AHMED SALAM RAOOF — THE USE OF BUILDING PRODUCTION SYSTEM TO EXAMINE DESIGN AND IMPLEMENTATION STAGES IN NORTHERN IRAQ-ERBIL — NEU 2019

THE USE OF BUILDING PRODUCTION SYSTEM TO EXAMINE DESIGN AND IMPLEMENTATION STAGES IN NORTHERN IRAQ-ERBIL

A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF APPLIED SCIENCES OF NEAR EAST UNIVERSITY

By
AHMAD SALAM RAOOF

In Partial Fulfillment of the Requirements for the Degree of Master of Science in Architecture

NICOSIA, 2019

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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To my beloved Wife …

ABSTRACT

The building production started with the history of mankind has continued improving in the period until today. This improvement starting with the primitive construction systems, has reached up to the traditional construction systems, prefabrication and industrial construction systems, which are the last stage achieved today. In this study, from the design stage to the implementation phase of the building production, building construction, which was put forward as a product of scientific thought, was taken into the study area. The investigation is made on local examples by observation method and the examination was tried to be made from the results.

First in the study, a system for building production has been formed by looking to the construction from the point of systems approach. First, the elements of the building production system were identified and information about these elements was obtained. Again, strategic decisions, tactical decisions, design phase and construction phases of the building production process were examined and information about inputs, processes and outputs of each phase were determined.

As a result of the examination, a data bank was created with the information obtained. In the light of these information, the results of the processes in the design and implementation of the buildings of three construction companies in Erbil, Northern Iraq were examined. Finally, the information needed for the solution of the systematic organization and the problems that will arise in the production of an international and comprehensive structure are given.

***Keywords*:** Building production; building production system; construction management; critical path method (CPM); North Iraq

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BIM:	Building Information Modeling
CM:	Construction Management
CPM:	Critical Path Method
CPS:	Critical Path Segments
CSO:	Central Statistics Organization
ECU:	Erbil Contractors Union
FF:	Finish-To-Finish
FS:	Finish-To-Start
GDP:	Gross domestic product
HVAC:	Heating, Ventilation, and Air conditioning
IAU:	Information and Analysis Unit
KRSO:	Kurdistan Region Statistical Office
LOB:	Line Of Balance
PERT:	Performance Evaluation Review Technique
PM:	Project Management
PND:	Precedence Network Diagram
SF:	Start-To-Finish
SS:	Start-To-Start
TFV:	Task/Flow/Value
UN:	United Nation

CHAPTER 1
INTRODUCTION

1.1 Background

The fate of Northern Iraq is the thing that Kurdish are constructing today, and the Northern Iraq objectives alongside different means and assets will enable the country to decide the fate of the nation. Northern Iraq has endured enormously in late decades because of occupation, termination, absence of assets, different problems have caused solidity in numerous parts of development and advancement of the society.

In spite of this, business and private construction work in Northern Iraq is expanding quickly to meet the developing needs and to stay aware of worldwide advancement. For Northern Iraq to advance as far as development, construction projects must be considered deliberately and arranged well keeping in mind the end goal to make the best outcomes so help to moving in the correct bearing to set up future objectives.

According to Benjamin Franklin the contrast amongst disappointment and achievement is the distinction among accomplishing something right and achieve incredible right (Carp, 2012). So failures does mean doing things not right, as well doing things right, this thought will prompt perceive an ideal approach to actualize project management in construction extends and to open a new period in imagining that will offer an incentive to the construction industry.

These conditions drove the researchers to consider how projects is overseen in city Erbil of Northern Iraq and what are the significant components and issues influencing the construction industry, and furthermore encouraged the analyst to recommend a system that adapts to the advancement and the developing concerns in regards to the construction industry with the city Erbil contrasted with other developing nations, to help directors to plan and actualize development extends appropriately that will prompt better outcomes and fewer risk, and to make progress with great quality.

1.2 Aim and Objectives of the Thesis

The main aim is the examination of the design and implementation stages in building production system, and examination of these stages on different construction companies in Erbil. To reach the thesis objectives that explained below:

- Analysis of the Northern Iraq construction industry specially focusing from the city Erbil and characterize the nature and execution of management in the industry, and its commitment to the general social life and economics.
- To feature the requirements and distinguish the issues and the obstructions that at present exist in construction extends within the city Erbil.
- To utilize the effects of this examination to help people in general and private areas in applying project management to enhance the nature of their work and avoid issues
- To feature the achievement factors in project management, particularly in the city Erbil, and attempt to enhance it by utilizing a system that composers work in building organizations

1.3 Problem Statement

Solving problems of construction through building production in a scientific and systematic way. Also, to find out whether these scientific and systemic commodities are used and applied in Erbil.

The present circumstance in the city Erbil of Northern Iraq needs to start an enhanced construction management structure with suitable ways, control and valuing system with effective plans and appropriate construction material, keeping in mind the end goal to help extend project manager or the construction manager to lead their organizations to progress, and to have any kind of effect in a very focused condition. To accomplish that, these inquiries ought to be replied:

1. How are constructions overseen in the Erbil (Northern Iraq Region)?
2. What are the issues causing failure in construction projects in the city Erbil?
3. Is there any system connected to project management in Erbil?
4. Is there any strategy for overseeing projects by public or private constrained organizations in Northern Iraq?
5. How is project achievement estimated?

These inquiries and others will be replied in this thesis work, keeping in mind the end goal to enhance project management execution in the construction industry in the city Erbil of Northern Iraq.

1.4 Significance of the Study

Make a contribution to construction management in North Iraq and provide guidance for building production. There are numerous imperatives in the construction field, which will be examined in a holistic way that include:

- The financing of the tasks.
- The reliance on financing and usage of help.
- Access issues identified with trust.
- Culture issues, environment.
- Weak foundation.
- Weakness of administration and information particularly in the Northern Iraq for example, ministries and municipalities.
- Security problems identified with political and financial insecurity in Northern Iraq and related political variables.

1.5 Methodology

The examination procedure portrays the yield of each phase in this work. The consequences of the examination have been explained in different territories and the accompanying segment portrays the production procedure of this work.

The thesis procedure consists of three stages. In the first stage hypothetical builds of this work were produced. In the second stage, the hypothetical builds were evaluated utilizing contextual investigations. In the third stage, the hypothetical builds were refined and additionally created utilizing the contribution from contextual examination. Below Figure 1.1 representing the conceptual design and research process carried out.

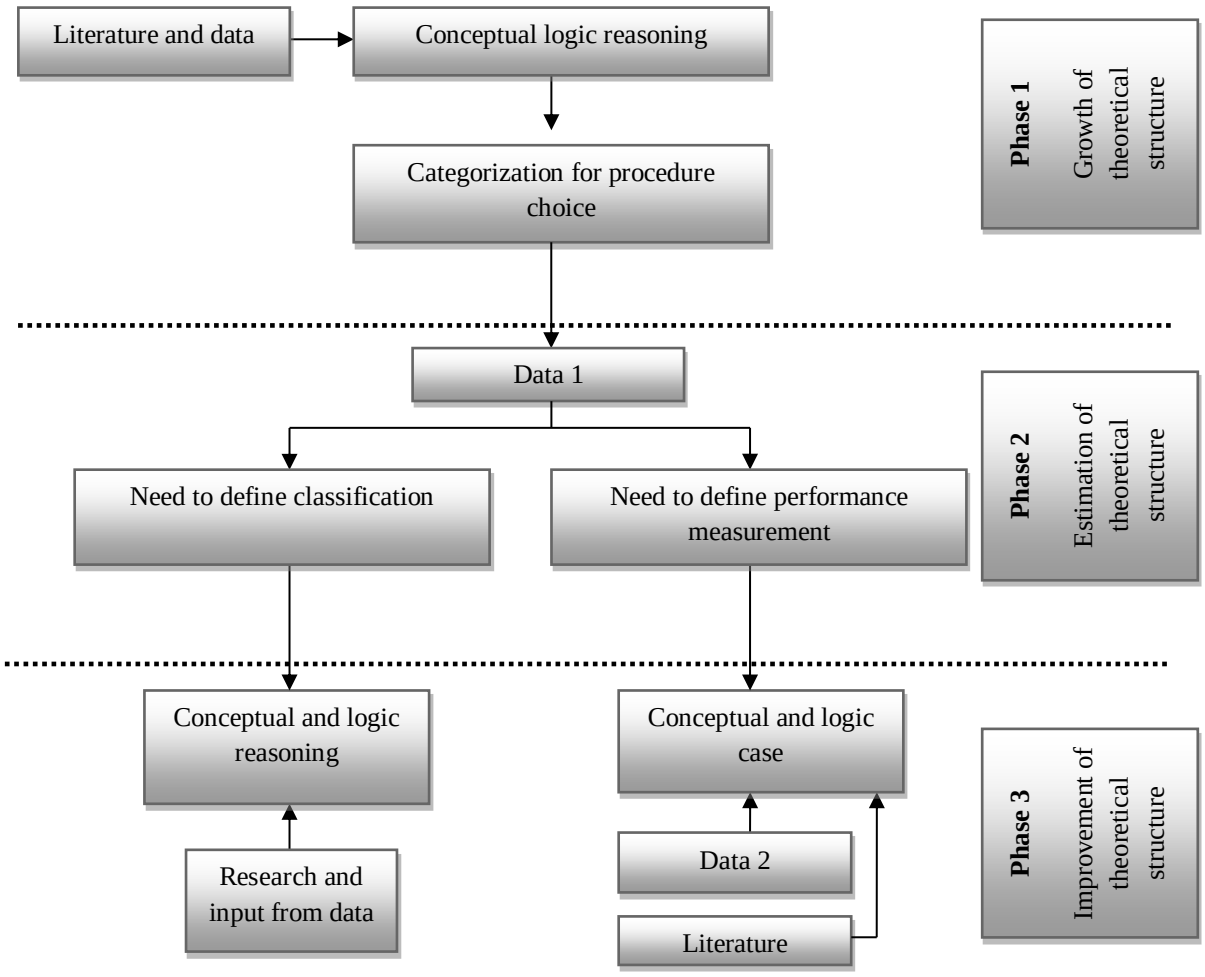


Figure 1.1: The conceptual design and research process

In the principal organize the hypothetical builds of this work are produced. Results from literature review and information from three organizations utilizing diverse production for the construction. Depending on literature review and using building production system as a tool to examine the three examples and evaluate their work. The outcome from this stage is to have a background on construction process, offering the likelihood to survey the relative capacity of various kinds of production frameworks to perform in various territories.

In the second stage, the underlying thought is to outline number of methods to control and organize production according to time, quality and cost to complete all stages of a production.

In third stage comes the examination on the three examples in Erbil city after the information gathered in the first and second stages on building production system and methods to control time, cost and quality. The examination is done according design and implementation stages of building production system to use it as a tool for this thesis work. This execution estimation framework gives a probability to assess diverse production frameworks in view of quantitative information which will encourage correlation between various construction frameworks.

1.6 Thesis Outline

This thesis comprises of five primary chapters as takes after:

- Chapter One: Introduction. This part represents to an outline of the principal destinations of the work, a declaration aim of the study, problem statement, significance of the study and finally the research approach how it will carried out in the thesis outline has been disclosed.
- Chapter Two: Building Production System. This chapter introduced an outline of the Building Production System, stages of Building Production System, tasks, and methods that are expected to comprehend the fundamental theory and standards of Project Management by means of the literature from the research published journals.
- Chapter Three: Organization and timing in construction. In this chapter, a research between the developed and under developing works will be concentrated to indicate how construction and project management are being produced according to time.
- Chapter Four: Case Studies. In this chapter three examples will be examined from Erbil city to demonstrate the strategy utilized as a part of this exploration with a specific end goal to accomplish the required targets.
- Chapter Five: Conclusions and Recommendations. An overview in to nearby construction organizations was led to acquire information and give knowledge into current circumstance, the result of this research and the profound meetings were discussed and finally conclusion and recommendations are drawn. As shown in Figure 1.2.

