESIGNED BY Consulting Bureau of Al-Mustathina University Checked by Consulting Bureau of Iraqi Engineering Union Approved by Consulting Bureau of Iraqi Engineering Union Scale: 1/50 Drawing No: 02	

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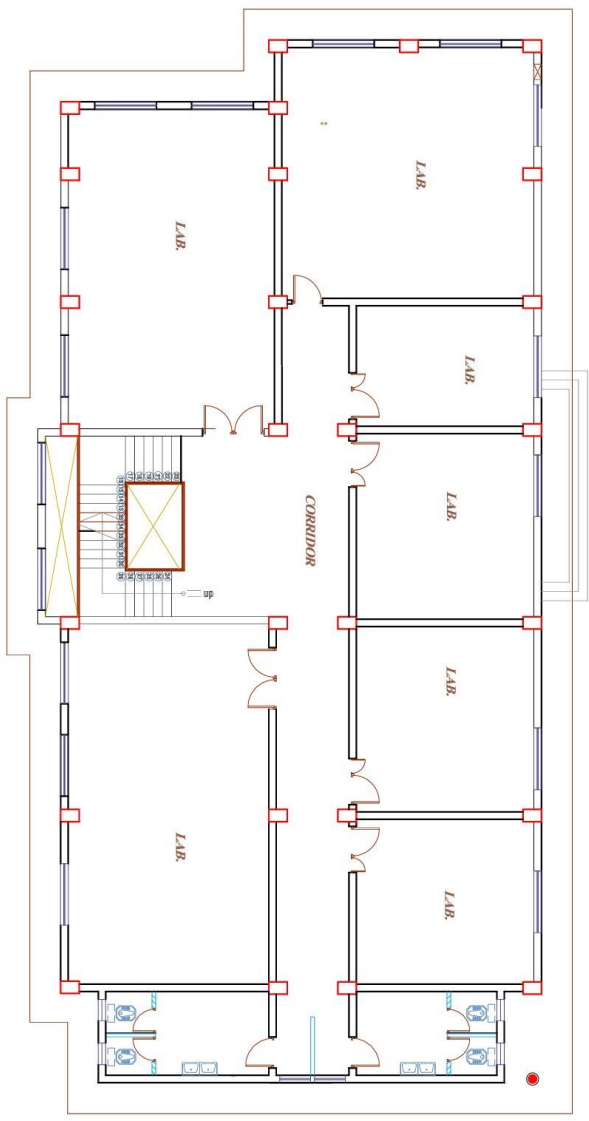


Ground Floor Plan

No.	REVISION	INITIAL	DATE	PROJ	EMPLOYER	SHEET COMMENT	SCALE	DATE
1	Consulting Bureau of Iraq Engineering Union		Sep, 2007	HILLA TRAINING CENTER	REPUBLIC OF IRAQ / MINISTRY OF ELECTRICITY DIRECTORATE OF TRAINING & DEVELOPMENT [Arabic text]	LECTURE BUILDING	02	Drawn By: [Name] Scale: 1/50 Date: 02 Sep 2007

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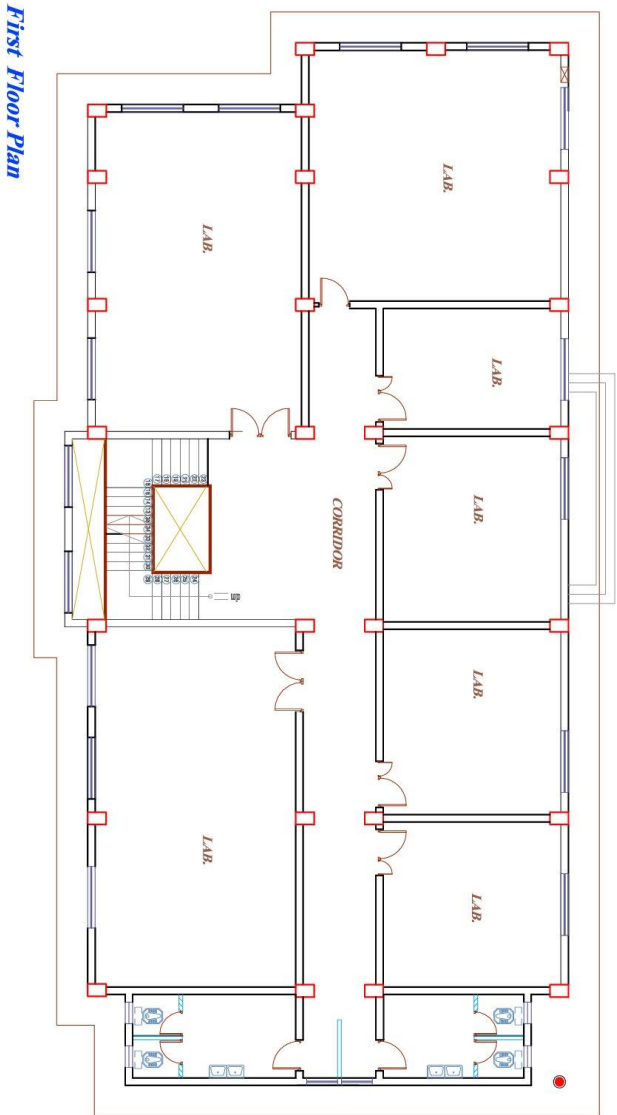
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Ground Floor Plan

No.	REVISION	INITIAL	DATE	PROJ	BUILDING	SHEET COMMENT	NO.	NO.
1	Consulting Bureau of Iraqi Engineering Union		Sep, 2007	HILLA TRAINING CENTER REPUBLIC OF IRAQ / MINISTRY OF ELECTRICITY DIRECTORATE OF TRAINING & DEVELOPMENT	WORKSHOP LABORATORY BUILDING	GROUND FLOOR POWER	02	EIF-02

