International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 03, March-2022

Project Delivery Systems and Contracting Strategies

Naser Saad Almutairi
Benha University
Faculty of Engineering – Civil Department

Prof. Dr. Nasser Musleh
Professor of Geotechnical Engineering
Faculty of Engineering (Shoubra)
Benha University

Dr. Mohammed Abdulhamid
Assistant Professor of Construction Management
Faculty of Engineering (Shoubra)
Benha University

***Abstract*: - The construction industry has grown during the last decades and has developed concurrent with technological and information development. The main objective of this paper is to investigate the different methods of project delivery systems and their relationship with the project organization represented by different project parties. The work also briefly describes tendering methods and the different contract types to identify how to create a contractual strategy for large construction projects.**

The construction industry is characterized by its multiplicity of parties involved in the implementation of mega projects. Each party has a key role in the success of the project during its implementation stages until the completion of the project.

There may also be multiple countries involved in implementing them. Hence, they are based on multiple contracts with different parties, responsibilities, and obligations that emphasize the role of "contract engineer" or "contract administrator".

It is the responsibility of the contract administrator to manage multiple contracts for different parties and from different countries that have added international character to the construction contracts. The overall responsibility is to ensure that all parties fulfil their contractual obligations as stipulated in the terms of the contract.

The contract can thus be considered a future plan for the implementation of the project. Therefore, the contract is a vision for the future, and projects do not pass without facing many risks surrounding them, i.e., whether there are external sources such as economic changes that affect prices, currency exchanges rates, or internal sources such as technical problems. The risk allocation must be balanced against the terms of the contract so that the project can conclude successfully.

PROJECT PARTIES AND ROLES

This section highlights the different project parties and their different roles and participation in the construction project.

1.1. Primary Parties

In the past, there were three project parties: owner, architect, and contractor.

The Owner is the party that wishes to create the project. This is also called the "client" or "employer".

The owner has to provide the financing for the full value of the project in periodic installments paid to the contractor and also provide the consultant's entitlements.

The Architect is the party that translates the needs of the owner into a concrete plan represented by preparing the design concept of the project and the specifications of each of its components through the ability to visualize the project as if it was created. The architect has knowledge to design the project and achieve its desired functions. The architect prepares detailed design drawings and project documents including its manual. The architect may be appointed by the owner to supervise the implementation of the facility.

The Contractor is the party who transforms the project plans and specifications into reality often using a group of consultants, trade contractors (subcontractors), and suppliers to implement the project.

The Supervisor Consultant is the party responsible for the supervision of the construction of the project works to ensure that they conform to the plans and technical specifications of the project. Major projects have multiple stages in the design and construction. They can have multiple consultants in view of the need for different areas of specialization.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 03, March-2022

Large projects require long-term study and design stages before the implementation can begin. Thus, the project owner usually does not retain contract supervision services at the early stages of a project. Hence, it is common in the Gulf countries (where many major projects are performed) that the owner contracts with the architect without supervision scope until the implementation can begin. That way, supervision of the project is put forward and contracted with the supervision consultant who may be a consultant office other than the one who has prepared the designs.

Development in the twenty-first century has led to the demand for a fourth party—project manager. This role is based on the needs and requirements of the owners in addition to technological advancements in the construction trade. There are complex information systems and computer technologies that have had a significant impact on architectural development and the construction industry. Finally, the project sponsor is another key role.

The Project Manager has two definitions: First, this person is a management consultant appointed by the owner who is responsible for the success of the project. The responsibilities include project management and contract administration at all stages, the development of the general project management plan of the project, as well as follow-up and control systems though planning, design, implementation, and operation. The second definition of the project manager is the individual who is appointed to manage the project.

The Project Sponsor is responsible for funding the project until it is completed and may include more than one entity for large construction projects to share financial risks via syndicated loans.

1.2. Construction Industry Nature and the Presence of other Parties

The nature of the construction industry is different from other industries due to its large size. The construction industry is based on many industries that grow and fall, and the vision of the construction industry from the perspective of the team implies that all of these teams work together despite the inherent nature of the project as temporary work.

However, these different teams must work together to transform a desire in the owner's mind into an integrated real-world architectural production that is used by the owner or the users or meets their project goals.

The structure of this industry is highly independent among different parties who work in all phases of the construction project. Each of these parties are independent of the others. Each party is represented by many individuals and each is independent from the other. This industry also distinguishes the change of teams or their members during the various phases of the project as well as changes of the various roles.

Thus, performance indicators are an important component of planning and follow-up. They are measures of how different parties work together as a single team. In general, the success of a project depends to a large extent on the trust, coherence, proportionality, and cooperation of each of these independent parties with others.

1.3. The Multiplicity and Chain of Contractual Relations

The overview of the different parties as related to the projects and their responsibilities illustrates how there may be many contractual relationships governing a single project. This is seen by the sequence of these contractual relations; the owner may contract with a consultant and a contractor. The consultant may also contract with one or more sub-consultants. The contractor also contracts with subcontractors, suppliers, etc. Thus, a chain of responsibilities and a series of overlapping responsibilities, obligations, and rights can arise from different contracts between different parties.

PROJECT LIFE CYCLE

The project life cycle is defined as the sum of stages or phases, i.e., from being an idea in the mind of the owner until the project is completed and delivered to the owner free of defects for that use that it was intended. This section summarizes the typical phases of the construction projects.

The stages of construction and buildings projects as presented in Fig. 2.1 and include the following typical phases:

1. Feasibility studies phase.
2. Design phase.
3. Tender placement and contract award.
4. Implementation phase.
5. Delivery and operation phase.

1.4. Feasibility study Phase

The objective of this stage is to ensure that the project will achieve its purpose, i.e., to achieve the desired return or the public benefit suggested in its establishment.

1.5. Design Phase

This phase enables the owner to identify and characterize the project requirements and define its functions by developing a program for the project “Briefing”. The conceptual design of the project is prepared based on the project briefing. Once

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 03, March-2022

approved, the design passes through the various stages of development, which ends with the preparation of detailed drawings and detailed specifications of the project and lists quantities and all documents that enable the contractor to implement the project.

The various design stages identified by the American Institute of Architects (AIA) are:

1- Conceptual Design.

2- Schematic Design.

3- Design Development.