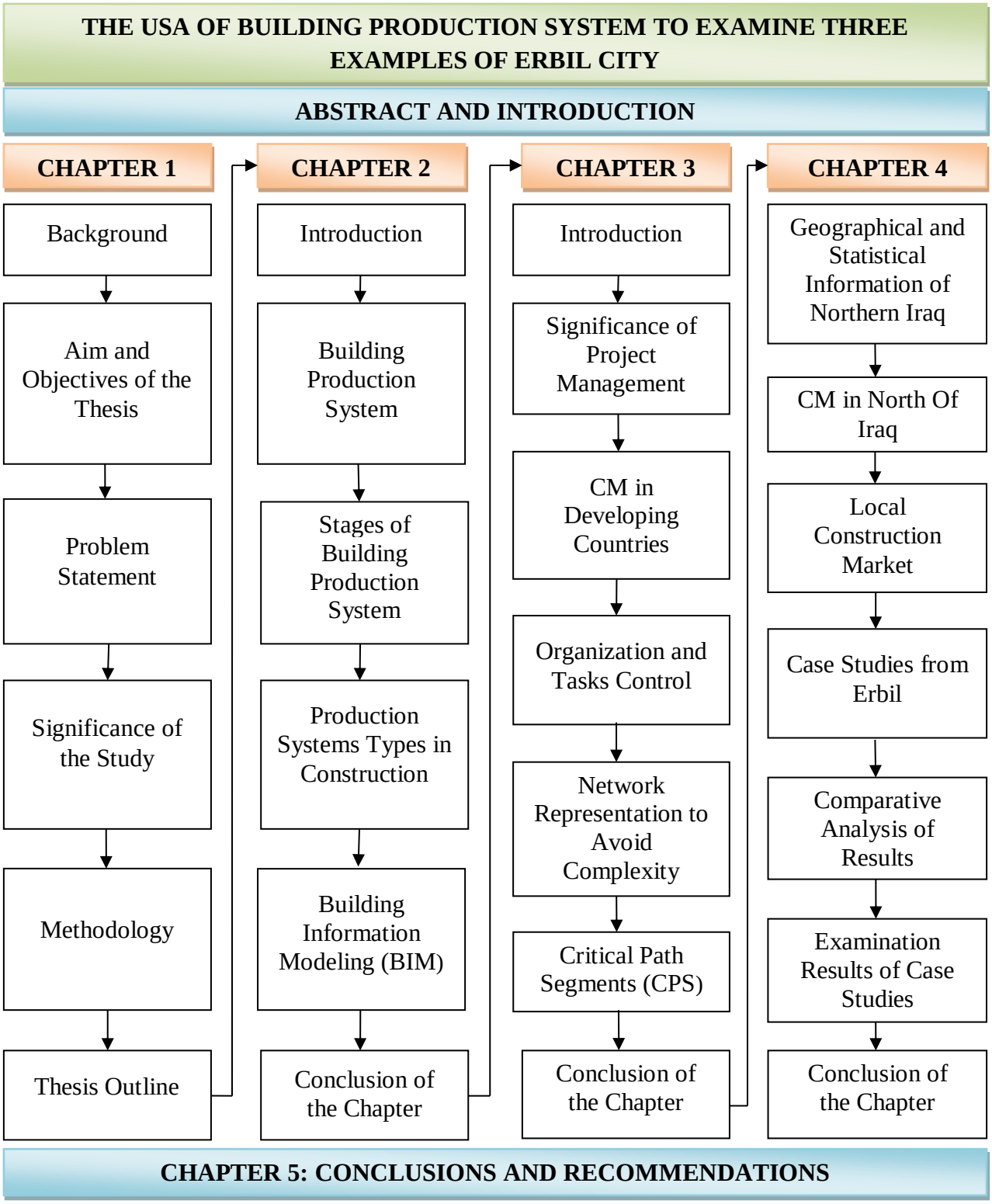


Figure 1.2: Thesis structure

CHAPTER 2
BUILDING PRODUCTION SYSTEM

2.1 Introduction

Construction is a crucial part contributing fundamentally to the financial matters everything being equal. The construction industry must be dynamic to have the capacity to react to the progressions that the world is frequently deal with and additionally, the social, financial and mechanical difficulties influencing all the construction related projects weather it might be the public construction or private. The openings and issues in construction are not quite the same as those of the most recent century. The requests of customers, organizations, and workers contrast every once in a while, and subsequently, the vision of the construction industry is constantly creating to keep up the management must change as well.

Any construction association must have a key arrangement and vision that lead the best approach to accomplishing its objectives. The way to accomplishing that lays ineffective management, by distinguishing needs and objectives the organization needs to accomplish. To do that, project management must be moved toward numerous levels, for example, executing, sorting out, assigning, basic leadership and performing. The survival and the advance of any organization rely on how well project management is actualized and how encountered the organization is in this field.

Because of the expanding number of project requirements in light of the dynamic idea of present day construction and the expansion of strain to convey quick and proficient construction, there is a regularly developing requirement for specialists in this field of designing. The primary job in any gainful production is production framework plan, which stretches out from worldwide association to the structure of activities; e.g., from choices with respect to who is to be engaged with what jobs to choices in regards to how the physical function will be practiced. A few terms are being utilized to make sure this phase of generation. Dubois et al. (2015) characterize producing design as including its equipment, material, data streams their coordination, and administrative rationality. With regards to construction, the idea of work organizing has been utilized to allude to production framework plan (Ballard & Howell, 2003).

In past, project planning in construction has concentrated essentially on hierarchical organizing and formation of work breakdown structures that separate the work to be finished. It is propose to incorporate the production framework itself, which has been for all intents and purposes undetectable and underestimated. Doing as such fundamentally includes moving from an origination of generation exclusively as far as change of contributions to the Task/Flow/Value (TFV) idea of production.

2.2 Building Production System

System is a number of components or things that are organized and working together for a specific goal. The method is shaped by the structure, participants, connections and the inputs of any process data then the outputs.

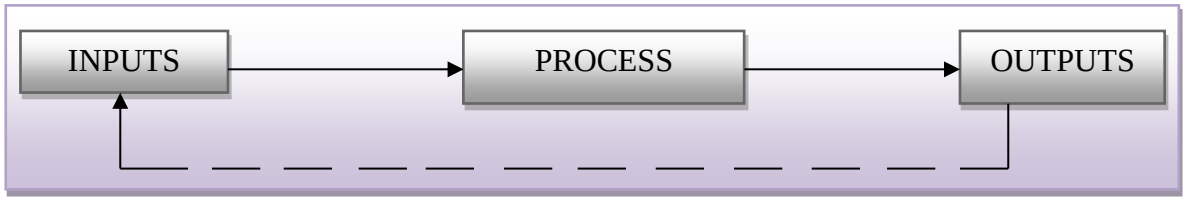


Figure 2.1: General production system

Production system is creating subsystems that include all connection and function required to produce, design, distribute, and serve a manufactured product which consist on number of components as shown in Figure 2.1 (Jonsson & Rudberg, 2014).

Building production system is the technologies that have been used in construction stages for production of buildings and patterns that are used for building production process in all phases. A number of elements or parts which are connected together directly or none directly at least to one another element. Figure 2.2 indicate elements of building production system.

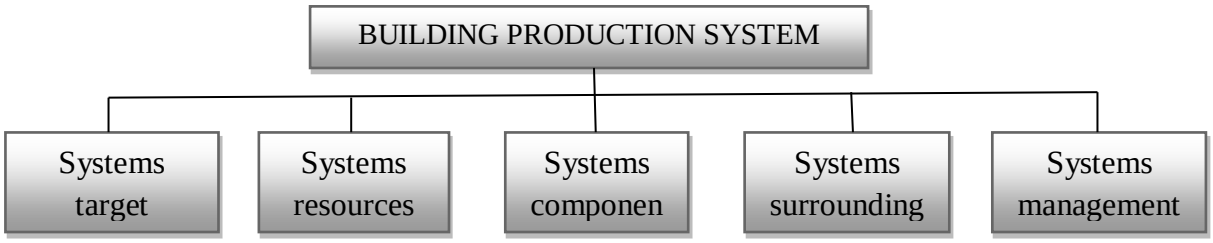


Figure 2.2: Elements of building production system

Elements of building production systems are:

1. Systems target: The main aim of building production system is to produce building or buildings. Here the rational use of limited resources is important. The basic thumb rule in any building construction production is implementation of production system by effectively establishing the system or the framework that how the flow of production work goes. In order to frame this system the management tools are subjected.
2. Systems resources: The resource system is managed by the procurement department in order to manage the resources which are required in the building production by looking into the key factors such as material required for the building construction along with the mechanical equipment required and also the following system resources are required in order to meet the building production system the key concern are as follows:
    - Material
    - Equipment
    - Energy
    - Financial resources
    - Men power resources
    - Regulation and data collection
    - Environmental resources
3. Systems component: The production system of building needs user action which is utilized by the various construction management software tools such that to meet the relevant planning and design. Therefore the following components are essential to meet the requirement for building construction production system:
    - Users action
    - Planning
    - Design
    - Construction
    - Use
4. Systems Surrounding: In order to meet the required production system the management tools which sets the resourcing system by looking in to the key concerns which are as follows:

- Resourcing system
- Managemental system
- Financial system
- Values system

5. Systems management: The management system plays an important role in production system and the key concern components are follows:
    - Specification of systems elements
    - Main and sub target of system
    - The connection of other surrounding system
    - To make a connection between systems, targets, evaluating, and make suggestion (Çağnan, 2015).

The building construction industry uses project the production practices and systems. Practices are constrained to evaluate the outcomes from the task plan as opposed to manage the reasons for deferrals in the production system. As (Jonsson & Rudberg, 2014) guideline demonstrates that the customary construction the executive's routine with regards to estimate economic or financial status of a construction utilizing plan/cost changes will result in a less exact appraisal of the throughput of the task. The building construction industry has no history of applying scientific ways to deal with model and oversee production. Scientific models have empowered a comprehensive knowledge of production system. For example, fabricating or pre-casting has a record of effectively production and utilizing vigorous numerical models to enhance efficiency, system understanding and time estimate.

2.3 Stages of Building Production System

Building production begins with the decision to investigate the user actions, to determine the existence of the need and to make a structure to meet this need. In the first stage, which is called as analysis and strategic design phase, different solution are examined with the analysis made about the needs and the state of the resources and the decision about the basic principle of production are determined. The results (outputs) of this stage are the inputs of tactical planning phase.

The second stage which is tactical planning is the stage in which the criteria of the previous stage are determined according to the objectives and requirements, and the decisions about pre-planning and programming are taken. The results of the pre-planning-programming phase are inputs to the design phase. The first and second stage are explained briefly because it's not related to this work, in the other hand the last two stages explained more detailed because its related to the scope of this work (Çağnan, 2015).

2.3.1 Designing stage in building production

The construction industry faces continuous difficulties. From an outside point of view, monetary vulnerability, expanded rivalry inside the industry and the developing impact of administrative offices drive net revenues down. From an inside perspective, the expansion in the quantities of highlights in a projects degree, against shorter construction due dates and confined spending or cost plans raise the intricacy of building construction projects. Furthermore, building construction frequently possesses the base of modern efficiency rank reports around the world indicating negative profitability rates. The construction segment depends on the board rehearses dependent on instinct, experience and poor hazard the board. These practices regularly block the proper dimension of capacity to deal with the vulnerability and multifaceted nature engaged with construction projects, bringing about project failures as far as completing construction inside due dates and spending plans. As showed in Figure 2.3 design stages consist of inputs, process and outputs (Çağnan, 2015).

- **Inputs:** Consist of some stages which are explained below:

- *Production policy & planning:* From an inside perspective, the expansion in the quantities of highlights in a projects degree, against shorter construction due dates and confined spending or cost plans raise the intricacy of building construction projects. Furthermore, building construction frequently possesses the base of modern efficiency rank reports around the world indicating negative profitability rates.
- *Criteria:* The construction segment depends on the board rehearses dependent on instinct, experience and poor hazard the board. These practices regularly block the proper dimension of capacity to deal with the vulnerability and multifaceted nature engaged with

construction projects, bringing about project failures as far as completing construction inside due dates and spending plans.

- *Product performance value:* As a typical practice, the building construction industry uses customary project the executives' practices and structures. Practices are restricted to surveying the outcomes of deviations from the construction plan as opposed to managing the reasons for deferrals in the production framework.
- *Specified problem:* At the strategic administration level, little consideration has been paid to production the executives in building and construction. Customary planning approaches in construction, for example, the basic way strategy, have been utilized freely, creating incomplete and flighty plans.
- *Building program:* Considerably more, a created estimation practice, for example, the line of equalization, neglects to convey a solid result. Rather than being gotten from assembling rehearses, the line of equalization was simply duplicated paying little mind to the inalienable production contrasts among assembling and construction projects. The two methodologies accept that construction forms are steady with some level of fluctuation, setting consistent estimation esteems for production and adding an additional measure to oblige varieties.

- **Process:** Is number of activates or steps that put in order to achieve a specific end in each stage as explained below:

- *Functional analyzes and synthesis:* The building construction industry has no history of applying scientific ways to deal with model and oversee generation. Numerical models have empowered an extensive comprehension of production instruments. For example, fabricating has a record of effectively creating and utilizing hearty numerical models to enhance profitability, framework understanding and occasion determining. All things considered, the assembling model does not specifically apply to construction. Relentless state conditions, non-ending occasions, long production runs, medium to low dimensions of vulnerability and lasting production offices describe production in assembling. Production in construction happens under a blend of relentless and temperamental state conditions, with ending occasions, short production runs and different dimensions of vulnerability, all directed in impermanent generation offices.

- *Cost analysis:* Shows that the regular construction the board routine with regards to estimating the general opportunities and budgetary status (position) of a project utilizing plan/cost changes will result in a less exact evaluation of the throughput (force) of the project.
- *Optimization:* The building construction industry ones analysis the cost planning along with the required functions then the project framework will be optimized in order to carry out the work flow accordingly.
- *Construction system choice:* The building construction industry has likewise exhibited enthusiasm for lean standards later named lean construction. The change, stream and esteem age sees related with an arrangement of standards establish the transformation-flow-value (TFV) hypothesis of production. In any case, the execution of lean standards has been sporadic, instead of an industry standard. A few inconsistencies to the lean qualities, for example, extreme utilization of crude material, separation of exercises, keeping the foundation of a stream, an emphasis on expenses over esteem, a wasteful estimation framework, large amounts of adjust because of production blunders or changes in specialized details and laborer wellbeing, still populate the rundown of the most widely recognized issues in construction attempts. Wastefulness at the strategic dimension is just a single hindrance to the reception of assembling standards. Natural tasks attributes likewise increment the difficulties to the business. Uniqueness each task creates an unmistakable item, administration or result with individual highlights of the construction work fleetingness demonstrates that a project has an unequivocal start and end and vulnerability are a few properties that separate activities and assembling. In actuality, even tedious construction projects portrayed by monotonous exercises.

- **Outputs:** outputs (results) are the final phase of design stage and the results of this stage go to the beginning of next stage implementations. The outputs consist on these:
- *Detailed application project:* In building construction industry considerably when the program and the key components of the process are set then the derailed application project report will be designed such that the entire key concerning details of the project are pictured.

- *Technical and administrative specifications:* The detailed reports on the building production system technical and administrative specifications are retrieved once the process stage has been successfully completed and therefore these specifications will guide in the whole project team their specified area of work accordingly.
- *Cost estimation reports:* The successful completion of the process stage the cost estimation reports are being generated such the whole project cost is been finalized and therefore these reports helps the budget spent timely on the required materials for the building production.

2.3.2 Implementation stage in building production

Implementation is the process of building the structure according to the prepared project and making it ready for use. As other stages implementation consist of three phases and this stage is the final stage in building production systems process (Çağnan, 2015).