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First Floor Plan

No.	REVISION	INITIAL	DATE	PROJ. NO.	PROJ. NAME	SHEET NO.	TOTAL SHEETS
1	Consulting Bureau of Iraqi Engineering Union		Sep, 2007			02	

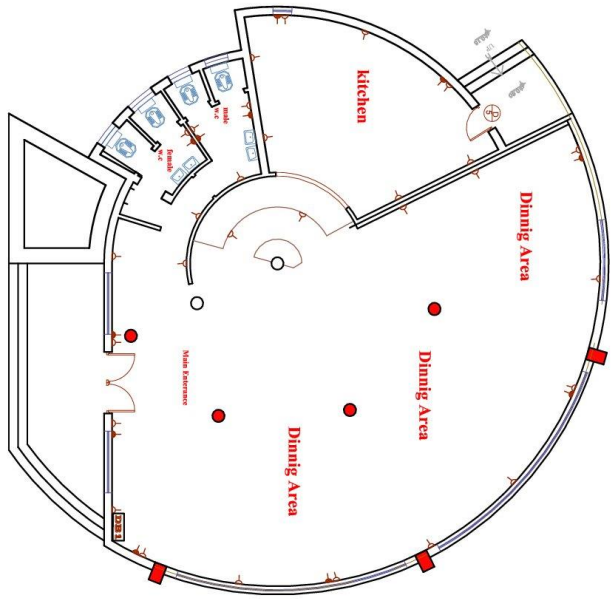
EMPLOYER HILLA TRAINING CENTER REPUBLIC OF IRAQ / MINISTRY OF ELECTRICITY DIRECTORATE OF TRAINING & DEVELOPMENT	DESIGNED BY Consulting Bureau of Al-Mustathmin University Consulting Bureau of Iraqi Engineering Union Approved By Consulting Bureau of Iraqi Engineering Union Scale: 1/50 Drawing No:	DRAWN BY Date: Scale: Date:
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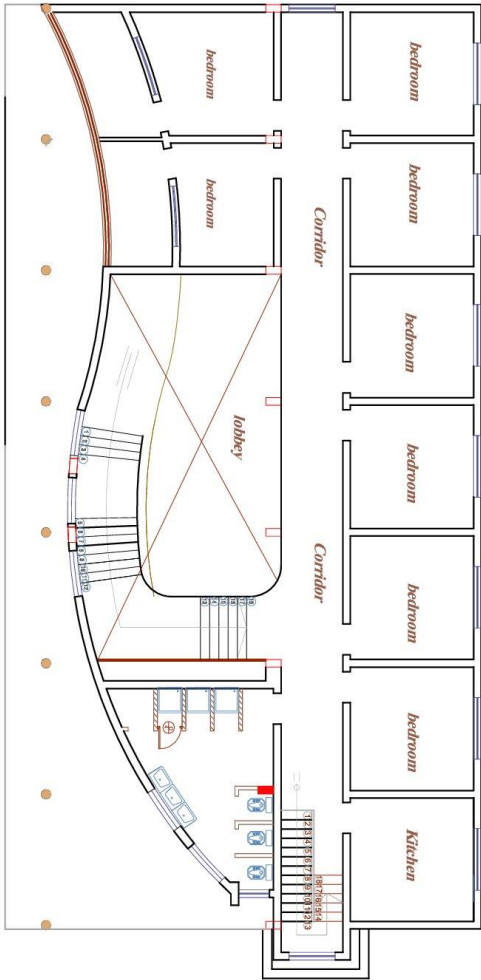


Ground Floor Plan

No.	REVISION	INITIAL	DATE	PROJ	BUILDING	SHEET COMMENT	NO.	DATE
1	Consulting Bureau of Iraqi Engineering Union		Sep, 2007	HILLA TRAINING CENTER	CAFETERIA BUILDING	GROUND FLOOR POWER	02	ELF-02

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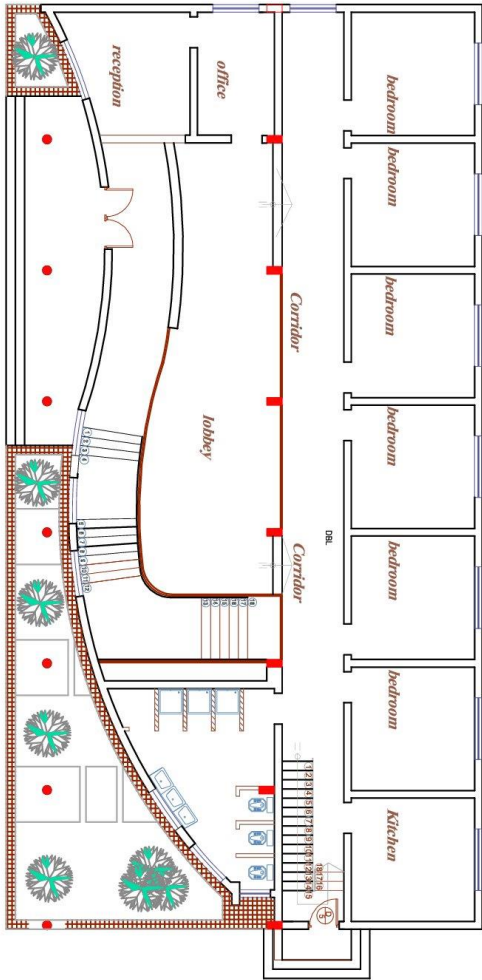
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First Floor Plan Windows & Doors
STUDENT HOUSE