4- Detailed Design.

5- Construction Documents.

The role of the architect/engineer (A/E) in the design should be in accordance with the budget allocated by the owner of the project based on feasibility study. This requires preparation of the estimated cost of the project from the beginning of the preparation of the idea through all following stages. The documents should be updated at each stage of the design.

1.6. Tendering and Contract Award Phase

This phase aims to appoint two sides: the supervision consultant and the contractor. The supervision consultant appoints the supervisor in case the supervision of the project execution is not within the scope of work of the design consultant. The supervision consultant should coordinate the work of the project between all parties of the project owner, architect, and contractor.

The second is the appointment of the contractor who will undertake the execution (or design and construction) of the project on site. This phase begins with the preparation of the project tender documents.

The prequalification process sometimes precedes the process of tendering to select only qualified contractors and invite them to submit their bids. After receiving the bids, the evaluation processes begins for the offers submitted by the contractors. This phase concludes upon selecting the winning contractor and signing the contract to carry create the project.

The tendering stage may also be applied for design work or project management services. In this case, the owner will have a draft of the TOR that include the scope of service.

1.7. Implementation phase

This phase (also called construction phase) implements the project within the agreed period and at the specified value in accordance with the quality stated in the contract specifications by utilizing the needed resources: labor, materials, equipment, subcontractors, and funds. The financial needs of the project must be determined during the implementation period.

This stage starts by informing the contractor in writing to commence execution.

The implementation phase usually starts with a specific limited period called the “mobilization period” to allow the contractor to mobilize equipment and move it to the project site. The contractor also appoints staff, subcontractors, and laborers. This period also includes preparation of the general method statement and the detailed contractor’s construction schedule (CCS). This period should generally not exceed 60 days from commencement date.

The last period of construction integrates, tests, and commissions the facility systems and equipment to confirm its fitness for purpose.

The supervision consultant oversees the contractor with respect to what work is to be done pursuant to the contract drawings and specifications. The resident engineer (RE) is the primary field representative to the owner and the contractor’s single point of contact. The execution phase may suffer cost overruns due to changes and delays or disputes with contractors. This can lead to contract changes and claims.

In most general contracts, the contractor is required to provide a forecast of cash flows so that the owner can arrange the necessary financing during this stage.

1.8. Delivery and operation phase (Close out)

This phase ensures that the building performs its functions as required and as described in the project documents. The project is delivered to the owner for its operation. Users are on trained to operate the systems. This phase typically includes substantial completion, defects liability period, and final completion.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 03, March-2022

1.8.1. Substantial / Practical Completion

A contract is substantially complete when issuing a "certificate of substantial completion" (sometime called "certificate of beneficial occupancy") by the owner so that facility users can occupy and begin use of the facility and equipment. This phase also includes administrative closing activities.

1.8.2. Defects Liability Period (DLP)

The defects liability period begins after substantial completion. It may be as long as one or two years according to the duration stated in contract terms. During this time, the contractor is liable for any malfunctions, breakdowns, or problems resulting from poor implementation, poor workmanship, or defective materials or equipment. The contractor bears the costs of repair unless the defect or problem is caused due to misuse by the owner or users.

1.8.3. Final Completion

After the expiration of the defect-liability period, the project is completely handed over to the owner and the contractor is deemed to have performed all contractual obligations. The owner then issues the final completion certificate to the contractor in accordance with the contract provisions.

After final completion, the contractor remains solely responsible for the safety of the building from fractional failure, partial failure, or latent defects in accordance with the laws governing the project country.

1.9. Multi-Packaging

It is sometimes in the interest of the project to be divided into specialized packages between general contractors and specialists. The project's multi-package system is applied to sections, which are quite similar to the system of multiple prime contracts (see sec. 4.5), but the goal is to divide the project and not lead to a multiplicity of contractors.

The project may be packaged, but the implementation still remains with one general contractor; the multiplicity of contractor systems can be applied only by dividing the project into packages.

Splitting the project into multiple packages is concerned with the implementation stage as is the case with multiple contractors. It may be applied during the design stage alone, or it may also include the tender stage.

In the case of applying the multi-package concept, each package may go through the stages of the project life cycle: design, tender and contract award, implementation, and close out. The concept of multi-packages of projects is mostly applied in mega projects and large infrastructure projects. It is characterized by the following:

- Helps the owner organize the funding required for the project if carefully planned.
- There is a strong motivator for the contractor to win another package of the project, which increases the competitiveness of tender prices.
- It is excellent at saving time—especially in large projects that include separate buildings. It is easy to split so that the work can be carried out in all buildings at the same time.
- The owner has strong benefits from using the resources of the project's group of contractors (in case of multiple primes) such as large housing projects, but this needs to provide funding for the project by the owner during a relatively short period.
- The multi-packaging is applied not only to save time but also to extend the time according to available financing possibilities.

The application of a multi-packing system is valid in the following cases:

- Major projects that are difficult to execute by a single contractor.
- Fast tracking projects that require quick execution and cannot wait for detailed design to finish such as design/build systems.
- Projects that include specific or rare specialties.
- Projects that are easy to be subdivided into subprojects.
- Medium-sized projects, but there may be some coordination problems due to interference with the subcontractors' work.

Multi-packaging should also be applied in the following cases:

- In accordance with the laws governing the project country which may have to split projects if their value exceeds a specified amount.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 03, March-2022

- The case of provisional sum items where money is allocated to some works to be put forward later by appointing nominated subcontractors.
- In the event that the main contractor is not reconciled to work with a nominated subcontractor. Here, the owner may split the project and contract directly with each contractor separately.

In order for this system to be successful, it would be preferable for each consultant or contractor to have a project manager who works for it as a representative. The duties of the project manager includes coordination and organization of work with other parties of the project so that the different packages can be controlled.

Contractual delivery systems and project organization

The organizational structure of the project depends on the different contracting systems. There are several contracting systems each with strengths and weaknesses. The organizational structure of the project is influenced by the contracting system on which the decision will be made. Cash flows depend primarily on the selected contractual system. Choosing the contractual system of the project determines the following:

(A) Identification of the responsibilities, authorities and contractual boundaries of the different parties.

(B) Determination of the relationship of each party to the other.

(C) Determination of the scope of work for each contract.