- **Inputs:** Consist of some stages which are explained below:
- *Detailed application project:* Once the designing process has been implemented then a detail application of the projects has to be implemented such that customary planning approach in building production gets approval from the necessary regulations and the specifications as per the law.
- *Specifications:* The prime objective to meet the production strategy of the building production the specification of the required material or the necessary actions which needs to be implemented has to over seen such that required production strategy will be addressed.
- *Regulations:* The building construction industry needs to follow the regulations addressed as per the local government has established such it meets the standards and hazel free the production system would be carried out.

- **Process:** Is number of activates or steps that put in order to achieve a specific end in each stage as explained below:
- *Site preparation:* Once the input of implementation of the building regulations are set then the process of site preparation gets in to frame where the layout of the construction site as per the specifications will be carried out such that the construction process gets into action.

- *Supplying the production factors:* The building construction industry relay on the supplying material required for the construction process, hence as per the specifications required given by the procurement team the required material or the mechanical goods required needs to be addressed to carry out the construction process.
- *Working program:* The required working force which might be the mechanical work or the labor force the work flow of the construction site needs to look and overcome the required working procedure which is designed as per the specification so that the production of building construction system is carried out.
- *Construction management:* In order to carry out the building construction system the management plays the whole and sole response for the production system. For instance, the designed specifications, the materials required, and the cost consideration along with the work force and the daily production of the construction site will be addressed.

- **Outputs:** Is the final phase of implementation:

- *Product (building &buildup complexes):* once the process stage has been successfully overcome along with the required key terms which are required in the construction process then finally the required building construction as per the scheduled date will be the outcome. Hence by this the client or the stakeholders who are involved in the whole construction will bear the fruitfulness.
- *Use of building:* The basic human needs is a constructed building which can be in a residential form or can be used as commercial and also in other forms, therefore if production planning of the construction building meets the required criteria as designed per the requirement accordingly then the use of the constructed building will be the final asset which is produced or constructed to meet the human requirement.

As it can be seen that the first and second stages which are strategic and tactical design explained shortly because they are not related to this work but on the other hand the other two stages of building production system which are *design* and *implementation* are explained more detailed because they are within the scope of this work.

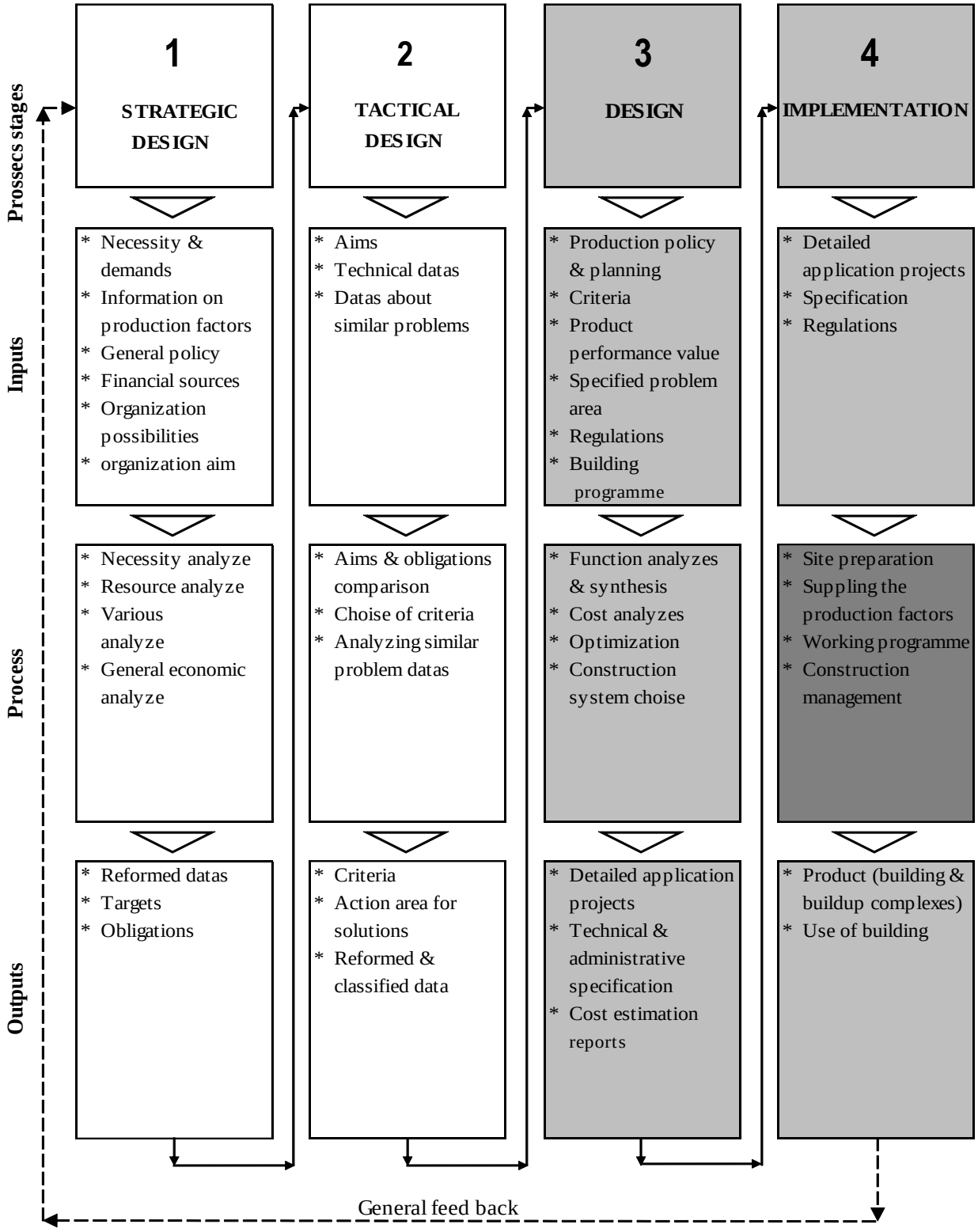


Figure 2.3: The stages of building production process (Çağnan, 2015:23)

2.4 Production Systems Types in Construction

Similarly, there are various sorts of production scope for customary gather there are distinctive methods for delivering multifamily living arrangements. Kamar & Ahmad. (2011) make a connection between different arrangements of manufacture frameworks in construction and from they conclude the accompanying seven production frameworks:

- Frame system
- Panelized system
- On-site fabrication
- Sub-assembly and components
- Block work system
- Hybrid system
- Volumetric and modular system

Contrasted with the seven production frameworks characterized by Kamar & Ahmad. (2011), where on location is incorporated, it can be contended that:

- On-site construction and sub-get together and segments compared to segment produce and sub-get together.
- Panelized framework compare to non-volumetric pre-gathering.
- Block work framework compare to volumetric pre-gathering.
- Volumetric and particular framework compare to secluded building.

Hybrid system is a mixture of minimum two of the construction frameworks characterized to incorporate that structure as production framework isn't viewed as vital. Casing system depicts pre-assembled confining frameworks however since a basic structure is incorporated into a wide range of structures the encircling frameworks are incorporated into every one of the four-production frameworks. For the reasons been given above it appears like the four structure frameworks gives a decent portrayal of various construction frameworks utilized for production of many living arrangements. The four sorts of construction characterized as takes after:

- *Part produce and sub-get together:* Many segments utilized as a part of construction are really sub-gatherings (e.g. entryway furniture or light suitability). This class incorporates

any little scale sub-congregations that could never look for on location get together for any developed nation. Non-volumetric, pre-gathering These things are collected in a plant, or possibly before being set in their last position. They may incorporate a few sub-gatherings and constitute a noteworthy piece of the building or structure. Illustrations incorporate divider boards, basic segments, and pipe-work gatherings.

- *Volumetric pre-cast together:* These things additionally gathered in manufacturing plant. They have been contrasted from non-volumetric in that they encase usable space and as a rule are introduced nearby inside an autonomous basic casing. Cases incorporate can cases, plant room units, preassembled fabricating administrations risers and measured lift shafts.
- *Measured Building:* this type are like volumetric units, yet for this situation, the units themselves frame the working and additionally encasing useable space, and they might be clad remotely on location with 'restorative' brickwork as an auxiliary activity. Cases incorporate office squares and motels and cement multi-story measured units utilized for private squares. To characterize diverse production frameworks in light of the level of off-site construction is generally utilized as a part of the writing. The subsequent stage is to perceive how the level of off-site construction influences the production frameworks capacity to convey producing yields (Gibb, 2001).

2.5 Building Information Modeling (BIM)

The idea of building information modeling (BIM) innovation is to delineate the working before it is physically worked with a specific end goal to tackle potential issues, upgrade correspondence amongst parties and empower reenactment. Building data displaying has the ability to incorporate all construction records, which encourage crafted by construction manager or by the project manager, identify mistakes and stay away from the additional expenses coming about because of such blunders.

By use of BIM innovation from the beginning times of the construction projects, the idea of constructability/build ability could be joined amid the building configuration procedure to shape more educated basic leadership process and emphatically impacts general undertaking proficiency and quality. Building Information Modeling gives planners a detail/incorporated articulation about undertaking data and it supplies a logical reproduction/investigation stage for specialists and

creator to put in mind the final goal to use 3D model to do an outline, development, and administration work.

BIM as An inelegant reproduction of the designer could be described by the accompanying: Digital, spatial, measurable, comprehensive, accessible and durable. (Jianhua and Hui, 2012) have specified more broad attributes/limits of BIM innovation as explained below:

1. *Visualization:* Visualization is a principal normal for BIM as it is an advanced portrayal of the undertaking data. This principle characteristic could help correspondence, plan, development and basic leadership forms.
2. *Coordination:* A construction project is a multi-disciplinary task. BIM can bolster extend supervisors in taking care of coordination issues as coordination is a basic undertaking in project administration.
3. *Simulation:* when configuration changes, there is a need to rehash examination and after that to recreate comes about appropriately to encourage basic leadership.
4. *Optimization:* better streamlining should be possible by the usage of BIM as it gives the balanced outcomes.
5. *Documentation:* All sorts of plans, areas, and so on could be completed all through the BIM condition.

Like other industry, the construction industry recorded low rates of efficiency in late decades. This demonstrates construction experiences an absence of improvement and reception of current thoughts.

As shown by (Grau & Haas, 2009) the main issues in the construction industry are because of these factors:

-Using conventional venture conveyance methodologies for example, design-offer form and their disservices because of detachment of plan and development stages which frequently prompt more changes/clashes.

-The embraced data innovation has not enhanced coordinated effort among project group as it works freely.

-A large number of undertaking partners.

-The low rate of interests in research, advancement, and preparing in the construction industry.

-Way of paying development pay rates to laborers.

BIM gives many alternatives with a specific end goal to enhance construction industry profitability encourage project management application.

2.6 Conclusion of the Chapter

This chapter presented the idea of the *building production system*, stages of building production system, building production in the construction procedure, construction project evaluation, functional methodologies for construction projects.

In the wake of concentrate numerous past examinations in this chapter, the elements influencing construction project process were sorted out. With respect to reasonable methodologies that could be utilized in the building production system process, the past investigations demonstrate that there are numerous methodologies that can be utilized to deal within the building production system within the study area, however the adequacy of these methodologies relies upon the type of the project, construction companies examination, and the target that the project manager needs to reach. Depending on the work has been done in this chapter on the stages of building production systems and explaining the first two stages briefly because it's not related to the scope of this work and explaining the design and implementation stage more detailed to make a reference for the examples which will be examined in chapter 4.

CHAPTER 3
ORGANIZATION AND TIMING IN CONSTRUCTION

3.1 Introduction

In the business of construction, control of the project, organizing the works in order is to warranty projects finish in time, with a budget plan and accomplish other project goals. An effective project is the main project which has achieved its specialized execution, kept up its timetable, and stayed inside budgetary expenses. Project management devices and strategies assume an essential job in the successful management of a project. Construction time and cost are essential contemplations in project management and viewed as most imperative parameters for estimating accomplishment of any undertaking. Poor execution of time and cost can prompt a lot of time and cost invades which is worldwide.

Time overwhelm can be characterized as late fruition of fills in when contrasted with the arranged timetable or contract plan. It happens when the advancement of an agreement falls behind its planned program. It might be caused by any gathering to the agreement and might be an immediate aftereffect of at least one condition. An agreement delay affects both the proprietor and temporary worker either as lost incomes or additional costs and it regularly raises the petulant issue of postpone duty, which may result in clashes that as often as possible achieve the courts Cost overwhelm can be considered as the contrast between real expense of an undertaking and its Cost limit. It happens when the resultant cost focus of a venture surpass its cost limits where Cost limit of an undertaking alludes to the greatest use that the customer is set up to acquire on a finished building project while cost target alludes to the suggested use for every component of a project.

Various inquiries about have plotted the issue of poor time and cost execution of construction project around the world In an investigation of 8000 construction projects from the city Erbil located in Northern Iraq, discovered that just 16% of the projects could fulfill the three acclaimed execution criteria: finishing projects on time, inside planned expense and quality standard, while in a worldwide report on cost invade issues in transport system project covering 258 tasks in 20 countries presumed that 9 out 10 projects confront cost overwhelm. Time and cost invade has been accounted for as real issues internationally. This force to consider the issues of time and cost

execution of construction extends in Northern Iraq. In any case, this investigation was constrained to the construction extends in the city Erbil of Northern Iraq.

Erbil construction industry is additionally confronting these issues fundamentally. In a study of delay review in Erbil's construction industry discovered that 89% of the respondent revealed that they have experienced delay in their activities with overwhelm in time of 10-45% of contract span while in concentrate expansive undertakings presumed that construction projects experienced an invade with normal of 31.05% of agreement length. It has been accounted for that the in construction projects of Northern Iraq cost overwhelm and Delay is exceptionally normal (Menesi and Hegazy, 2008).