No.	REVISION	INITIAL	DATE
1	Consulting Bureau of Iraq Engineering Union		Sep. 2007

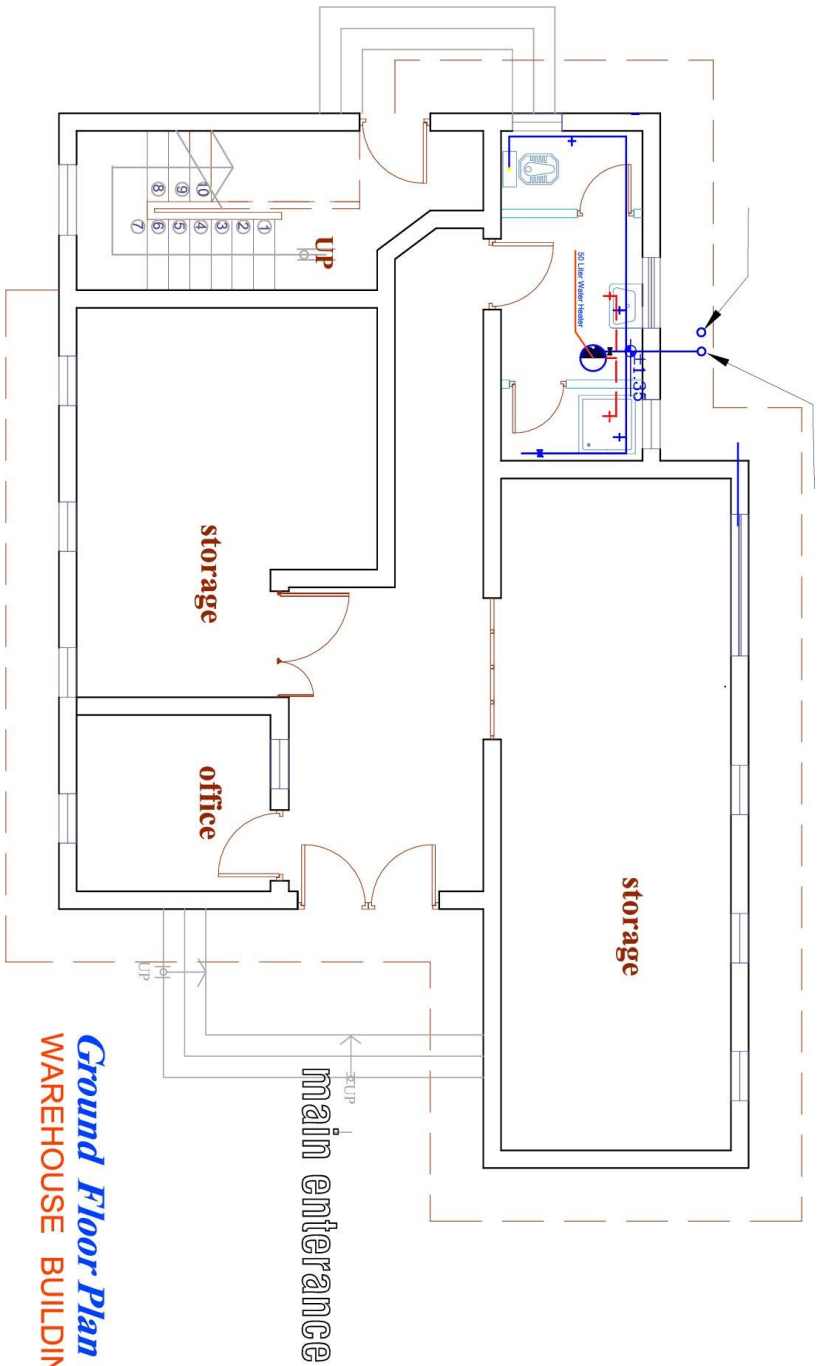
PROJ HILLA TRAINING CENTER	EMPLOYER REPUBLIC OF IRAQ / MINISTRY OF ELECTRICITY DIRECTORATE OF TRAINING & DEVELOPMENT	SHEET COMMENT STUDENTS HOUSE BUILDING	DRAWING NO. 02	ARCHITECT CONSULTING BUREAU OF IRAQ ENGINEERING UNION APPROVED BY: [Signature] DATE: 17/09/2007 SCALE: 1:100



Ground Floor Plan Windows & Doors
STUDENT HOUSE

No.	REVISION	INITIAL	DATE	PROJ	EMPLOYER	SHEET COMMENT	SCALE	DATE
1	Consulting Bureau of Iraqi Engineering Union		Sep. 2007	HILLA TRAINING CENTER	REPUBLIC OF IRAQ / MINISTRY OF ELECTRICITY DIRECTORATE OF TRAINING & DEVELOPMENT	STUDENTS HOUSE BUILDING	02	ELF-02

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Ground Floor Plan
WAREHOUSE BUILDING