(D) Determination of the value of each contract and payment system.

(E) Determination of the time of each contract.

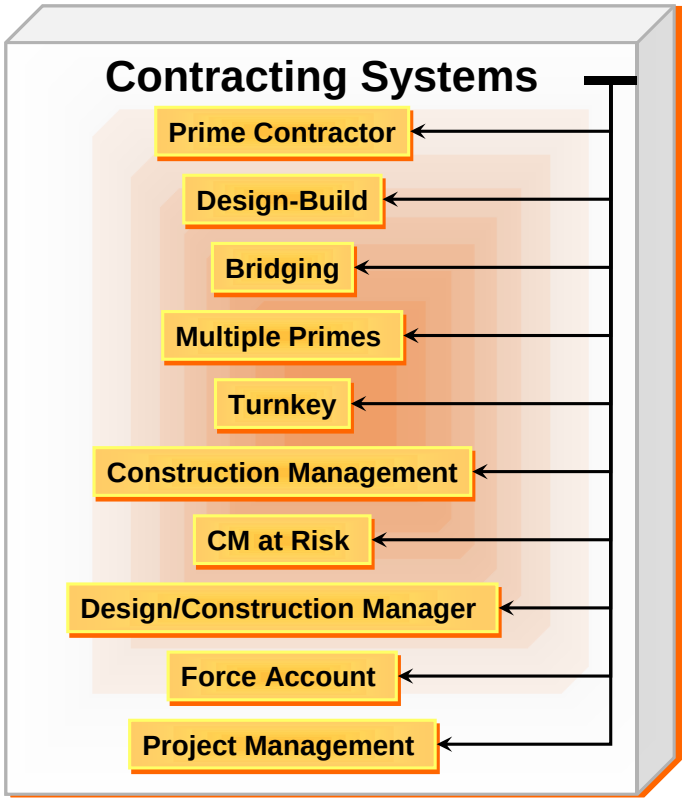

Fig. 4.1 Different Contracting Systems for Construction Projects

Each of the contractual approaches determines the scope of work for each participating party and is a financial consideration for the performance of the work.

This highlights the importance of contract management and follow-up as a component of the system. These different approaches also highlight the importance of studying the economics of different contracting systems and their impact on the cash flows of the project and the financing required by the owner.

The optimal contracting system must be defined for every project to achieve the best economic return for the project. It must be integrated so as to achieve the objectives of the owner. Contracting systems can be identified as described in Figure 4.1

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 03, March-2022

1.10. Prime Contractor System / Design Bid Build (DBB)

Prime contracting is a form of procurement in which the owner enters into a relationship with a contractor who provides a single point of contact (prime contract) to deliver one or more projects.

This system uses a chief contractor who has a contract with the project owner and has the full responsibility for its completion. A prime contractor performs a complete contract and may employ (and manage) one or more subcontractors to carry out specific parts of the contract. This system is also called “main contractor” or “general contractor”.

This system is also known as DBB and describes the popular model of construction management, in which the general contractor is engaged through a tender process after designs have been completed by the architect or engineer. It is also called the “general contractor system” or the “traditional system”.

It is a linear system that is not initiated before the completion of the previous process. The consultant is selected first to prepare the designs and specifications and all the project documents including the estimated cost of the project. The project then goes for tender to the contractors as soon as the documents are completed and approved by the owner. The tenders and contracting with a single contractor are then evaluated usually with the lowest price. The general contractor then contracts with specialized sub-contractors through subcontracting contracts.

The DBB system may result in delays in starting the implementation of the project. However, this delay can be overcome by applying the fast-tracking method. The project is submitted for tendering before the design is completed but at a stage suitable for tendering. The owner has the risk of changing the price upon completion of design documents. This method may not be applicable to government projects.

Prime contractors tend to be large construction companies with significant resources that are appropriate for large clients (e.g., the government) and large projects.

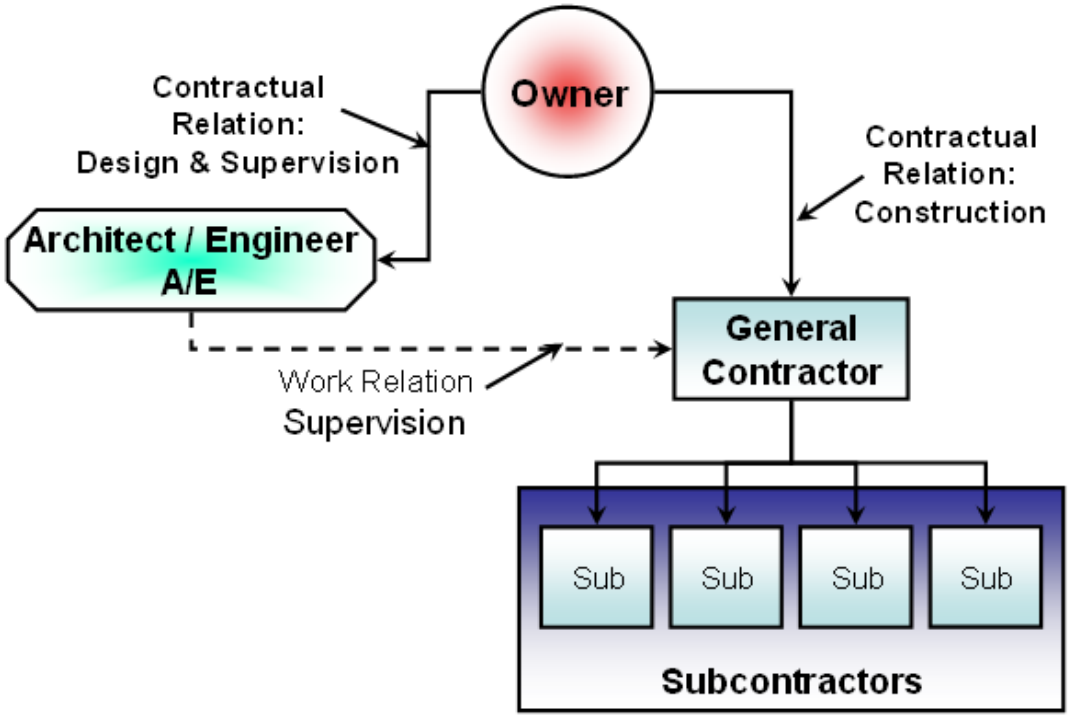

Fig. 4.2 Prime Contractor System: Designer and Supervisor are One Entity

One of the best benefits of the prime contractor system is that it removes the need for owner co-ordination of multiple contracts which could in itself require the appointment of external consultants. It also has a clear line of communication and accountability.