The significance of expense and time control is generally perceived by construction experts. The documented study with the three construction organizations in the city Erbil uncovered that two out of three organizations apply time controls to their projects and the other organization delights that infrequently they utilize the construction management apparatuses. The most prominent time arranging and control method is Gantt Bar Chart, which utilized by 20% of temporary workers and 25% specialists. This is nearly trailed by Critical Path Method (CPM) utilized by 18% contractual workers and 27% experts. The explanations behind the prominence of these strategies may be because of the way that they are the most settled systems in the business. However usability and appropriateness to the construction procedure can likewise be contended as being in charge of their prevalence. Other utilized systems incorporate the Milestone Date Programming Technique, Performance Evaluation Review Technique (PERT), Precedence Network Diagram (PND), Elemental Trend Analysis/Line of Balance (LOB), and Simulation. The utilization of programming bolster is across the board. Three clear driving applications are Microsoft Project, Asta Power Project and Primavera are been reviewed by the construction companies in Northern Iraq.

3.2 Significance of Project Management

It’s important to know that project management (PM) is intended to make control the primary imperative components that give down to earth data for accomplishing project destinations in a productive path. Walker (2011) describes PM as the utilization of assets in the organization on a

specific movement inside time, cost, and execution. A fourth key factor is great client relations. Walker included client connection as a fourth critical factor with cost, time, and execution.

(Kerzner, 2017) expressed a project is brief and that implies it has a clear start and a distinct end. At the end of the day, the time is restricted however does not really mean a brief span the term of the project relies upon task compose. Extraordinary implies that each venture or a project is unique and every project has some distinctive highlights. Regardless of whether the project has tedious components.

PM described as "…task administration is the arranging, sorting out, coordinating and controlling of organization assets for a generally here and now target that has been built up to finish particular objectives and destinations. Moreover, project management uses the systems way to deal with management by having utilitarian staff the vertical progressive system relegated to a particular task (the level chain of command)." (Kerzner, 2017:15). Figure 3.1 shows that PM is intended to monitor the key components that give reasonable data to accomplish project destinations in an effective way.

Figure 3.1: Basics of project management

The distinction is that PM is interesting inside a constrained time. This need growing new system and an instrument to guarantee accomplishing objectives. Then again, strategical management must have more shared basic leadership and a boundless time plan that includes conceptualizing in all stages of the association.

The researchers trust that each one of the past definition increases the importance of PM in its specific manner, every one of them motivated the analyst to characterize PM as a workmanship, a

charm and expert experience that give every one of the methods for succeeding, inside all the confinement and the assets gave to accomplish a specific objective.

Construction project management does not dissimilarity from project management as a rule. Walker (2011) showed that it as the arranging co-appointment and control of an undertaking from origination to finishing in the interest of a customer requiring the identity of the customer's goals as far as utility, work, time, cost, quality and the foundation of relation between assets, coordinating, checking and dominant the supporters of the task, assessing and choosing choices in a quest for the customer's fulfillment with the projects result.

Construction Project Management has an indistinguishable principle objects from project management which are time, cost and execution, however in construction PM its time, cost and quality as Walker said, which not alteration on a very basic level but rather might take a more extensive territory in alluding to individuals and the significance of working with others, likewise in development.

3.3 Construction Management in Developing Countries

To have the capacity to deal with the distinctive difficulties that the creative work faces a production methodology needs to exist. A production technique encourages an organization to settle on operational and key choices that take after a legitimate example. At the point when there isn’t a system work out for the choices will be reckless and subjective (Mbachu, 2008).

As pointed in the original research by Clark (2009), construction methodology alludes to misusing confirmed properties for assembling capacity as a focused arm. from that research, production methodology characterized and deciphered by different analysts. In assembling system, Dangayach, & Deshmukh (2008) arranged meanings of manufacture technique detailed by different writers. There are a few varieties in the definitions yet all things considered they are very comparable. For instance, construction system as an aggregate example of choices that follows up on the definition and organization of assembling assets. To be best, the production system should act in the help of the general vital headings of the business and accommodate the upper hand (Dangayach and Deshmukh, 2008).

3.4 Organization and Tasks Control

There are different methods to plan and control each task in a project activity according to time to determine which task should take place first agents the other one even some tasks can work in parallel together to know the duration of a project. The three most common methods explained in following subsections.

3.4.1 Critical Path Method (CPM)

Planning, organizing out and controlling are the three most critical elements of the construction. Of these three, planning is the most psychologically demanding. Thus any logical guide to the official in the execution of the planning capacity, particularly the organizing of projects, is dependably an appreciated alleviation. Since the 1900s, logical models which help in the organizing, management, costing, and execution of vast scale, complex projects have been settled on accessible to leaders. A technique for project arranging was created in the late 1950s known as Critical Path Method (CPM). CPM had developed to help and fill in as options in contrast to Gantt diagram. CPM is project managements move by move technique to process planning that defines critical and non-critical task with the aim of preventing time problems and process tasks and determine a specific time for each task. There for CPM is used for creating scheduling to control and plan a project and minimum completion time of a project along with start and finish period for each task of the project stages (Menesi and Hegazy, 2008).

According the work done by researches the Critical Path Method (CPM) calculation needs upgrade was recognized:

1. Improving system portrayal to stay away from many-sided quality.
2. Improving the portrayal of action advance.
3. Incorporating limitations into CPM.
4. Enhancing project control and calendar investigation.

3.4.2 Program Evaluation Review Technique (PERT)

Project Evaluation and Review Technique (PERT), is a system based guide for arranging and scheduling the many interrelated undertakings in a substantial and complex project. It was produced amid the structure and development of the Polaris submarine in the USA during the

1950s, which was one a standout amongst the most perplexing assignment at any point endeavored at the time. These days PERT procedures are routinely utilized in any huge project for example programming advancement, building development and so on supporting programming, Microsoft Project, among others is promptly accessible. It might appear to be odd that PERT shows up in book on improvement, however it is as often as possible important to upgrade tie and asset obliged frameworks, and the fundamental thoughts of PERT help to compose such a streamlining.

PERT uses a system portrayal to catch the priority or parallel connections among the errands in the project. For instance of a priority relationship, the edge of a house should initially be developed before the rooftop can go on then again, a few exercises can occur in parallel: the electrical framework can be introduced by one group in the meantime as the pipes framework is introduced by second team (Best & Lewis, 2015).

3.4.3 Gantt Chart

Henry Gantt built up the Gantt graph over a hundred years prior and promoted it for the project management. At the time, the idea was viewed as progressive in the field of the management. It was imagined to show a project schedule, featuring various factors including Name of each activity start and finish dates, dependencies/precedence, percentage complete.

With the approach of accessible computing and rearranged programming during the 1980s, the utilization of Gantt chart detonated and it has given a genuine advantage to administrators' capacities to layout, arrange, plan and execute projects. The representation of undertaking plans enables administrators to effectively dissect conditions and asset bottlenecks in their ventures.

At its most key dimension, the Gantt chart demonstrates the connection between work components over a period range. They are utilized most broadly for production planning, scheduling, and control (Schwalbe, 2015).

- *Points of interest of Gantt chart:* Like any device, the Gantt graph is utilized and abused in any number of ways. The objectives of its client will characterize its viability for a given undertaking. It does, anyway offer various positive favorable circumstances to a director looked with complex activities.

- *Clarity:* The Gantt can help picture complexities of an arrangement and plan. People are incredible at examining visual information, and a Gantt can help feature regions of slack space in the timetable, basic conditions and unexploited open doors for simultaneous action.
- *Communication:* A reasonable outline that speaks to various errands, partners and conditions can be a viable specialized device to give situational mindfulness both to senior administration and to extend partners. Groups can pick up a fast energy about their own advancement as for different groups, with whom they probably won't associate with all the time.
- *Coordination:* Gantt charts give a look at the time and asset planning at the full-scale level, permitting project supervisors and group pioneers to work together on sequencing and compromise.

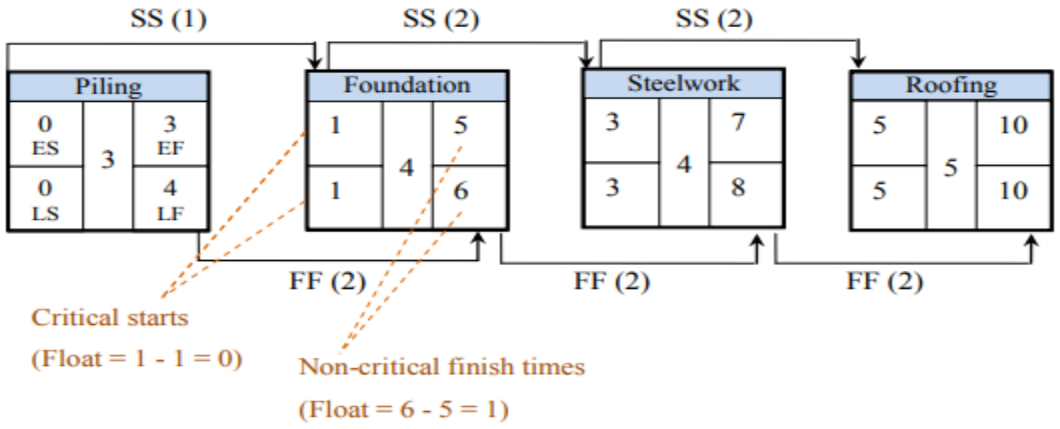
3.5 Network Representation to Avoid Complexity

Regularly, construction projects include circumstances that command the utilization of non-conventional connections and slacks to speak to vital interrelationships among the exercises. For instance, a planner may need to demonstrate that mechanical work can begin five days after the beginning of the electrical work. For this situation, the planner needs to utilize a start-to-start (SS) association with a slack of five days between the electrical and the mechanical exercises.

Be that as it may, complex connections, for example, finish-to-finish (FF), start-to-start (SS), and from start-to-finish (SF) confound the CPM arrange. All the more significantly, the utilization of such connections can prompt circumstances in which the begin dates of some basic exercises may be basic yet their complete dates are not (Schwalbe, 2015).The CPM calculation and existing programming frameworks are by and large unfit to depict these exercises as somewhat basic, for the most part on account of the suspicion that every action is a solitary unified bar with a given span as shown in Figure 3.2.

It demonstrates in the figure a system in which every movement is connected by both a SS and a FF connection. The system counts for this situation, has appeared on the figure, uncover that the begin dates are basic for all exercises; in any case, on account of the cover made by the SS and FF connections, the complete dates for the first three exercises contain a marker (Schwalbe, 2015).

A. How complex relationships create partially critical activities



B. How existing software indicates all activities as critical, in contrast to the calculations in part A

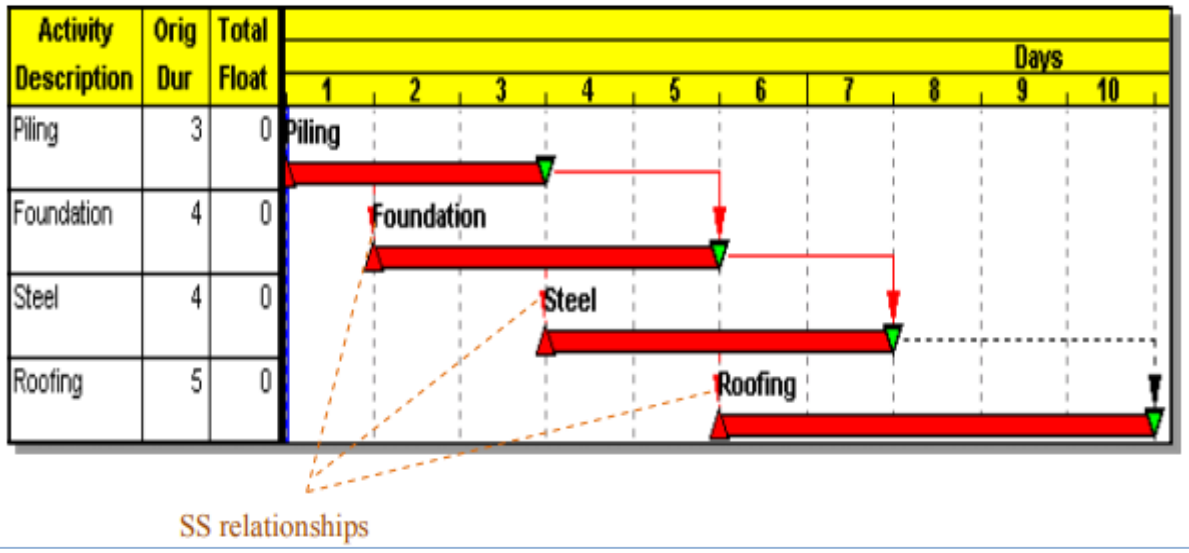


Figure 3.2: In this case study appearance that complex connection can make partially critical efficiency

3.5.1 Representation of activity progress

The portrayal of exercises and their spans are the premise of timetable estimations. An imperative thought is along these lines the impact of real advance and site occasions on the portrayal of the movement and on the count of the rest of the length. At the point when the timetable is refreshed

with the real advance, varying presumptions can be made when the rest of the length of exercises is assessed (Figure 3.3). While a few schedulers or the planners may expect that the rate of advance experienced to date will proceed for the rest of the work, others would appraise the rest of the length in light of the first arranged term. Conditions for figuring the rest of the term in either case (or a weighted normal of both) are exhibited in Hegazy and Petzold (2003). These suspicions may prompt differences among the project parties about the project fulfillment date, and about the way in which defer investigation comes about are created.