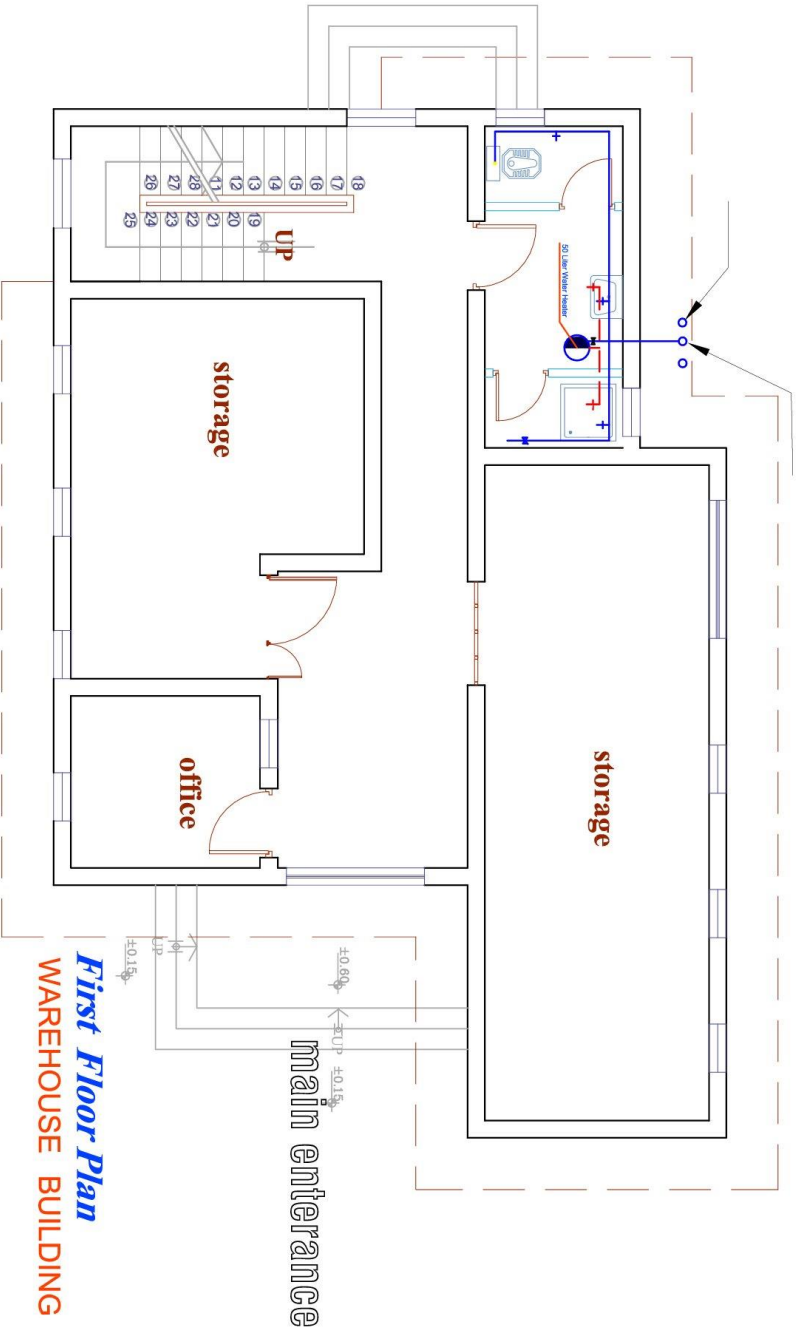
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AS BUILT DRAWING		Project	
Employer	REPUBLIC OF IRAQ MINISTRY OF ELECTRICITY DIRECTORATE OF TRAINING & DEVELOPMENT	HILLA	TRAINING CENTER
Constructed By	Designed By Consulting Bureau of AI Mustansiriyah University Construction and Contracts Ltd. Construction Company Approval	Consultative	of AI Mustansiriyah University Resident Engineer Approval
Scale :	To Fit	BUILDING :	F SAN
Drawing By:	Eng. Sameer Abdulah	Warehouse	3
		SHEET CONTENT:	Ground Floor Water Supply

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT



First Floor Plan
WAREHOUSE BUILDING

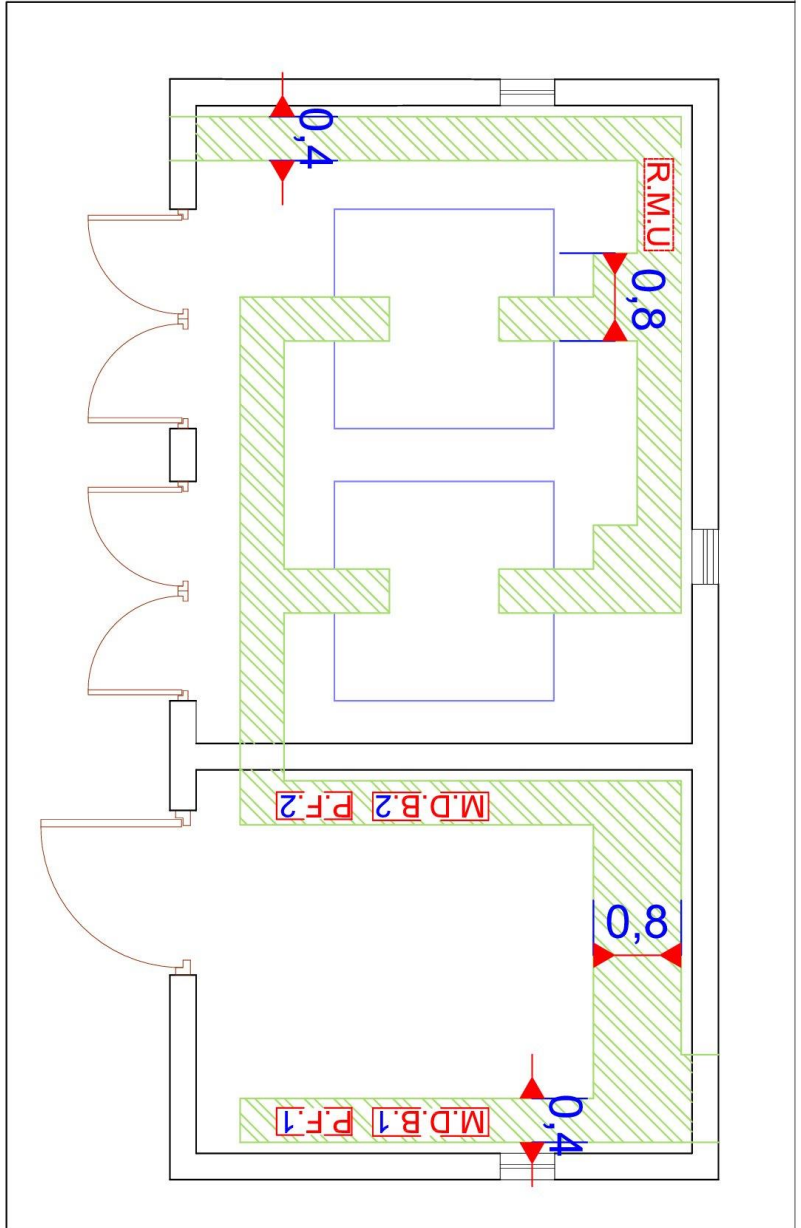
AS BUILT DRAWING		Project	
Employer	REPUBLIC OF IRAQ MINISTRY OF ELECTRICITY DIRECTORATE OF TRAINING & DEVELOPMENT	HILLA	TRAINING CENTER
Constructed By	Designed By: Construction and Contracts Co. Ltd. Mustansiriyah University Consulting Bureau Approval	Consultative	Resident Engineer Approval Mustansiriyah University
Scale :	To Fit	BUILDING :	F SAN Warehouse Building
SHEET CONTENT:	4	First Floor Water Supply	