However, it is criticized in that it can be seen to exclude smaller companies and to stifle competition and innovation. They can become too ‘costly’, simply adding another layer of overheads and profit, and there is even the danger of fraud. Consequently, projects must be clearly defined at the outset, and carefully controlled throughout. Strategies might include:

- Open-book accounting.
- Clear measurable milestones.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 03, March-2022

- Clear allocation of risks.
- Fraud detection and prevention.
- Ongoing performance measurement and continuous improvement.

A branch of this system is to split the design and supervision functions. The owner may have contract with the design consultant and other contracts with supervision consultant. This system results in the current nature of large construction projects, which can take a long time during the study and design stages. Thus, the owner does not want to contract supervision at an early stage and usually prefers to wait until construction begins.

One of the most important features of this system is that it removes the conflict of interests where there are some design defects, errors, or inconsistencies in the design documents that may be discovered by the contractor during implementation. The DBB is also characterized by competition when selecting the supervisor consultant through the tendering process.

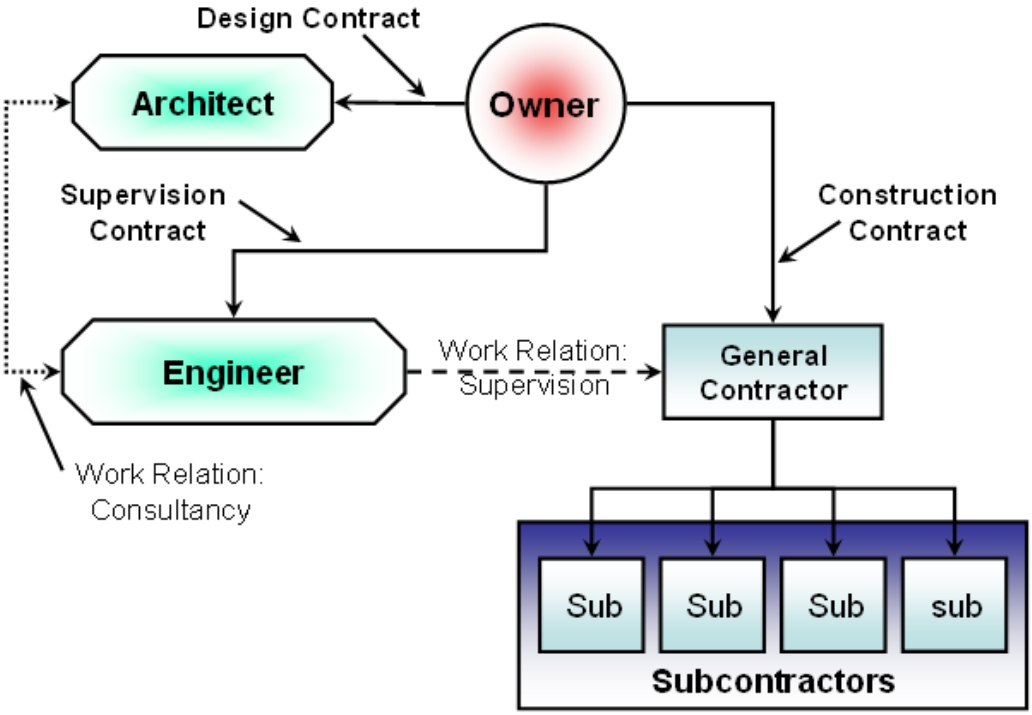

Fig. 4.3 Prime Contractor System - Designer and Supervisor are Two Entities

However, it is faulted in that the supervisor consultant is not responsible for correcting design defects or deficiencies of design during the implementation phase. Thus, the contract of the design professional with the owner should allow for provisions for this liability during implementation.

This system can be applied in most large construction projects, and projects that need a long time for the design to be completed. It is preferably used when the owner employs a project management company applying the project management techniques presented in section 4.10.

1.11. Design-Build System

In the design-build system, the owner assigns full responsibility to one party for both design and construction. This party is often a contractor who in turn uses subcontractors to carry out specific parts of the project. Figure 3.3 presents the design-build system.

The responsibility of the owner is limited to the approvals of designs and specifications and the interim payments to the contractor. Most of the responsibilities fall on the contractor.

The owner may be assisted by an architect or a project manager whose role is limited to developing the terms of reference (TOR) for the design requirements, specifications, design criteria, and special conditions of the contract in order to issue design-build tender for the project. In this system, the owner bears the risk of choosing the design and construction entity.

This system requires that the contractor have a strong financial position, strong management skills, and good performance. If the contractor is weak in one of these points, then it is difficult to replace it without losses to the project in terms of time, cost, or quality of the work. The impact of these risks increases as the project progresses.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 03, March-2022

There are three main advantages to a design-build contract. First, the construction team is motivated to work with the design team to develop a practical design. The team can find creative ways to reduce construction costs without reducing the function of the final product. The second advantage involves the schedule. Many projects are commissioned within a tight time frame. Under a traditional contract, construction cannot begin until after the design is completed and the project has been awarded to a bidder. In a design-build system, construction activities can proceed concurrently with the design. The third advantage is that the design-build contractor has an incentive to keep the combined design and construction costs within the owner's budget.

One disadvantage of this system is that the owner contracts the project without being aware of its design. The owner may get a building that is over-designed to increase profits for the design-builder or a building built with lesser-grade products to maximize profits.

Another disadvantage with design-build contracts is an inherent conflict of interest. In a traditional system, the designer is responsible to the owner to review the contractor's work, thus ensuring that the products and methods meet specifications and codes. In the design-build system, the contractor may overlook design flaws that may not be seen or might go unnoticed (or unmentioned) because the builder is also the designer.