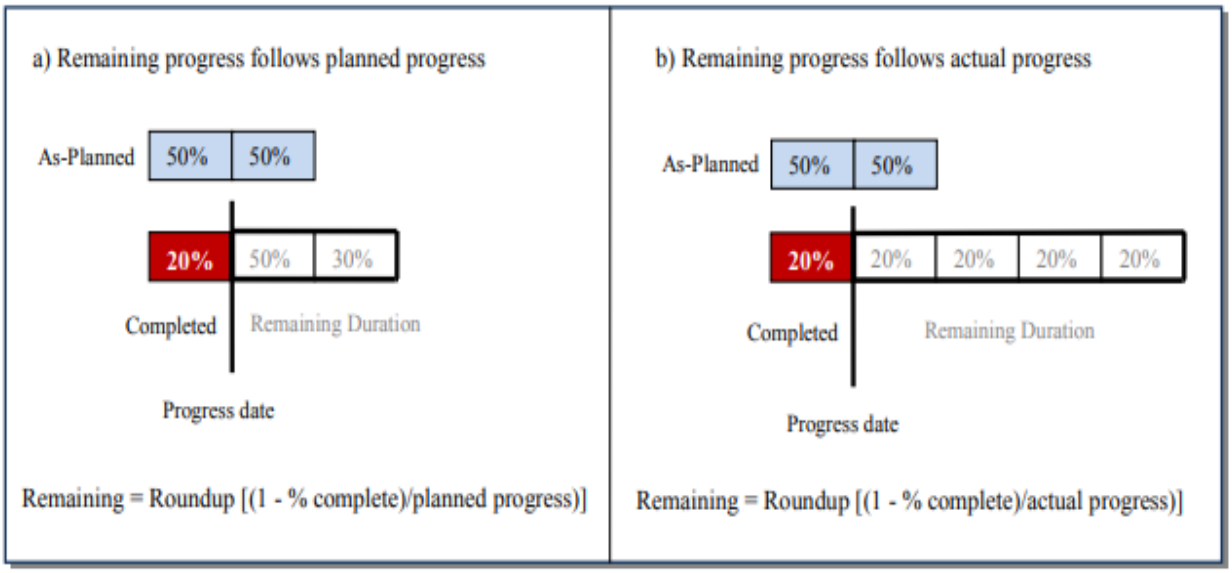


Figure 3.3: Calculating two methods for the remaining period of action that isn't showed in existing tools

The portrayal delineated in Figure 3.4 demonstrates a day by day level of the action and hence shows plainly which computation technique is utilized for the rest of the term, and also the moderate and expedient advance dates. Rather than this portrayal, existing programming frameworks speak to exercises as strong bars that traverse the whole span, with no sign of advance sums or the technique used to ascertain the rest of the term. Since the product portrayal of advance information isn't appropriate for clear timetable investigation, Hegazy et al. (2008) built up a bar diagram in which the bar for every action is made out of spreadsheet cells, with every cell speaking to number of days or number of weeks, or some other unit of period. The exercises are accordingly spoken to not in strong bars, as in business programming, but rather as a gathering of adjoining

cells that make up the span of the action. Such a portrayal can better speak to site occasions related with the diverse gatherings.

3.5.2 Combine boundaries into the CPM

Notwithstanding the impact of complex connections, the basic way and buoy computations are altogether influenced by circumstances that include asset limits and numerous schedules. The resource constrained project, the retrogressive pass CPM count may deliver mistaken aggregate buoys on the grounds that the grouping of a few exercises depends on the intelligent connections as well as on asset conditions. One key issue with existing devices is the way that every action is considered as a solitary bar, which does not speak to the way temporary workers settle asset requirements, especially amid real advance. In existing programming, for instance, once an action is begun, no parts can be acquainted all together with resolve asset over-portion on a given day (Tang et al, 2014).

Regardless of the headways in CPM planning programming amid the most recent two decades, the determination of asset over-assignment still should be incorporated as a component of the CPM definition, not as an outer change. Another thought that ought to likewise be consolidated into the CPM count is the dynamic idea of the term of the exercises. Presently, spans are evaluated and pre-settled before the CPM estimation. CPM examination ought to progressively consider the span of an action as a component of the schedule date on which the movement is to begin. For instance, when the CPM forward pass begins an action in a low-efficiency season, the span of the movement ought to be changed appropriately.

Notwithstanding its restrictions concerning asset breaking points and dynamic activity length, consistent CPM examination isn't defined to decide a calendar as an element of a given due date. While the writing depicts a few procedures that have been produced so as to determine these issues separately, i.e., time-cost exchange off examination and restricted asset designation, little exertion has been given to thinking of them as at the same time, generally due to the natural unpredictability of ventures and the challenges related with demonstrating the mix everything being equal (Kim and de la Garza 2005).

3.5.3 Project control and schedule analysis

Since it is uncommon that a construction project continues precisely as booked, construction advance should be ceaselessly observed and recorded, deviations must be distinguished, and ideal restorative activities recommended. Day by day site occasions is typically recorded in an assortment of media, including everyday site journals, notes from advance gatherings, day by day climate records, photos, and week after week advance reports. In spite of the fact that the everyday site report is an imperative record for the next advance of action, usually given the slightest consideration. Scarcely any specialists have been keen on creating modernized frameworks for day by day site revealing (Hegazy et al. 2008).

Halfway through the execution of a project, the gatherings may concur on a timetable refresh for reasons, for example, the temporary worker's remedial activity to recuperate delays, e.g., quickening and rationale changes, reactions to proprietor asked for changes; and reactions to changed asset loads. The refresh turns into another pattern for estimating progress. In such a case, the prior segment of the project is estimated against the main pattern, while the segment that happens after the refresh is estimated against the new standard. In this manner, a superior portrayal of the gauge information/choices should be detailed. Furthermore, a deliberate strategy for plan investigation is required so as to represent fluctuating baselines, especially when standard updates include changes to the term of an action and to legitimate connections. Among late improvements for enhancing plan investigation and undertaking control is the exertion by Hegazy and Menesi (2008) to build up a system for considering various gauge refreshes.

3.6 Critical Path Segments (CPS)

The accompanying subsections portray the new Critical Path Segments CPS portrayal of an construction system and action advance, which tends to the territories of required upgrade in a down to earth way and inside a bound together structure (Menesi & Hegazy, 2008).

3.6.1 Network representation

Since the portrayal of exercises and their terms are the reason for plan estimations, enhancing the portrayal of the exercises would take care of huge numbers of the issues specified previously. Rather than the customary method for speaking to the exercises as strong bars that traverse a given

span, CPS speaks to every activity as various isolated, however, associated time portions that signify the aggregate length of the action. For instance, an action with a span of three days is spoken to by three-time portions. This technique allows the portrayal of any sensible relationship (Start-to-Start, Finish-to-Finish, or Start-to-Finish) utilizing just a Finish-to-Start (FS) relationship (Figure 3.4). As appeared in the figure, SS and FF relations are effectively changed over to FS relations. Likewise, slack circumstances, which are the wellspring of numerous estimation issues in customary CPM, are not required.

It ought to be noticed this altered CPM examination utilizes physically isolated action parcels not similarly as an issue of portrayal but rather that it likewise then applies plan counts, not at the entire movement level but rather at the individual fragment level. Fundamentally, CPS utilizes a step by step as opposed to activity by-action CPM examination.

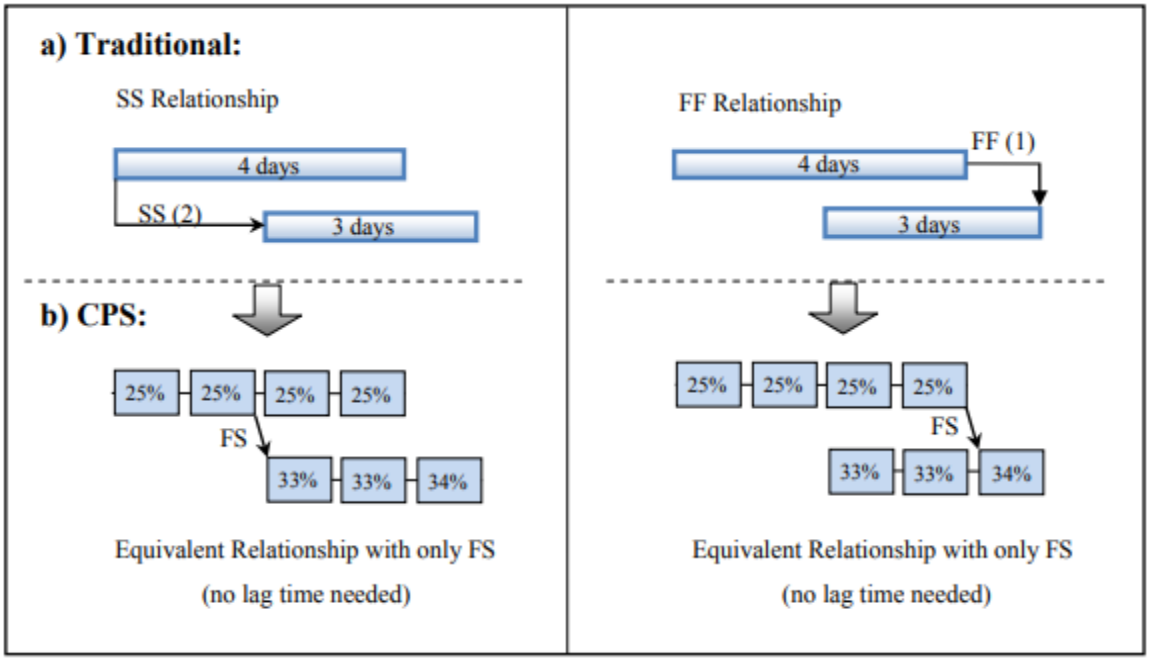


Figure 3.4: Representations of actions as detach time segments to avoid complex connection and lateness in times

The changes that CPS gives contrasted with CPM are expected not exclusively to the lessened intricacy of the system yet in addition to more precise counts. CPS can recognize any mostly basic exercises and along these lines deliver a more precise basic way (Hegazy and Menesi 2008). These two figures allow a correlation of the customary portrayal of project exercises appeared in Figure

3.5 with the CPS portrayal outlined. It can be seen that the CPS portrayal plainly shows the connections between the exercises just as FS connections without slacks and that it likewise characterizes the basic parts of these exercises, which current programming instruments can't do.

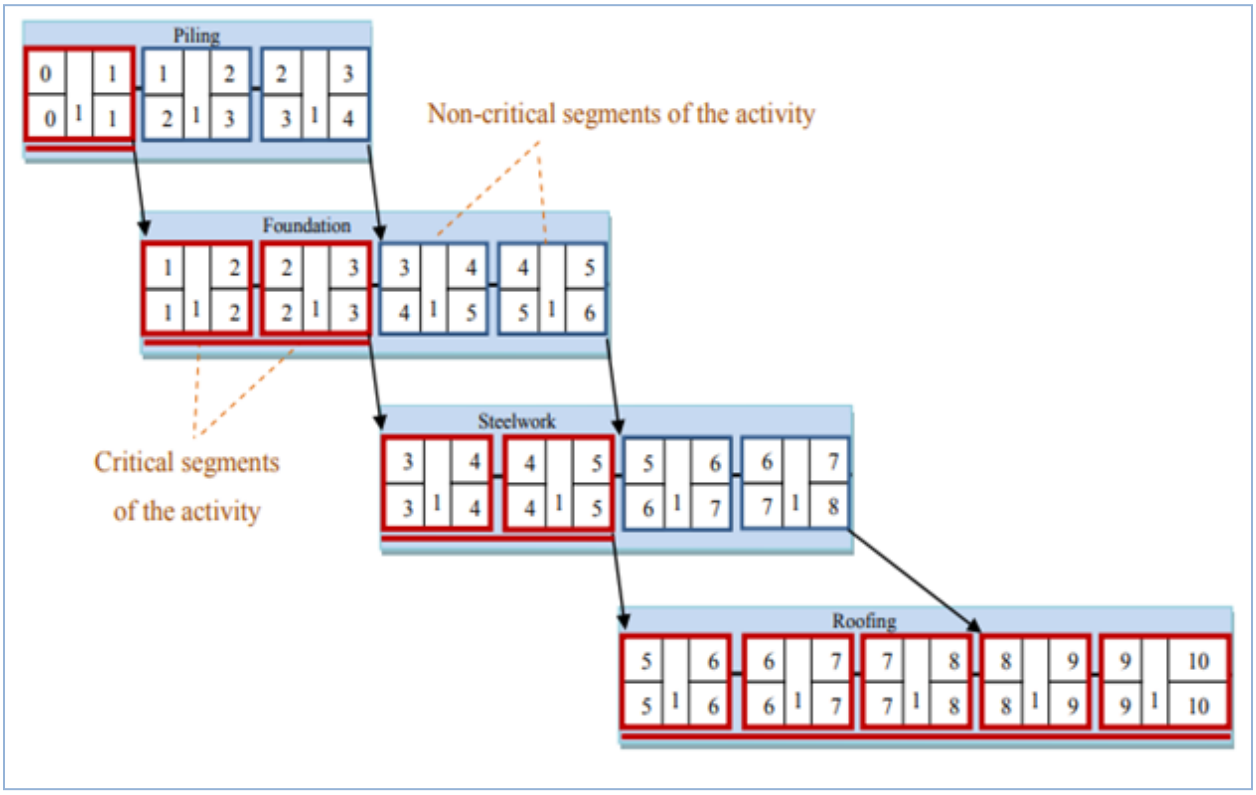


Figure 3.5: CPS representation precisely recognize the critical segments of the actions

A critical extra advantage of the new system portrayal is the expanded capacity to speak to the aim of the connections between the exercises. The CPS model can characterize the connections between exercises as time-based, as well as manufacture based. For instance, instead of showing steel fortification work can start two days after the work starts, CPS empowers the project director to mark that each 20% of the formwork done is trailed by 20% of the steel support. This type of connection is represented in Figure 3.6. This portrayal of connections accordingly imparts the purpose behind the relationship as well as disentangles arrange estimations.