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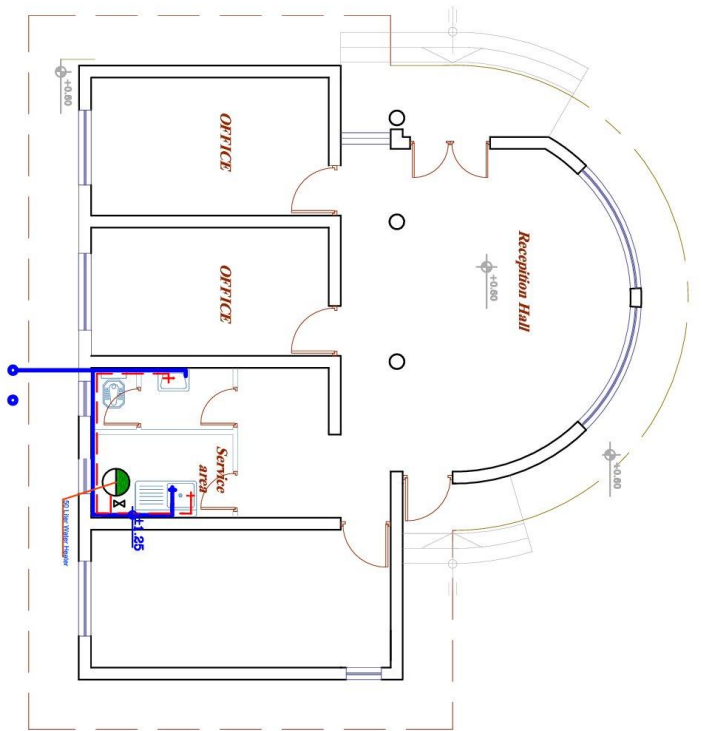
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AS BUILT DRAWING		Project	
Employer	REPUBLIC OF IRAQ MINISTRY OF ELECTRICITY DIRECTORATE OF TRAINING & DEVELOPMENT	HALLA TRAINING CENTER	
Constructed By	Designed by: Consulting Bureau of AI Mustansiriyah University Construction and Contracts (T.C)	Consultative Mustansiriyah University Resident Engineer Approval	
Construction Company Approval		Consulting Bureau Approval	
Scale :	To Fit	BUILDING :	H Elec
Drawing By: Eng. Sameer Abdulrah		Powerhouse	2
		Building	
		SHEET CONTENT: Power Distribution Layout	

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AS BUILT DRAWING		Project	
Employer	REPUBLIC OF IRAQ MINISTRY OF ELECTRICITY DIRECTORATE OF TRAINING & DEVELOPMENT	HILLA	TRAINING CENTER
Constructed By	 Construction and Contracts Co. Ltd. Consulting Company Approval	Designed By	Bureau of AI Mustansiriyah University Consulting Bureau Approval
Scale :	To Fit	BUILDING :	1 SAN
Information	Building	3	SHEET CONTENT:
Drawing By: Eng. Sameer Abdulah			

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PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

	Inner Roads Concrete	AS BUILT DRAWING	
	Walkway Concrete	Employer REPUBLIC OF IRAQ MINISTRY OF ELECTRICITY DIRECTORATE OF TRAINING & DEVELOPMENT	Project HILLA TRAINING CENTER
	Green Areas	Constructed By Middle Euphrates Company For Construction and Contracts LTD	Designed By: Consulting Bureau of Al Mustansiriyah university Consulting Bureau Approval
	Interlocking Bricks Pavers	Construction Company Approval	Resident Engineer Approval
Scale : To Fit		Site	1
Drawing By: Eng. Sameer Abdullah		SHEET CONTENT: Site Areas	

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Appendix (B)

Laws and Regulations of Contracting

The following is a summary of the most important laws that are relied upon during concluding contracts with the government departments. The contract of building a training center for employees of the Ministry of Electricity in the city of Hill depended on these laws.

Instructions for the implementation of government contracts no. (1) for the year 2014.