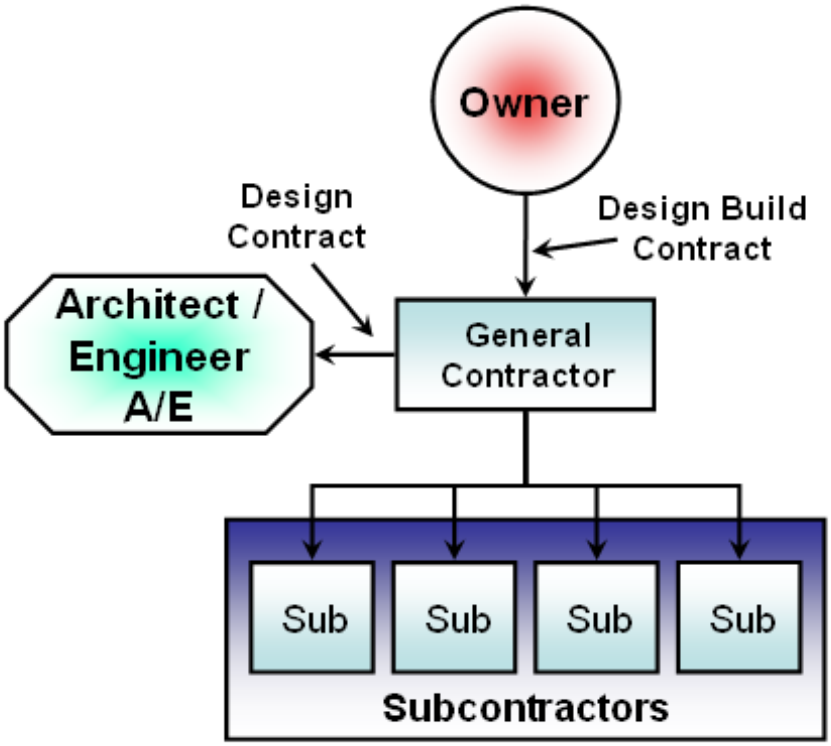

Fig. 4.4 Design-Build system with General Contractor

1.12. Turnkey System

The turnkey construction project system is the transfer of the completed project by the contractor's company to the customer in operation and in full working order. The contractor undertakes the entire responsibility from design through completion and commissioning. The client or customer only has to turn the proverbial key to find everything function as it should. This type of service has become much admired in recent years.

The turnkey system is the same as the design-build construction system and is commonly used, but it is different in that it includes the financing of the project and sometimes also includes the purchase of land. In this system, the contractor will implement the building in its entirety including the furnishings.

The main advantage of this system is the provision of providing alternatives for financing to the owner where the contractor is responsible for financing.

It is suitable for projects that require special equipment or furniture such as hotels, resorts, factories, and hospitals. It is also widely used in housing projects. Many companies often offer their customers construction of the house using a turnkey construction project system via advertisements.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 03, March-2022

In a turnkey system, the owner may contract with a design-build construction company or with a general contractor who is contracted to the design professional. The owner may also work with an engineering consultant office to perform the design function. The general contractor hires the specialty subcontractors besides his own labor force.

The execution of the project begins after project approval. The construction firm is obligated to complete a project according to pre-specified criteria, and thus it is important to make all necessary documents before construction.

This system uses a fixed price at the time that the contract is signed. As a result, the construction company is held responsible for exceeding the budget. Turnkey construction contracts reduce the risk to the buyer of the construction services and provide an incentive for the constructor to stay within budget.

1.13. Multiple Prime Contractors (MPC)

In the multi-prime contractor system (Fig. 4.7), the owner contracts with a group of contractors so that each contractor has a main contract. This system clearly requires that the project be divided into multi-packages. The opposite is not required, i.e., the owner may use a single general contractor despite the splitting up of the project into multi-packages.

Multiple prime contracts are awarded for interrelated major elements of the work that must be performed simultaneously. These contracts are considered for one project and require close coordination of the different work elements.

The multiple prime contractor system is preferred for large construction projects, multi-stage projects, accelerated (fast track) projects, projects that include multi-buildings, or repetition of the buildings.

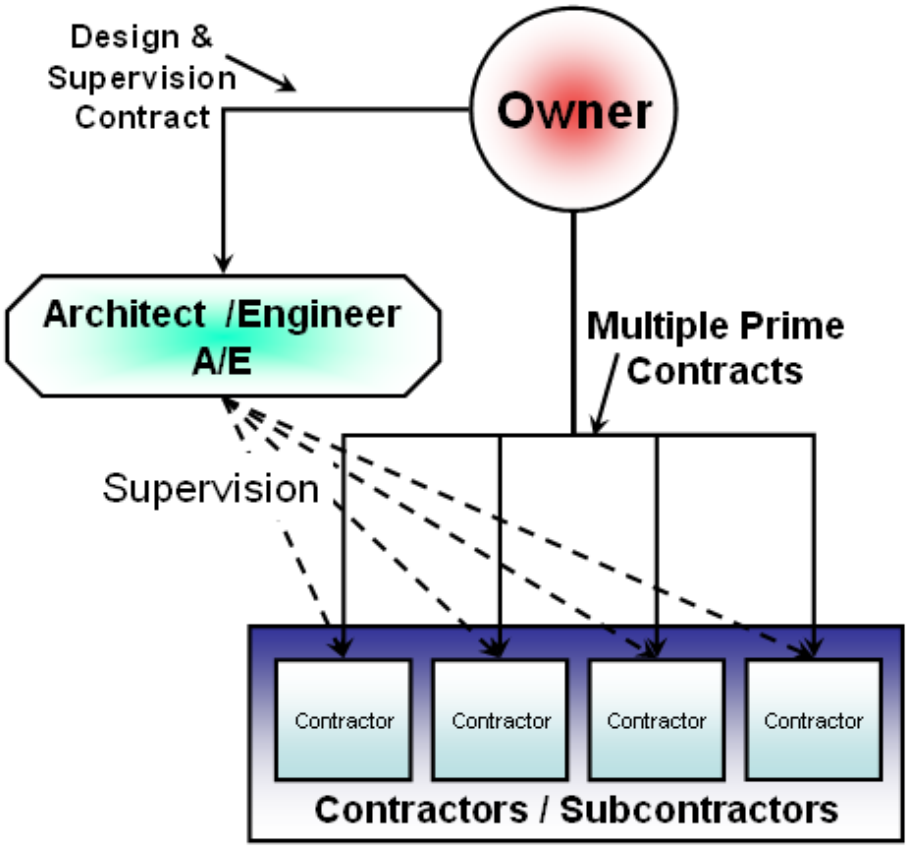

Fig. 4.5 Multiple Prime Contractors System

Multiple prime contracts (MPC) are sometimes referred to as “multi-contracts” or “separate contracts”. The owner aims to implement a MPC system to reduce the total value of the project, but there are many risks in return: coordination between multiple contractors and the overlap of the scope of work between them. Conflicts always occur when applying this system especially if there are technical gaps between the contracts. This system is subject to special contractual provisions as well as the multiplicity of financial claims and a lack of clarity in terms of responsibility in the case of delay.