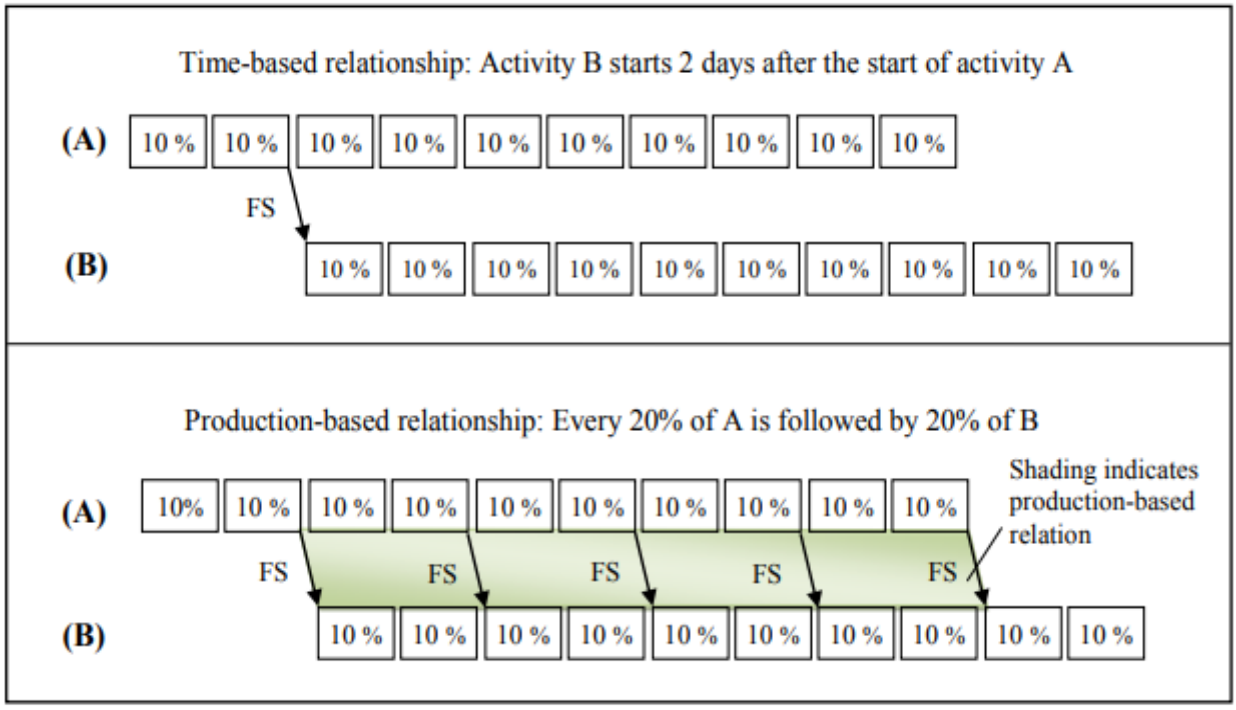


Figure 3.6: Time founded and manufacture founded options in CPS representation

3.6.2 Activity progress new way of representation

CPS, advance is clearly spoken to so plan examination can be completed precisely with less contradiction among parties. With CPS portrayal, advance information has appeared on the activity fragments, and different occasions, for example, those including the proprietor, the temporary worker, and the climate can be embedded as extra sections. Figure 3.7 demonstrates the CPS portrayal of a movement with a five-day pattern term. Amid the genuine advance, the contractual worker utilized a one-day begins postponement to determine an asset over-distribution. After the fulfillment of 20%, the work was ceased for two days, with one because of proprietor intrusion and one too awful climate. The temporary worker accordingly had just a single day in which to finish the movement as arranged. Appropriately, the temporary worker chose to utilize a speedier and more costly technique to quicken the action and complete the rest of the work in two days, and each was at that point allotted 40% of the work.

Such a nonexclusive portrayal of the exercises plainly demonstrates the advancement of all action occasions, including the impact of choices, for example, increasing speed and asset assignment. This portrayal is accordingly sufficiently broad to allow the thought of various connections and in

addition the estimation of the buoy, the rest of the term, restorative activities, baselines, and calendar investigation.

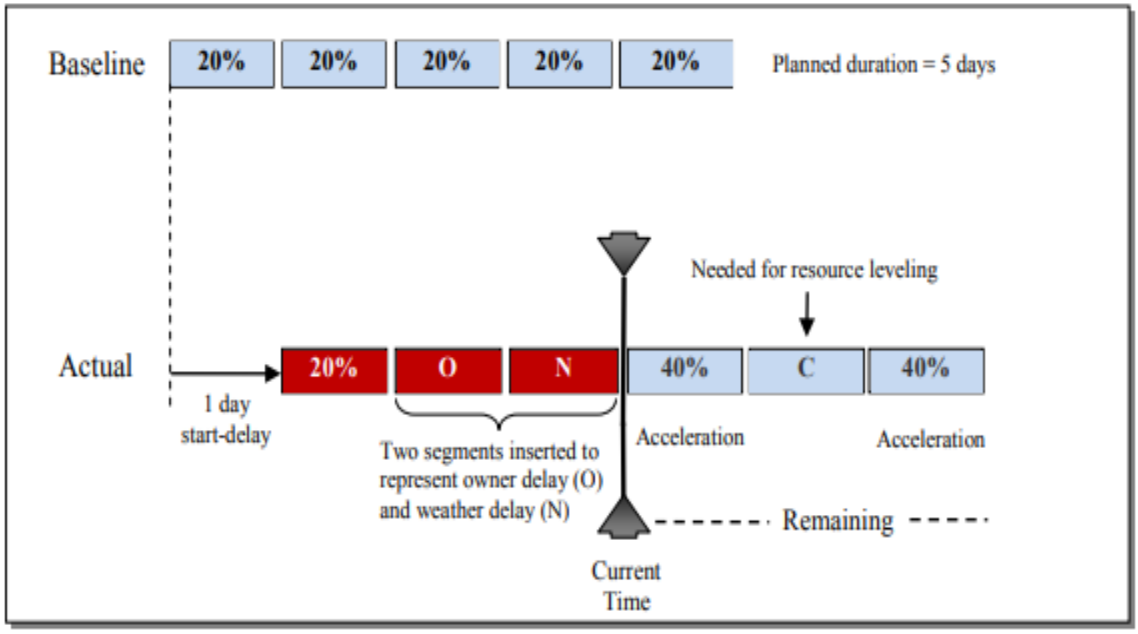


Figure 3.7: Progress events in CPS representation

3.7 Conclusion of the Chapter

Cost performance and poor time are large problems that been noted in today's construction industry, especially in construction companies. This chapter estimate cost and time performance in the construction industry of and specified major inhibiting factors.

CHAPTER 4
CASE STUDY FROM NORTHERN IRAQ – ERBIL CITY

4.1 Geographical and Statistical Information of Northern Iraq

The Northern Iraq Region it consist of three governorates of Erbil, Duhok and Sulemani. It borders Iran from east, from west with Syria and Turkey in the north part where fertile plains meet the Zagros mountain. It is crossed by the Tigris River, Sirwan River and its tributaries, the Great Zab and the Little Zab and the area being 40,643 square kilometers with the population being 3,757,058. The geographical location of the northern Iraq is represented Figure 4.1.

Figure 4.1: Geographical Location of Northern Iraq (https://www.google.com/search)

Iraq Knowledge Network Survey 2011 is part of a project implemented jointly by Central Statistics Organization (CSO), the Kurdistan Region Statistical Office (KRSO) and the United Nations to establish a socio-economic monitoring system in Iraq. Adopted by the Ministry of Planning to support evidence-based planning in implementing development plans at the national, sub-national and local government level (Socio – Economic Monitoring System for Iraq, 2011). The survey was managed as follows Steering Committee: Chaired by Head of Iraq's CSO and the Deputy Special Representative of the United Nations Secretary-General and Resident & Humanitarian

Coordinator for Iraq, with the membership of heads of UN organizations, Information and Analysis Unit (IAU) and KRSO, and Technical Committee: Consists of representatives from CSO, KRSO, the UN and IAU.

4.2 Construction Management in North of Iraq

In Northern Iraq, there are specific achievement factors that must be examined. Northern Iraq has interesting characteristics that make it unique in relation to different spots, and this exploration will center around those and will feature the failure signs in overseeing development extends in Erbil.

Along years and regardless of the misfortunes and troubles, the Northern Iraq economy could wake up and try to survive. The construction sector is a basic part in the Northern Iraq's economy, giving a standout amongst the most imperative wellsprings of pay for Kurdish families. Development made occupations for no less than 25 percent of the Kurdish work constrain and contributed 25 percent of the aggregate Gross Domestic Product (GDP) in 2012, and in different examinations, it surpassed 20 percent of the national pay, in spite of the fact that it reject again following 2012 when the second rebellion started. These days the construction sector is developing again and stays critical of the Northern Iraq's economy. Project management is more vital than any time in recent memory, as the key marker of how extends are imagined, outlined and constructed (Kurdistan Regional Government Ministry of Planning 2016).

4.3 Local Construction Market

Northern Iraq needs huge reproduction construction work. The city Erbil alone, around 31% of the Northern Iraq people calls home, needs significant reclamation, restoration, and improvement to make an advanced capital for the nation and empower the load of structures utilized for government and trade to work as per current norms. Originators, designers, and expert architects working with the state and metropolis governments will all have the capacity to exploit various chances to remodel Erbil into a cutting edge and productively working metropolis.

Individuals with the learning of new advancements in building and structural designing will have the capacity to add to the plan and construction of present day improvements like those found somewhere else in the Middle East. Open doors for the private division to take an interest are

relatively boundless and incorporate city arranging, shipping framework, tradition focuses, civil structures and social and entertainment offices. Shopping centers and retail benefit bunches are additionally required.

As indicated by the Inter-Union Department of Statistics and Socioeconomic Studies construction business is contained three portions of Construction structures framed by the development which are Heavy development, foundation extends and concentrated administrations. As indicated the construction of private structures, the development of business structures and the development of mechanical structures speaking to a yearly turnover of $ 4.41 Billion (Kurdistan Regional Government Ministry of Planning, 2016). Construction business has particular attributes as the determinants of intensity they are:

- *Heavy construction:* Agreement administration limit and satisfaction of subcontractors picked items, and the organization with innovation holders.
- *Residential Buildings:* Fundamental reason is taken a toll, showing that this item has a high consideration. Cost and financing are other primary factors in the buyer's choice.

Figure 4.2: Residential buildings (Zakaria buildings) in Erbil city (Photo by: Author)

- *Commercial Buildings:* Particularly doctor's facilities, hotel and strip malls, the basic reason is the conveyances that term, guarantee and work conveyance speed are necessary.

Figure 4.3: Commercial building (Gulan Tower) in Erbil city (Photo by: Author)

4.3.1 Statically information of construction industry of Erbil

The Erbil Contractors Union (ECU), which is a piece of the Northern Iraq Contractors Union, states that the aggregate figure of construction temporary workers in the Northern Iraq Region is roughly two thousand five hundred. The Northern Iraqi Contractors Union has an aggregate of just about 2,000 individuals: 400 in Dahuk, 735 in Sulaymaniyah and 863 in Erbil. There are 59 outside individuals, of whom 51 are Turkish and 8 are Iranian. The dominant part of Turkish firms builds up associations with Kurdish partners in the Region.

The distinction in the numbers expressed above can be credited to a few elements. Numerous outside temporary workers chipping away at extensive ventures worth over $10 million don't join the Kurdistan Contractors Union, despite the fact that their subcontractors might be individuals. Expansive construction employment, particularly those outside benefactor financings, go specifically through the service included and are not detailed by the Kurdistan Contractors Union. Until the point when one uniform technique for enrolling contractual workers and announcing exercises is actualized, there will keep on being contrasts in construction part measurements.

- *Cement:* The evaluated bond utilization in all of Iraq is assessed to be 10 million tons for every year, 25%– 40% of which is utilized by the construction business in the Northern Iraq Region. Prior to the ongoing remodel and development of new plants in 2006, an expected 7 million tons were foreign made from Turkey, Jordan and Iran. In spite of the fact that bond generation limit has expanded, concrete will at present be foreign made into the Northern Iraqi Region in the present moment to keep pace with interest made by expanded construction movement.

Figure 4.4: Makhmoor cement factory in Erbil (Photo by: Author)

- *Steel:* Steel is foreign from Turkey, Ukraine, and China. There has not been a noteworthy exertion to reuse scrap steel and iron in Northern Iraq. As of now, there is one little steel fabricating company in the Region, Erbil Steel. Since the iron metal in the Region is low in ferric oxide (Fe2O3) content, piece press is best utilized in the manufacturing unit.

Figure 4.5: Steel work on construction site (Photo by: Author)

- *Bricks:* The Halabja Group works the Aso Brick Factory, which is situated in Takiya Subdistrict, 35 kilometers southeast of Sulaymaniyah. The Aso Brick Factory's standard creation is 590 tons of green (unfired) items every day, or 138,000 standard-estimate blocks every day. There is another new block production line being set up in the Koya region among Mosul and Erbil; hardware and apparatus are being introduced.

Figure 4.6: Halabja brick factory (Photo by: Author)

4.3.2 Economic information of building cost

As in many parts of the world, building costs have been rising fundamentally in Northern Iraq because of rising costs for fuel, work, and materials. For instance, since 2000 bond costs have expanded from $25 per long ton to $125– $150 per long ton, paying little heed to inception, and rebar steel has expanded from $200 per ton to $700– $800 per ton. The Contractors from Northern Iraq Union expresses that institutional development costs have expanded 5%– 600% in the course of the most recent 10 years.

The development materials advertise in Northern Iraq is assessed at $500 million to $600 million dependent on aggregate development esteem gauges and "principle guideline" estimations. Cement, steel, and blocks make up an extensive offer of the construction materials utilized in Northern Iraq. Be that as it may, quite a bit of these Construction materials, including steel fortifying bar, apparatuses, wiring, tile, and completing items, are transported in. The Government of Northern Iraq Ministry of Industry records 204 firms, of which more than 100 are Turkish, that are providing items to the development business in the country. The absence of testing offices in the country impedes the business' capacity to guarantee the nature of building materials.