1. The laws

(2014)

First: The provisions of these instructions shall apply to:

- A- Contracts that concluded by the official contractual agencies are represented by the Presidency of the Republic, the Council of Ministers, the Council of Representatives, the Supreme Judicial Council, the General Secretariat of the Council of Ministers, the ministries and agencies which are not related to the Ministry, and the region and the governorates which are not organized in a region with the Iraqi and non-Iraqi agencies for the implementing of general contracting, consulting projects and contracts, and contracts for the processing of goods and services that calculated on the investment, current and operational budgets.
- B- Public companies when implementing their projects that listed in the investment or current curriculum funded by the general budget.

Second: The provisions of these instructions shall not apply to:

- A- Projects and contracts of the State and public sector departments financed by foreign countries, or international or regional organizations, or nongovernmental organizations which are implemented relying on special agreements or protocols concluded with the Iraqi contracting authority. The provisions of these instructions

are applied in the absence of any provision preventing their application in the convention.

- B- Public companies when executing contracts referred to them by the official contractual agencies. They are considered as a contractor or consultant, and depend on the controls approved by the board of directors and by the head of the associated organization in choosing the appropriate contracting method and conducting the price negotiation without conflicting with the legislation and laws which organize their activity.
- C- Ministries of defense and interior, security services in terms of armament contracts, contracts of processing equipment, and security and military services to be subject to controls set by the competent sectorial committee in the Council of Ministers.

Third: The powers and functions stipulated in the internal system which is established in accordance with the law of public companies in the implementation of their contracts, which do not apply to the instructions of implementing the general contracts, for example, marketing contracts and investment contracts taking into consideration the relevant legal legislations.

2. Requirements before preparing tender documents

(2014)

First: The contracting party is committed to complete the following requirements before preparing tender documents for investment projects:

- A- Preparation of technical and financial feasibility or technical report study,, cost and benefit study, designs and billings for investment projects in accordance with the instructions of the Ministry of Planning, including the estimated cost of the project accompanied with the project form when discussing its inclusion in the investment budget, excluding projects for dismantling and treatment of destroyed nuclear facilities and chemical waste.

- B- The concerned Ministry should not include any project in the federal investment budget without obtaining the approval of the Ministry of Planning as stipulated in paragraph (a) of this item. The Ministry and the organization, which requests the project, bear the responsibility of the project.
- C- Identifying the executing agency and beneficiary of the project when approached the Ministry of planning.
- D- The existence of an open public estimate cost for the contractor or project contractors prepared by a competent technical authority based on the comprehensive study of the prevailing market prices when preparing for the purposes of the assignment supported by the table of quantities to be adopted as a measure of the analysis of bids and the balance of the price of its paragraphs, except the controls of the speculative costs of the contract associated with stock prices in accordance with the controls and circulars issued by the Ministry of planning in this regard.
- E- Conditions, specifications, quantities, maps, tables and other are accurate in order to avoid making changes or additions during implementation.
- F- The agreement of competent authorities with the project site and allocating the land required for it or work on it before the inclusion of the project consultative authority. The contracting authority obtains the approvals of the concerned authorities for the implementation of the project including the approval of the concerned authorities such as environment, tourism and archeology.
- G- Remove legal and physical problems if found in the workplace The site should be ready for direct implementation of the action.
- H- Take any other procedures required by the nature of the work or the contract to be achieve.

Second: the contracting authority commits to complete the following requirements before preparing the tender documents for a contract funded by the current and investment budgets:

- A- The existence of a study about the actual need of the contracting or about providing the contracting authority with goods or service.
- B- Determine the requirements for contracting or goods or services according to a technical report in coordination between the implementing agency and the beneficiary. These requirements should have accurate technical specifications.
- C- Providing financial allocation for the processing of goods or services or contracting with the support of the finance service in the contracting authority.
- D- The existence of a public speculative cost prepared hand, by specialized technical and updated authority which is based on the comprehensive study of the prevailing market prices during preparing materials or services to be processed or works required as a measure for analyze bids and know the balance of its clauses prices and tender assignment. Taking into account controls and circulars issued by the Ministry of Planning in this matter.
- E- Obtaining approvals fundamentalism from the contracting authority for achieving the renovation contracting or processing goods or services, taking into account the financial power.

3. Methods of contracting

(2014)

The head contracting authority or whoever is authorized by him at the suggestion of the head of the administrative formation of contracts should use the following methods to achieve public contracts except the methods of one tender and direct contracting, either nationally or stately when the conditions are achieved:

First: Public tenders: This method is implemented by announcing public invitation to those who wish to participate in the implementation of contracts of various kinds and who meet the conditions of participation. The procedures are general, competitive, fair, public, clear and take into account the financial ceilings approved in the instructions of implementation of the federal budget when adopting this method.

Second: Restricted Tenders: This method is implemented when the goods, consultancy services or tender contracts are available to limited authorities in terms of competence for the purpose of submitting their bids in accordance with the specifications, designs and conditions prepared by the contracting authority. This method is announced to all those wishing to participate in providing their duties and who meet the conditions of participation in accordance with the following procedures:

- A- - The first procedure includes the delivery of documents related to the legal, technical and financial dilution of the participants in the tender to be evaluated by a specialized committee in the contracting authority in accordance with the technical, financial and legal qualification required to select who are qualified to participate in the second procedure and they should not be less than (3) eligible.
- B- Second procedure: The contracting authority invites all qualified persons free of charge to submit their technical and commercial documents for the purpose of study, evaluation and placement in accordance with the provisions of these instructions.