The law sometimes requires that if the value of the project exceeds a certain amount, then it should be introduced by the system of multiple prime contracts to reduce the cost of the projects.

However, there may be times and reasons to use the prime contracts system. This depends on the nature of a project and the size and complexity of an individual division of the work. It is generally recommended to have the minimum number of prime

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 03, March-2022

contracts on a project wherever possible unless saving time, money, or achieving a higher quality product can justify it otherwise.

Cost alone should not be the sole determining factor for qualifying a construction operation as a major subdivision of the project. For consideration as a major contract, a construction operation should involve a specialty contractor and several trades. Most major contracts should last throughout the construction period.

Coordination becomes difficult to handle efficiently during design and construction if there are many contracts. Thus, the contract documents should clearly define the division of work. The fragmentation of documents into smaller bid packages sometimes leads to the duplication of responsibilities that may result in problems. Thus, care must be exercised to properly identify and allocate work to avoid gaps or overlapping responsibilities among the contracts, which can be difficult depending on the complexity of the Project.

A clear assignment of responsibilities must be included in the divisions of the project—especially at points where different contracts meet or interface.

The consultant/designer needs to clearly specify the scope and responsibilities of each contract and cross-check the responsibilities for each contract to ensure that no overlaps or gaps exist. The designer is responsible for the overall design coordination of the project between MPCs.

Accordingly, these types of projects require separate project manuals for the subdivisions of the work. Separate drawings must be prepared for each MPC. This is to avoid confusion on the part of the contractors as well as to preclude the possibility of contradiction in the contract documents. Clear identification of the work of each major trade within the documents when projects are approved for bidding is very important. This clarity and separation of scope within the single-contract documents facilitates sub-contractor bid take-offs during the bid period and helps ensure that the bidder has sound cost proposals from their sub-contractors.

Clearly, good judgment must be used when deciding which prime contractor should be responsible for specific scopes of work. Construction under multiple contracts often means that different contractors require access to the same space at the same time. Coordination problems can develop if the work installed by one contractor obstructs or disturbs the work of another.

Coordination is essential for the success of multiple-contract projects because they are prone to delays caused by the need to coordinate elements of the project among several contractors. Contract provisions should allow each prime contractor to be responsible for coordinating the activities of their subcontractors and the work between other prime contracts in a cooperative manner.

During construction, the owner is the main contractor and must coordinate work among the different prime contractors. The owner or their representative direct and coordinate construction operations between the prime contractors. The owner may (and should) retain construction management services.

The best project results occur when the documents are properly coordinated and the project properly managed during the construction phase. For this system to succeed, one of the prime contractors should be selected as the main contractor to carry out the general coordination responsibilities. This should be in the first section of the master format, e.g., preparation of the complete construction schedule, especially if the owner does not have a suitable team relative to the size of the project for coordination responsibility.

Most often the owner transfers coordination responsibilities to the supervisor and contractors together. The risk to the owner increases as the number of prime contractors increases.

1.14. Construction Management System

The construction management system (also called management contract system) is similar to the multiple-contractor system, but the owner contracts with a construction management company to transfer the risk of coordination between the multi-prime contractors from the owner to a specialized construction company. The CM assumes coordination responsibilities between multiple contractors.

In return, the owner bear the remuneration of the CM working team, which shall be determined by the size of the project and the size of the various multi-contracts from the primes.

Like the multi-primes, one of the prime contractors may be selected as the main contractor for general responsibilities and coordination per division one in the master format. However, this system can also be applied in the case of contracting with a single prime contractor and not multiple contractors in large projects. Here, the CM does not carry the risks of project delay or over-budget.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 03, March-2022

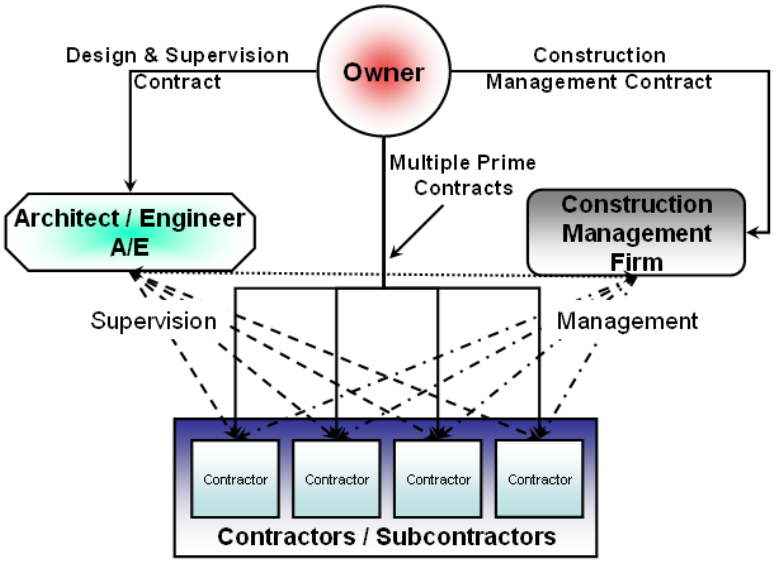

Fig. 4.6 Construction Management (CM) System

The most important feature of this system (Figure 4.8) is the possibility of contracting between the owner and the CM. This system saves time at the beginning of the project. The operational studies are commensurate with the different possibilities of implementation through the cooperation of contractors with the management company. This system is prevalent in the Gulf Area.