4.3.3 Labour force

In northern Iraq 44% of Iraqis (7.9 million persons) are in the labour force (using relaxed definition) and where as 72% of males are in the labour force and just 13% of females. The government provides 40% of jobs; the remainder is in the private sector. It provides 45% of all employment in urban areas and 28% of employment in rural areas of all working females, 60% are working in the government sector. Overall, one out of six persons in the labour force is a woman (Socio – Economic Monitoring System for Iraq, 2011).

Unemployment rate is 11% nationally (7% of males and 13% of females). 653,000 people are unemployed, of which 496,000 are male and 157,000 are female. Youth unemployment is higher in urban areas compared with rural areas. Unemployment is higher among youth with a higher education. Youth (15-24 years) unemployment is high at 18% (27% of females and 17% of males) (Socio – Economic Monitoring System for Iraq 2011).

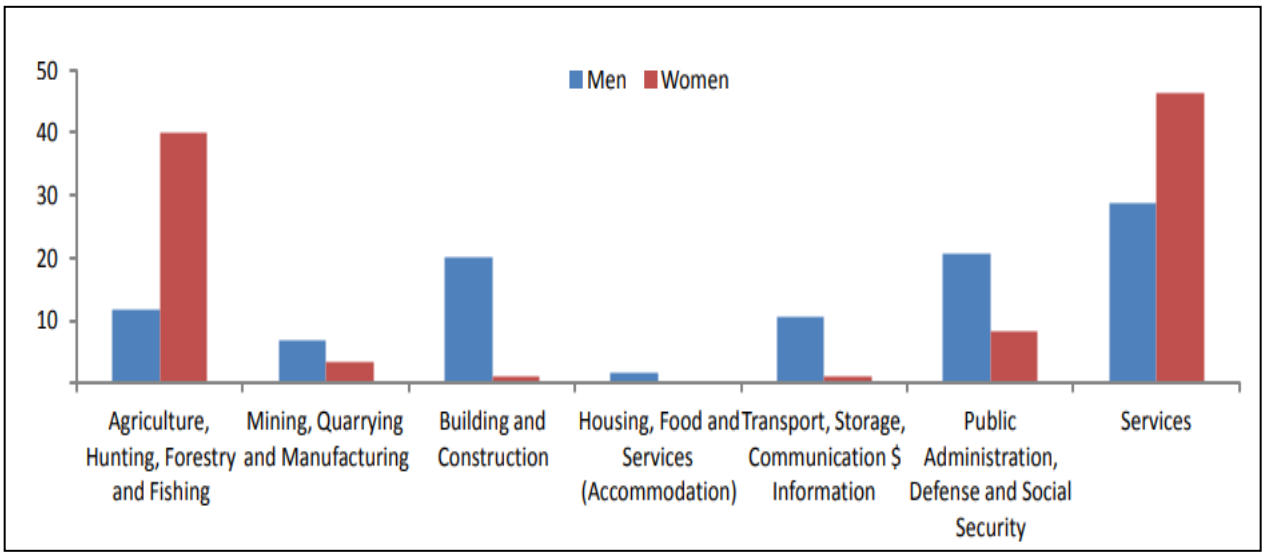


Figure 4.7: The labor force from different industries of Northern Iraq (Socio – Economic Monitoring System for Iraq 2011)

4.3.4 Housing and municipal services

Far-reaching and solid insights are essential for arrangement plan in any district or nation. Statistics make it conceivable to recognize the most squeezing needs, track the advancement of current approaches and activities, and plan future improvement. Above all, statistics are the establishment for successful approach arranging in numerous regions. Northern Iraq comes up short on the insights it needs to enhance infrastructure, empower private-area improvement, foreign investment, and make supported financial development. For example, high youth joblessness rates in the Middle East have prompted mounting dissatisfaction and social distress. Joblessness was a key worry of Northern Iraq, yet the legislature did not have solid joblessness information for the Northern Iraq, not to mention the young joblessness rate, which enables it to analyze any current issues and create arrangements to address them.

The Northern Iraqi government has officially made extraordinary walks in building up a strong information gathering framework. They are in a decent position to expand on the advancement made to date, to actualize new information accumulation exercises, and to increment institutional limit. Needs distinguish for Northern Iraq incorporate building up an arrangement of top-notch work power and endeavor reviews. Making these and other information accessible to policymakers in a straightforward and auspicious way will help the Northern Iraq government accomplish its approach objectives.

The Northern Iraq shares certain authoritative forces recorded in Article 114 of the Constitution (counting yet not constrained to traditions the board, vitality generation and appropriation, ecological, wellbeing and instructive strategy) with the government experts in these regions, however need is given to the forces of the Kurdish specialists once worked out. Regardless of the above mentioned, the most critical government business laws, for example, the Civil Code, the Civil Procedure Law No. 83/1969, the Income Tax Law, the Labor Law, the Companies Law, the Commercial Law, the Commercial Agency Law, the Customs Law, and the Banking Law are connected in the Kurdistan Region subject to specific changes by the Kurdistan authoritative specialist. As of now we see a propensity of the Kurdish enactment to sanction separate business laws for the Kurdistan Region, for example, the Competition Law No. 3/203.

Construction contracts in Northern Iraq are administered by Articles 864-890. These arrangements give the structure to the principal prerequisites for the "muqawala" (contract for works). Article 864 characterizes contracts for fills in as contracts in which one of the contracting parties embraces to play out specific works or administrations for thought which the other contracting party attempts to give. A primary temporary worker has three essential commitments emerging from a construction contract under Northern Iraqi law:

1. Execution of the work allocated as per the arrangements of the construction contract between the gatherings.
2. . Conveyance of the work away at culmination.
3. Risk to ensure the works upon conveyance.

4.4 Case Studies from Erbil

Examination of design and implementation stages in building production system with three examples from Erbil will be made in this part. The examination will be made through inputs, process and outputs as shown in Chapter 2 stages of building production (Figure 2.3).

4.4.1 Example 1: Construction company A

Organization A was established in the 1980s, working in national capitals. Its profile incorporates projects of private houses and structures, corporate structures, shopping malls, medical facilities,

education centers such as universities and colleges, and also manufacturing plants. All through its history, it built in excess of four million square meters, and right now has 5 projects in process.

Production planning and control process in company A is done as an association between the production management and the consulting group. The planning objective is to set up a calendar that goes to the completion date agreed between company and the client, even that this implies outlandish targets are set. This calendar contains an exceptionally important long haul planning which sets up worldwide goals and production forms speed.

As a rule, company A as planning is stick on to the customary arrangement of planning and control, as it has a sole arrangement formalized in a long haul arranging exceptionally definite. This planning is constructed intensely in light of the basic way strategy using the construction management tools such as CPM, PERT and Gantt chart. The physical streams between the exercises are not considered, and also the idea of significant worth construction, the construction condition, and the learning age opportunity.

The current construction project of the company A being a residential building consists of 23 floors on the land area about 785 square meters as shown in Figure 4.8, and the construction project was started on December 23rd 2017 and the project accomplishment date was set to April 25th 2019, therefore in order to accomplish the present construction project the company starts with the process stage by subsequently dived into two major phases being Designing Stage and Implementing Stage. The following subsections have briefly discussed these two stages in order to know the whole building construction process.

Figure 4.8: Project example for construction company A

4.4.1.1 Designing stage of project

Design process goes through some phases like inputs, process and outputs to complete each task.

- **Inputs:** Basically in order to carry out the building construction project the inputs of the production process of the construction project has been initialized were the key factors such as:
  - *Production policy and planning* are set, in order to carry out this process the designing and consulting team were assigned the tasks related to building production policy, planning and strategies along with the criteria which are needed, a team of engineers and architects discuss the production process that how to initiate the geometric state of the building, pick the required materials and roughly cost. The meanings of the extent of work and the relating work periods of the Fee Regulation for Architects and Engineers were dispensed.
  - *Product performance value***:** Insufficiency happens in detail periodically, for instance, if the comprehension among architects is deficient. Designers add relating particulars to the

building configuration to finish it. At that point, the structure should be satisfied adequately, however it has been seen that the work which was relegated to the consultant and advisory group has been effectively cultivated the assignment given about the material, planning and estimation of the present building development. The prerequisites for the present construction project as been consequently structured as shown in table 4.1.

Table 4.1: The types of data designed for the construction project

Type of Data	Project Specification data		General Data	
	Example	**Sources**	**Example**	**Sources**
Object data	Properties of -Structure -Geometry -Position -Quantity -Material	-Drawings -Plans -Building models -Preparation of work -Site drawings	Composition of -Common structural components	-Catalogs -Product specific -CAD Drawings
Process data	Position of -Storing -Access path -Technology	-Manufacturing planning	Performance factor -Labor -Construction material	-Company archive

- *Regulations:* All laws and regulations for the manufacturing of buildings are taken into account according to the law posed by the local government. The design varies in detail depending on project size and type. There were no changes or additions during the further project development; the building design is usually very dedicated and consistent.
- *Building Program:* Construction is a creation of a complex calculated arrangement of individuals, apparatus, instruments, and materials, which can conceivably cause pointless costs, a more extended development period and lower quality amid the usage. The organization investigated the controls which were presented by the legislature and gave the adolescent business and furthermore to the individuals who claim the development apparatuses so as to meet the necessity and furthermore the building production systems compasses to the conclusive stage.

- **Processing stage:** Once the input of the designing stages was initialized then the process that how the construction work needs to be accomplished has been focused, and thus the concerned key factors are subjected in the processing stage.
  - *Function analyzes and synthesis:* The character of structures makes an exchange of the connected assembling process on other construction projects troublesome. The construction procedure is generally viewed as finished in the wake of being completed, so the site the board winds up capable to design the genuine interest for staff and assets in detail, to react in the present moment to unexpected occasions by unconstrained compensatory measures and to assess the effect of such occasions on contract claims. Additionally, the construction arranging was adjusted to each new item independently.
  - *Cost analyses:* There is typically a high time and cost weight amid the planning stage and also amid the development time frame. These abatements the ideal opportunity for a top to bottom plan stage. Then again, it requires an all arranged construction execution, which conclusive is a contention. Consequently, it was broke down on the present construction project for each individual case, to what degree a gain in productivity can be normal with extra costs amid the arranging stage.
  - *Optimizing:* Experiences from different project managing the production of items appear, that a devoted production of assembling forms empowers critical chances if the required information premise can be made and improved. There for the arranging can begin with the initial steps of item structure and ought to expect to embrace further subtleties later. The legitimacy of arranging builds as indicated by the dimension of detail of the item structure and prompts a dependable portrayal of the production procedure toward the end by enhancing the material required and by empowering the production and planning stage.

- **Outputs:** When the process phase is finished then it come the outputs
  - *Detailed application project:* Amid the key arranging, a development procedure can be depicted just generally. The main articulations about allotment of assets and process terms were at that point made at this stage. These announcements can be advanced with subtleties conveyed by later determinations and changed over into a correct asset designation plan. These aides, to diminish the quantity of sudden episodes altogether. Responses to aggravations caused by outside effects can be facilitated better, which underpins the agent

fabricating the executives. In this manner, the individual procedures are composed as far as utilization of assets and timing. Therefore, a general smooth generation process is in the focal point of enthusiasm rather than the inclinations of the individual gatherings.

- *Technical and administrative specifications:* Clear, short details are fundamental in accomplishing quality and effectiveness in building development. Consequently, details characterize singular obligations, estimation and installment methods, and give the correspondence between the customer and the temporary worker. Remembering that the present difficulties in the building development program put an incredible interest on the private and business structures for clear and succinct determinations. Elements which add to these difficulties include:
  1. Increasing task unpredictability and degree.
  2. Increasing authoritative and regulatory prerequisites
  3. New innovation applications.
  4. Shortage of faculty in number and experience.
  5. The multiplication of agreement cases and case.
- *Cost Estimation Reports:* Once the work obligations are recognized, a survey of the estimation and installment methodology is expected to guarantee that the grouping of each gathering's activities was distinguished and further it has been educated at the season of understanding and the agreements were marked between the customer and the contractual workers that any time of time it will be engaged to meddle with the estimation of the work quality and amount. The premise of installment for the work mirrors the obligation and consummation definitions incorporated into the work depiction.

  The aggregate undertaking has a financial plan of $65 million and the building cost of $48 million. The real building expense per square foot was determined to be $125. The explanation behind this distinction in expense can be advocated. The genuine building cost thinks about the numerous comforts. This present undertaking is a progressive structure for a private building concentrating on the utilization of innovation and taking a stab at certification.

4.4.1.2 Implementation stage of the project

After the design stages are finished then the implementation part start through the phases of inputs, process and outputs.

- **Inputs:** The outputs of design stage became the inputs of implementation stage which are:
  - *Detail application process:* Once the designing phase has been successfully drawn then a detailed application process as an output of the construction project has been implemented for instance the working drawings of the project were submitted to the governmental authorities to get the permission to start the building construction process along with all the contractors and parties who are involve in the construction with the contracts and agreements in detailed. Addition to this a list of materials and the machineries which are required a detail report along with the cost analysis has been furnished by the procurement team.
  - *Specifications:* In order to accomplish the current project the procurement team has furnished a detail specifications of the project of which the major required materials to complete the structure such as cement, steel and brick work are as follows:
    1. *Cement:* The estimated cement consumption for the current project is estimated to be 2755 bags of cement for each floor (50 kgs each bag), 60% of which is consumed in the constructing the structure. Prior to the ongoing redesign and development of new plants in 2006, an expected 7 million tons were transported in from Turkey, Jordan, and Iran. Despite the fact that concrete generation limit has expanded, a bond will at present be transported in into northern Iraq in the present moment to keep pace with interest made by expanded development movement.
    2. *Steel:* Steel is transported in from Turkey, Ukraine, and China. There has not been a noteworthy exertion to reuse scrap steel and iron in Northern Iraq. Right now there is one little steel producing office in the Region, Erbil Steel. Since the iron metal in the Region is low in ferric oxide (Fe2O3) content, piece press is best utilized at the office. In this way for the present development process around 6760 kgs of fortified steel for each floor has been assessed.
    3. *Bricks:* The Halabja Group works the Aso Brick Factory, which is situated in Takiya Subdistrict, 35 kilometers southeast of Sulaymaniyah. The Aso Brick Factory's standard creation is 590 tons of green (unfired) items every day, or 138,000 standard-

estimate blocks every day. There is another new block industrial facility being set up in the Koya region among Mosul and Erbil; gear and hardware are being introduced. The new processing plant will deliver block with the crude materials found adjacent in the Makhmour region. In this manner according to the prerequisite the blocks will be transported from all the previously mentioned zones and it has been evaluated that 243698 block are required for each floor.