Third: The general tender by technical rehabilitation method: This method is implemented by announcing the tender to all those wishing to participate in the submission of their technical and commercial bids and in two separate cases for a price, taking into account the following points:

- A- Opening technical bids and study them by committees of analysis in the contracting authority to select qualified bidders who are respondents to the required conditions.
- B- - Opening of commercial tenders for qualified bidders who should not be less than three and not less than three to choose the best tender thereof, taking into consideration the financial powers approved for purposes of referral in this regard.
- C- Return the commercial biddings of bidders who are not technically qualified to their providers without opening them and then making the procedures of analyses and contracting according to the contexts adopted in this regard.

Fourth: tender in two stages: This method is implemented in two stages. It may be preceded by the pre-qualification starting method. It is used in contracts that are difficult for the contracting authority to prepare their technical specifications or designs in contracts with complex technology and specialized contracts of developed scientific nature. The stages of this method is:

- A- Stage 1: A general invitation is announced to who are interested for a price to submit their technical tender on the basis of preliminary designs and functional requirements or a general description of the stages of work implementation in order to be studied by a specialized technical committee for the purpose of selecting the appropriate extinguishers in accordance with technical, financial, legal and similar standards. The technical authority must edit the technical specifications and other requirements in accordance with the submitted and modified bids after the technical negotiation and it must also edit the estimated cost when necessary.
- B- Stage 2: Direct invitation to bidders whose bids have been accepted in accordance with the standards of rehabilitation in the first stage due to submit their commercial bid on the basis of revised tender documents and then proceed in the contractual process in accordance with the procedures specified in these instructions.

Fifth : The direct invitation: this method is implemented by direct free invitation to at least (3) three of the contractors or processors or consultants accredited for their ability, competence and technical and financial efficiency to implement projects or contracts of official bodies and when one or more of the following justifications are available:

- A- If the contract requires confidentiality in the contract and implementation.
- B- There should be security reasons that require this.
- C- Emergencies and natural disasters.
- D- The provision of medicine, equipment and specialized life-saving medical supplies.

- E- Bidders' reluctance to participate in public tenders announced for the second time or in case of receiving tenders that do not meet the conditions and specifications for the second time.
- F- Specialized contracts issued by the General Government Contracts Department and in coordination with the competent sectorial committee in the Council of Ministers.
- G- - The strategic and large projects that require foreign expertise, which are determined by the competent sectorial committee in the Council of Ministers in coordination with the Ministry of Planning. This committee is executed by international companies with expertise of at least 5 years and similar works of not less than (3) in this field.

Sixth: One bid (the only offer): The invitation is free to only one competent authority or contractor or consultant to implement the contract with the approval of the Central Committee for review and approval of the assignment when one of the following cases is available:

- A- When the goods or advisory services or monopolistic nature of the contracting are available at the monopolist which owns the patent or license or exclusive rights.
- B- If the goods or constructions are required for maintenance purposes or for preparing spare tools for previous contracts.

Seventh: Direct contracting: The invitation is free to contract directly with one authority to achieve this method with the approval of the competent sectorial committee in the Council of Ministers and with the recommendation of the Central Committee for the review and approval of the assignment of import or local contracts for processing goods of a non-monopolistic specialization, provided that the following conditions are met::

- A- Contracts should be related to the security and sovereignty of the State, which is absolutely necessary.
- B- Contracts should be characterized by technical specifications of high technology or advanced. It is permissible to accept a more advanced standard or technical

posters, which are presented by the contracting authority, after being supported by a competent technical authority in the contracting authority.

- C- The contracting entity must be a licensed, certified and well-known manufacturer of the required materials or services.
- D- The existence of a technical report of the needs and specifications prepared by a competent technical authority approved by the Central Committee for review and approval of the assignment.
- E- The presence of a competent examiner that has been approved to ascertain the accuracy of the required specifications and the extent of compliance with the conditions required to contract.
- F- The competent sectorial committee shall issue its decision within fourteen (14) days from the date of registration of the application.

Eighth: Direct purchase from firm manufacturers:

- A- Public companies that engage in commercial profit-making activity should buy directly from firm manufacturers discreet and their contracts should be subject to the Board of Directors' approval.
- B- Public companies should negotiate prices with those who contracted this way to carry out their projects or contracts if the bid is higher than the estimated cost of the contract.

Ninth: Purchasing committees: This method is used to equip the state departments with goods, services and business according to the controls contained in the instructions of implementation of the federal budget for the concerned year.

In addition, there also an important law.

4. Settlement of Disputes

(2014)

First: Each Contracting authority should establish a central committee to consider the objections submitted by the bidders on the referral decisions under the chairmanship of an

employee whose rank is not less than the first degree and the membership of a number of persons with experience in the financial, legal and technical fields.

Second: The Committee should examine the written objections submitted by the bidders or their official agents who did not request withdrawal of the initial deposits according to the following:

- A- Submission of the objection within (7) working days from the date of notification of the assignment letter.
- B- The objector should introduce an official undertaking duly certified by an accountant according to the law to pay the damages incurred in the interest of the contracting authority about the delay in signing the contract for reasons that are malicious or unjustified.

Third: The committee should submit the recommendation for the object of the objection and its reasons within a period not exceeding fourteen (fourteen) working days from the date of filing the objection.

Fourth: The head of the contracting authority or whoever is authorized by him should decide the recommendation within (7) working days from the date of filing the recommendation in his office. Not taking a decision is a refusal to object when the time passes this period.

Fifth: The contracting party should not sign the contracts until the objections are resolved by the head of the contracting authority as stipulated in this article.

Sixth: conflicts should be settled after the signing the contract by mutual agreement and they should be through the formation of a joint committee between the parties to the conflict represented by the contracting authority and the contractor in accordance with the provisions of the law, the relevant instructions and the terms of the contract. The agreement shall be ratified by the head of contracting authority.