1.15. Construction Management at Risk System

Construction management at risk system (CM@Risk) is a system branched from the CM system where the construction management company bears the risk of implementing the project in terms of time and cost. It is similar to the DBB system and the general contractor system with three major differences:

First, a construction management company known as CM@Risk is appointed to manage the implementation phase including selecting and coordinating multiple contractors.

Second, the design and implementation phases can be overlapped through the coordination between the architect/design professional and the CM@Risk. This approach saves project time.

Third, the CM@Risk is responsible for the quality of the work, the time schedule, and the estimated cost of the project. This person must provide a guaranteed maximum value for the project as the CM at-risk is a delivery method that entails a commitment by the construction manager to deliver the project within a guaranteed maximum price (GMP).

The CM@Risk is responsible for the cost and time risks, and thus this system is fundamentally different from the previous system (CM system) in that the CM@Risk is the one who contracts with the contractors and not the owner. Thus, they have a right to choose them except in the case of the nominated subcontractors

The CM@Risk delivery method is best for large projects—both complete construction and renovation. Thus, they are not easy to define, have a possibility of changing in scope, or have strict schedule deadlines. This is an efficient approach in projects with technical complexity, multi-trade coordination, or multiple phases. This type is not applied in Gulf countries where management companies do not prefer to bear the cost and time risks (Figure 4.9).

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 03, March-2022

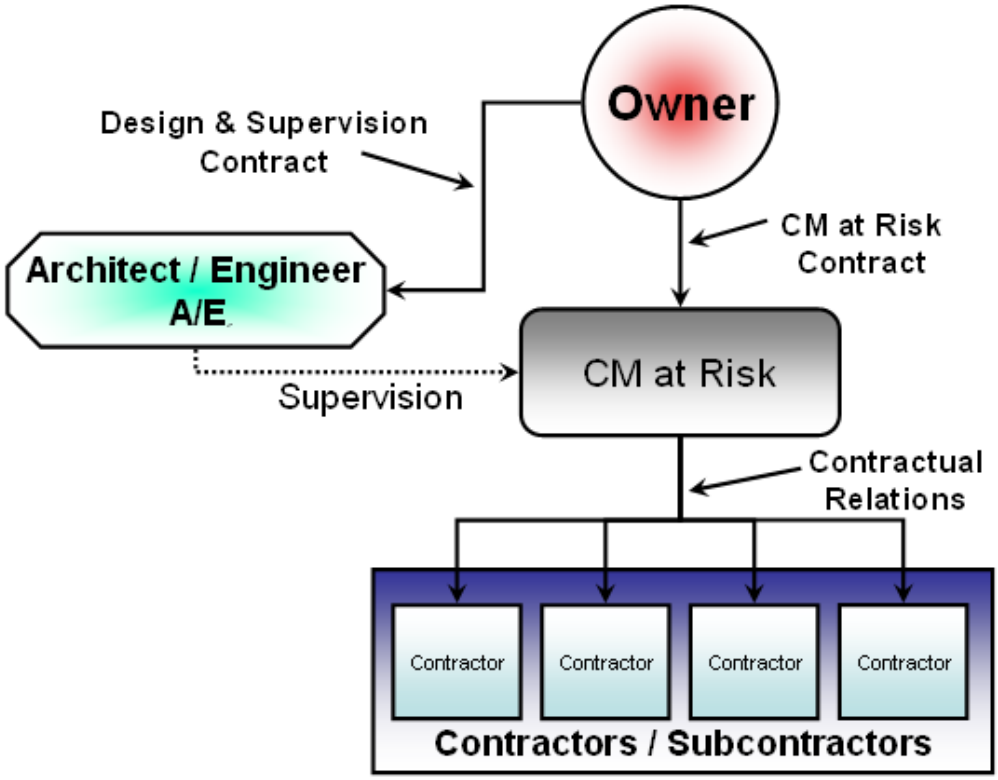

Fig. 4.7 Construction Management at Risk (CM@ Risk) System

1.16. Force Account System

In this system, the owner contracts with the consulting firm only to carry out the design work and supervise the work of the concrete structure. They do not contract with a general contractor and use the principle "do it yourself."

The owner in this system plays the role of the contractor. Accordingly, the role of the supervision consultant is weak. The owner should have the team that qualifies him to carry out the self-execution as well as hiring the required equipment for the project. He contracts with trade contractors to carry out the specialized work.

The owner benefits from this system and saves the cost of the project against all risks of implementation. This protocol is similar to the multiple primes approach but on small scale projects.

This system is only suitable for simple and small projects. This system does not favor investors because of the multiple risks to the owner.

1.17. Project Management System

Branching off from the previous systems is the project management system where the owner contracts with a project management company to manage the different phases of the project. Figure 4.11 is an example of the application of the project management system with a design professional, a general contractor, and supervision consultant.

Construction project management (CPM) is a project management approach that applies to the construction sector including DBB, design-build, MPC, CM@Risk, and public-private partnerships. Every construction project features some amount of project management.

It is a professional service that uses specialized project management techniques and appoints a professional management team with a certified project manager to oversee the planning, design, and construction of a project from beginning to end. It is the overall planning, coordination, and control of a project from inception to completion and is aimed at meeting a client's requirements to produce a functionally and financially viable project.

The project management system can be applied to any of the previous mentioned systems and is based on the decision of the owner in terms of the extent to which he needs an organization that manages the project on his behalf. The decision of the owner depends on the size and nature of the project and the level of quality required and the extent of its ability to intervene in the work and follow-up with the team.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 03, March-2022

The function of construction project management typically include: planning, design management, cost management, time management, quality management, contract administration, safety management, defining the responsibilities and management structure of the project management team, organizing and leading by implementing project controls, defining roles and responsibilities, developing communication protocols, and identifying elements of project design and construction likely to give rise to disputes and claims. In general, the PM's responsibility to the owner is to complete a successful project.

Project management is typically suitable for lengthy, large-scale, high budget undertakings (commercial real estate, transportation infrastructure, industrial facilities, military infrastructure, etc...). These are called capital projects or development projects.

CONTRACT TYPES (PAYMENT BASED)

There are different forms in the contractual relation between the owner and the contractor based on the pricing method. These can be divided into two basic types:

First: Predetermined prices methods.

Second: Reimbursable cost methods.

Figure 6.1 illustrates the different methods of contracts based on the pricing method. In general, each type of contract pricing has strengths and weaknesses, but may be most appropriate for certain projects or circumstances. Risks are distributed between the owner and the contractor based on the selected pricing method.

1.18. Predetermined Prices Methods

In the predetermined price contracts, prices are agreed upon before commencement of work. The contractor is then exposed to financial risks. He incurs any additional costs incurred as a result of increased prices than those that existed during the tendering period. The risks are affected by the fact that the contract is fixed or may be adjusted in light of price inflation. In this adjustable price type, the final cost will not be known until the end of the project due to the difficulty of predicting the price changes that may occur. The owner has the right to reject bids if the value of the lowest bidder exceeds the specified budget of the project.

1.18.1. Lump sum contract

A lump sum contract is the most common type of contract pricing. The contractor and the owner agree on the overall cost of the construction project and the owner is responsible for paying that amount whether the construction cost exceeds or falls below the agreed lump sum price.

1.18.2. Unit Price contract

The unit price type is used when the quantities of work cannot be determined accurately ahead of time as in infrastructure projects. A bill of quantities is used for pricing and payment purpose; the final account is based on the actual quantities executed.

1.18.3. Schedule of rates

The schedule of rates is the same as unit prices but the bill used does not include estimated quantities.

1.18.4. The Concept of Fixed and Variable Price: Economic Adjustment

In pre-determined contracts, the lump sum price or unit prices may be fixed or variable. The contract sometimes allows lump sum price/unit prices with escalation. It may include a provision to allow payment of price differences for specific items such as steel or concrete and may also include increased labor wages.

The main objective of this approach is to exclude the additional amounts, i.e., the unsecured risk cost, that the contractor may include in his prices of his bid as a result of the uncertainty of future price escalation. Thus, the owner obtains a fair price at the time of the tender. On the other hand, this approach ensures that the contractor will receive a price increase.

This approach is useful in the volatile economic conditions and in major projects and international projects that continue for many years. It is difficult to control prices in such projects, e.g., due to importation of materials from different countries, changes in currency exchange rates, and price inflation.

In summary, there are two cases of stability or variability in the unit prices or lump sum price:

1- Fixed Price case: The contractor is not entitled to any increase in his price or unit prices regardless of the price changes. This is called firm fixed price contract (FFP).
2- Variable Price case: The contractor is entitled to demand price differences for the agreed materials to modify the price of the items of work that have not yet been implemented in accordance with the terms of the contract. This is called fixed price with economic price adjustment (FP-EPA).

The variable pricing method is better applied in projects that require a long period of time so that the owner does not pay the risk of price increases unless they actually occur during implementation. This results in a reduction of the tender prices.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 03, March-2022

1.19. Reimbursable Cost Methods

In contrast to the predetermined price methods are the cost-reimbursable methods. Such methods are classified into different methods of payment contracts: The general principle in this type of contract is that the owner agrees with the contractor to execute the project against the recovery of any costs incurred in addition to the contractor's fee.

The contractor's fees shall include its general and administrative expenses incurred and an allowance for its profits. This type of contract depends primarily on the good relationship and mutual trust between both the contractor and the owner. This is sometimes called an “open book contract”.

The contractor's fee may be a fixed amount or a percentage of the cost. It may also have a single target value and may have incentives for achieving specific objectives. Cost reimbursable methods also include a guaranteed maximum price (GMP) method that is a contract-specified upper limit to the project's final price.

The financial risks range from a lack of financial risk to the contractor (cost plus percentage) until the risk is distributed almost equally between the owner and the contractor in the GMP contract type.

It is preferable to use the appropriate type of cost-reimbursable contract in the circumstances of uncertainty about the nature of the project, the absence of clear or undetermined scope of work, or in the case of the owner's desire to practice and participate cost management with the contractor. It can also be applied in urgent cases.

BIBLIOGRAPHY

[1] V. Atkinson, “Civil Engineering Contract Administration”, Hutchinson, 1985 Chapter 2 “Standard forms, types of contract and documents” PP 26-43.
[2] Bruce M. Jervis & Paul Levin, “Construction Law Principles and Practice”, McGraw-Hill, 1988.
[3] Daniel W. Mead, “Contracts, Specifications, and Engineering Relations”, McGraw-Hill, 1958 Chapter 10 “Construction by Direct Employment and by Contract” PP 160-174.
[4] Fisk, Edward, “Construction Project Administration”, Prentice-Hill, 4th Edition, 1992.
[5] Gilbereath, Robert D., “Managing Construction Contracts”, John Wiley & Sons, 1983.
[6] Glenn M. Hardie, “Construction Contracts and Specifications”, Reston Publishing Comp. Inc., 1981 Chapters 3 to 5, PP 27-70.
[7] Hinze, Jimmie, “Construction Contracts”, McGraw-Hill, 1993.
[8] Joshua Mutize & Evan B. Stregger, “Canadian Building Law”, Canadian Institute of Quantity Surveyor, 2001 Chapter 6 “Construction Contracts”, by Clive E.J. Evans PP 61-71.
[9] Keith Collier, “Construction Contracts”, Prentice-Hall, Inc. 1987.
[10] Park, William R., “Construction Bidding for Profit”, John Wiley & Sons, Inc., 1979.
[11] Stokes, McNeill and Finuf, Judith L., “Construction Law for Owners and builders”, McGraw-Hill, 1986.
[12] The Aqua Group, “Tenders and Contracts for Building”, Blackwell, 1999.

ARABIC REFERENCES

[13] Ahmed A. Abdel Raouf, “Integrated Cash flow Management System for Construction Projects”, PhD Thesis, Cairo University, Faculty of Engineering, Civil Dept., Egypt, 2010.
[14] Adel Mahrous Ahmed, “Manufacturing and Management of Engineering Projects”, Commercial Ahram Printing, Egypt, 1990.
[15] Ibraheem Abdel Rasheed, Prof. Faculty of Zagazig, “Construction Project Management”, University Publications, Egypt, 2001.
[16] M. M. Awaida, Prof. Cairo University, Faculty of Engineering, “Economic Studies for Buildings”, Researches and Studies Magazine – Article.
[17] Mostafa Talha, “Architectural Project: Preparation and execution – Vol. 1”, Madbouly Bookstore, Egypt, 1989.