Seventh: When no friendly agreement is reached, one of the following methods is used, which must be provided for in the contract are as follows:

A- Arbitration is in accordance with the following points:

- National arbitration: It is in accordance with the procedures specified in the tender conditions or the Civil Procedure Law No. 83 of 1969.
- International arbitration of the contracting authority: choosing an international arbitration for settling conflicts in cases of necessity, and for major or strategic projects. When one of the contract parties is foreign, the following points must be taken into consideration:
 - (First) one of the approved international arbitration bodies should be chosen.
 - (Second) determine the place and the language of the arbitration.
 - (third) Adoption of Iraqi law as applicable law.
 - (four) The contracting authority shall have the necessary qualifications for the settlement of disputes in this manner.

B- Refer the dispute to the competent court in the subject to settle it.

Eighth: The two parties to the contract must choose the best way to settle the disputes arising from their implementation according to one of the prescribed methods in this article which meet the agreed contracting conditions. These conditions should be mentioned in the tender documents.

5. Insurance, delay penalties, the duration of the contract and the extension

(2014).

First:

- A- Determine the initial insurances at a lump sum of at least (3%), three percent from the estimated cost for the purpose of assignment in the processing of goods, services and general contracting of various kinds of contracts, taking into account the importance of the tender. This percentage decreases as the amount of the estimated cost increases.
- B- Initial insurances of bidders are not acceptable except when the bids are in the form of a letter of guarantee or a certified instrument.

- C- Initial insurances should be provided by the bidder any of the shareholders of the company or participating companies under a partnership contract for the interest of the contracting authority which includes reference to the name and tender number.
- D- Public companies shall be exempted from providing the initial insurances and the good letter of guarantee that stipulated in the instructions.
- E- Bidders; who participate in tenders to be referred with limited tender method, or the second stage the tender method in two stages, or direct call method, or the only bidding method, or the direct contracting method, or the method of direct purchase from firm manufacturers, are exempt from providing the initial insurances.

Second:

- A. The final insurances are presented in the form of a good letter of guarantee of the contract at a rate of (5%) five percent of the contract amount after notification of the letter of assignment and acceptance of the contract signing.
- B. Foreign companies may submit the final tender contract during (21) twenty one days from the date of signing the contract after the approval of the Central Audit Committee and the approval of the assignment in the contracting authority.
- C. The final insurances should be released only after the issuance of the final acceptance certificate and the liquidation of the accounts. Parts from the cost of the good letter of guarantee may be released after the final delivery of these parts and the issuance of a certificate of acceptance to them in support of being eligible for use.
- D. The entities stipulated in paragraph (c) of item (7) of Article (3) of these instructions provide the final insurances Ensure good implementation) of (5%) five percent. In case of any other insurance, the approval of the competent sectorial committee of the Council of Ministers is obtained.

Third:

- A. Controls and instructions issued by the Central Bank of Iraq and the Ministry of Special Planning sponsor with the letters of guarantee.
- B. The form of the letter of guarantee is clear in terms of its amount number and writing. It determines the authority to be issued in its favor, the effective date, its conditions, the purpose of its issuance and others in accordance with applicable laws, regulations and banking standards.
- C. The contracting authority must verify the validity of the letter of guarantee with the renewal or change of the amount when changes are made to contract terms.

Fourth:

- A. The delay penalties is determined by the Contracting Party at a rate not less than 10% and not more than 25% twenty five percent of the contract amount. The contracting authority fixes this percentage in the contractual conditions in the tender documents and instructions to the bidders.

Apply the following equation when calculating this fine:
 The amount of contract (the amount of the original contract + - any change in the amount) / total duration of the contract (the original contract period + - any change in duration) * (10-25%) = fine per day.

- B. The delay penalty is reduced according to the percentage of completion of the contractual obligations specified in the execution plan of the contract, in which a certificate of initial delivery of the work performed or the processed goods or required service is conformed and prepared for use according to the terms of the contract and the application of the equation as follows:

Value of unexpired obligations / total contract period * (10-25%) = one day fine

- C. - The delay penalties is deducted at the end of the original contract period plus the additional terms granted to the contractor when they are due in the completed contracts according to the labor supply platform. The mechanism of deduction is determined in the tender and contract conditions.

- In contracts that executed according to a timetable or according to stages, and in which the cost is determined and each stage is extended, the delay fines for each stage is deducted at the end of the period.
- The head of the contracting authority may delay the deduction of delay penalties at the request of the contractor only for twice, provided that it is deducted at all before the final payment is due.
- The contract is renewed by a decision of the head of the contracting authority when the conditions stipulated in the regulations issued by the Ministry of Planning are available.

CURRICULUM VITAE

Name: Omar Alhachami

Country, City: Iraq, Baghdad

Education

Degree	Filed	University	Year
Undergraduate	Economics and administration	Mustansiriya	2003-2007

Work Experience

Work Place	Position	Year
Iraqi Ministry of Electricity/ Training Department	Accountant	2004-2009
Iraqi Ministry of Electricity/ Training Department	Asst. of Head of the financial Dep.	2009-2012
Iraqi Ministry of Electricity/ Training Department	Head of the financial Dep.	2012-2015

Languages: Arabic, English.

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Turnitin Orijinallik Raporu

Tez Omar Alhachami tarafından

ÖDEV 2 (SBE TEZ 1) den



- 31-Tem-2017 14:02 EEST' de işleme konu
- NUMARA: 834263779
- Kelime Sayısı: 43706

Benzerlik Endeksi
%7

Kaynağa göre Benzerlik

Internet Sources:
%5

Yayınlar:
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Öğrenci Ödevleri:
%4