- *Regulations:* The Northern Iraq shares certain administrative forces recorded in Article 114 of the constitution (counting however not restricted to traditions the board, vitality generation and dispersion, ecological, wellbeing and instructive strategy) with the government experts in these zones, yet need is given to the forces of the Kurdish specialists once worked out. In spite of that, the most imperative government business laws, for example, the Civil Code, the Civil Procedure Law No. 83/1969, the Income Tax Law, the Labor Law, the Companies Law, the Commercial Law, the Commercial Agency Law, the Customs Law, and the Banking Law are connected in the Northern Iraq Region subject to specific adjustments by the Northern Iraq authoritative expert. Right now it has been seen a propensity of the Northern Iraq enactment to institute separate business laws for the Northern Iraq Region, for example, the Competition Law No. 3/203. Development contracts in Iraq are represented by Articles 864-890 of the ICC. These arrangements give the system to the principle prerequisites for the "muqawala" (contract for works). Article 864 characterizes contracts for fills in as contracts in which one of the contracting parties embraces to play out specific works or administrations for thought which the other contracting party attempts to give. A primary temporary worker has three foremost commitments emerging from a development contract under Iraqi law:

  1. Execution of the work allocated as per the arrangements of the construction contract between the gatherings.
  2. Conveyance of the work away at culmination.
  3. Risk to ensure the works upon conveyance.

  Therefore according to the above mentioned laws and regulations the building project has been successfully eliminated.

- **Processing stage in implementing the project**
  - *Site Preparation:* In order for the excellent projection of the current project, the condition of the project site included subsurface and surface condition which has been investigated and assessed thoroughly Figure 4.9 for the site location.

Figure 4.9: Construction site of the residential building of company A (Google map)

Typically in the Northern Iraq especially in the city Erbil area the favored technique for development is thrown set up cement. It is intriguing that the auxiliary framework is chiefly customary steel development. With building stature not being a structure limitation, in regard to expanding number of floors this may have calculated into the technique picked. The site permits constrained nearby stopping and road stopping is accessible for flood stopping. The encompassing region is for the most part business and private and road stopping will give adequate parking spots amid development.

Figure 4.10: The structure of the residential building project from Erbil of company A (Photo by: Author)

Site evaluation included deciding the present and establishment of underground administrations indicate appropriate establishment rely upon proposal of geotechnical report, foresee the dimension of ground water, reviewing sum required for seepage to push water far from the structure, regardless of whether the site is hard to unearth or not, ice infiltration profundity. To construct the structure according to the plan, gauge the unearthing volume precisely, and give reasonable seepage, basic rises and design were been completed with significant exactness.

Figure 4.11: Site working of construction company A (Photo by: Author)

- *Working programme:* The current project was designed by bearing the following rule so that project can be executed:
    1. Dates and durations were allocated to each task which has to be carried out.
    2. A critical path (the sequence of critical tasks upon which the overall duration of the programme is dependent).
    3. Tasks which can only be carried out after other tasks have been completed.
    4. Tasks which can be carried out simultaneously.
    5. 'Float' within tasks that are not on the critical path (that is, delays that can be incurred without affecting the critical path). Identifying float can be helpful in highlighting where it may be possible to transfer resources to tasks that are on the critical path.
6. The need for specific resources such as plant, services or materials and their lead time.

- *Construction Management:* The first task was masterminded to be a design build with CM at risk. Through discussions with included gatherings, the venture has transformed into a progressively conventional design bid build conveyance. The first conveyance technique was enabled the undertaking to start advancement preceding finish of all construction documents. To take into consideration fruition on time and fulfill the needs from the proprietor in the time wanted made a situation that would be best fit by the design build with CM at risk delivery method. Figure 4.12 shows the connection between the company A as an owner of the project and the way of organizing the work and dividing it into two

other companies by contracts ant the secondary companies gave part of the work by subcontract to other companies so the work finish in expecting time.

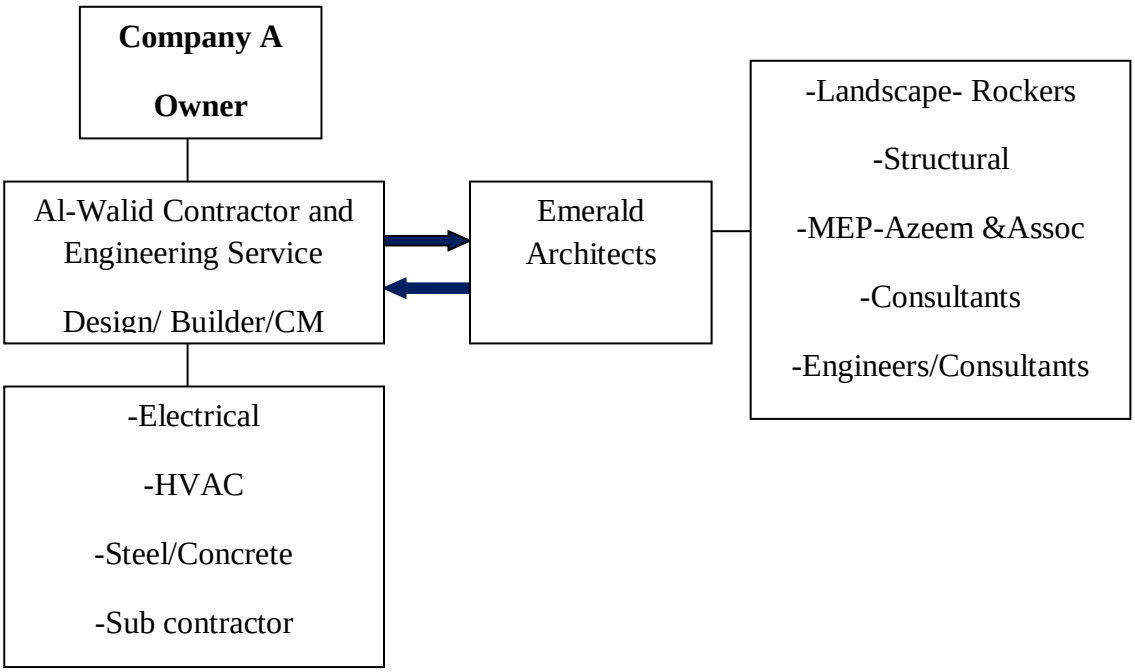


Figure 4.12: Organizational chart of the project work allocated to different teams

- *Project Schedule Summary:* The project undertaking is booked to take 492 Days approx. This does exclude pre-plan destruction. The substructure is anticipated to most recent 158 days, the superstructure will take 246 days and the unpleasant in and complete course of events are 250 days. The last consummation is relied upon to be April 23, 2019. Gantt outline Summary Schedule as shown in Appendix 1.

4.4.2 Example 2: Construction company B

The company B was established in the 1990s, working in the metropolitan region of the city of Erbil. Its profile incorporates townhouses of private houses and structures, corporate and business structures. All through its history, they have executed 65 projects plus, representing 1,243 units conveyed and in excess of three hundred thousand square meters. Right now has 3 projects running 5 future discharges.

Planning company B is mostly stick to the conventional collection of planning and control, as it has sole arrangement formalized along extremely important term planning, construct vigorously with respect to the basic way strategy and valuation system and program audit. Ideas like physical streams between the exercises, consistent work process, impact the construction condition and the learning age opportunity are consolidated but in developing shape. The control of the production is amassed in singular sub forms, without losing center around the general procedure. The idea of significant worth construction is disregarded.

Planning is completely planned as a framework and also estimation of execution frameworks. Defining objectives depends on the experience of those workforces included, thinking about fractional information on profitability, development forms, ignoring construction limit.

The current construction project of the company B being a residential building consists of 10 floors on the land area about 525 square meters, and the construction project was started on October 12th 2017 and the project accomplishment date was set to May 18th 2019, therefore in order to accomplish the present construction project the company starts with the process stage by subsequently dived into two major phases being designing Stage and implementing Stage. The following subsections have briefly discussed these two stages in order to know the whole building construction process.

Figure 4.13: Project example for construction company B (Photo by: Author)

4.4.2.1 Designing stage of project

Design process goes through some phases like inputs, process and outputs to complete each task.

Figure 4.14: Site working on construction company B (Photo by: Author)

- **Inputs:** Basically in order to carry out the building construction project the inputs of the production process of the construction has been initialized were the key factors such as:
  - *Production policy and planning:* are set, in order to carry out this process the designing and consulting team were assigned the tasks related to building production policy, planning and strategies along with the criteria which were required, a team of engineers and architects discuss the production process that how to initiate the geometric state of the building, pick the required materials and roughly cost. The meanings of the extent of work and the relating work periods of the regulation for architects, designing consultants and Engineers were mete out.
  - *Product performance value:* Insufficiency happens in detail periodically, for instance, if the comprehension among architects is deficient. Designers add relating particulars to the building configuration to finish it. The structure should be satisfied adequately, however it has been seen that the work which was relegated to the architects and structural designing consultant and advisory group has been effectively cultivated the assignment given about the material, planning and estimation of the present building development. The prerequisites for the present construction project was been consequently structured.
  - *Regulations:* All laws and regulations for the construction of residential building are taken into account according to the law posed by the local government. The design varies in detail depending on project size and type. There were no changes or additions during the further project development; the building design is usually very dedicated and consistent.
  - *Building Program:* Construction is a creation of a complex calculated arrangement of individuals, apparatus, instruments, and materials, which can conceivably cause pointless costs, a more extended development period and lower quality amid the usage. The organization investigated the controls which were presented by the legislature and gave the adolescent business and furthermore to the individuals who claim the development apparatuses so as to meet the necessity and furthermore the building production systems compasses to the conclusive stage.

- **Processing stage:** Once the input of the designing stages was initialized then management has set the process that how the construction work needs to be accomplished was focused, and thus the concerned key factors are subjected in the processing stage as mentioned below.

- *Function analyzes and synthesis:* The construction procedure is generally viewed as finished in the wake of being completed once, so the site the board winds up capable to design the genuine interest for staff and assets in detail, to react in the present moment to unexpected occasions by unconstrained compensatory measures and to assess the effect of such occasions on contract claims. Additionally, the construction planning was adjusted to each material which is required for the building production independently. Because of the uniqueness of the task, an abnormal state of mechanization would not end up being compelling and gathering and coordination forms are regularly performed physically.
- *Cost analyses:* There is typically a high time and cost weight amid the planning stage and also amid the development time frame. These abatements the ideal opportunity for a top to bottom plan stage, it requires an all arranged construction execution, which conclusive is a contention. Consequently, it was broke down on the present construction project for each individual case, to what degree a gain in productivity can be normal with extra costs amid the arranging stage. Therefore the procurement team was assigned the task to estimate the cost of the materials required, and eventually the teams has successfully determined the cost estimated report.
- *Optimizing:* Experiences from different project managing the production of items, that a devoted production of assembling forms empowers critical chances if the required information premise can be made and improved, the assembling arranging can begin with the initial steps of item structure and ought to expect to embrace further subtleties later. The legitimacy of assembling arranging builds as indicated by the dimension of detail of the item structure and prompts a dependable portrayal of the production procedure toward the end by enhancing the material required and by empowering the production and planning stage. Therefore the present residential building project has been optimized the designing and planning stage.

- **Outputs:** When the process phase is finished then it come the outputs
  - *Detailed application project:* Amid the key arranging the present building development process has been depicted generally. The main explanations about allotment of assets and process spans were adjusted at this stage. These announcements has enhanced with subtleties conveyed by later details and changed over into a correct asset distribution plan.

This aided, to diminish the quantity of sudden episodes essentially. In this way, the individual procedures are composed as far as utilization of assets and timing. Therefore, a general smooth building development creation process is in the focal point of enthusiasm rather than the inclinations of the individual gatherings.

- *Technical and administrative specifications:* In the building development program put an extraordinary interest on the private and business structures for clear and brief details. Clear, brief determinations are basic in accomplishing quality and proficiency in each building development. Determinations characterize singular duties, estimation and installment methods, and give the correspondence between the customer and the temporary worker.
- *Cost Estimation Reports:* Once the work obligations are distinguished, a survey of the estimation and installment methodology are guaranteed that the grouping of each gathering's activities were recognized and further it has been educated at the season of understanding and the agreements were marked between the customer and the temporary workers that any time of time it will be engaged to meddle with the estimation of the work quality and amount. The premise of installment for the work mirrors the obligation and fulfillment definitions incorporated into the work portrayal. The aggregate venture has a financial plan of $10 million and the building cost of $6 million. The genuine building cost per square foot was determined to be $125. This distinction in expense can be legitimized. The real building cost thinks about the numerous pleasantries. Thusly the cost estimation report which were given by the acquisition group was been surveyed by the all gatherings who were associated with the present development venture.

4.4.2.2 Implementation stage of the project

After the design stages are finished then the implementation part start through the phases of inputs, process and outputs.

- **Inputs:** The outputs of design stage became the inputs of implementation stage which are:
  - *Detail application process:* Once the designing phase has been successfully drawn then a detailed application process as an output of the construction project has been implemented for instance the detailed drawings of the project were submitted to the governmental authorities to get the permission to start the building construction process along with all

the contractors and parties who are involve in the construction with the contracts and agreements in detailed. Addition to this a list of materials and the machineries which are required a detail report along with the cost analysis has been furnished by the procurement team.

- *Specifications:* In order to accomplish the current project the procurement team has furnished a detail specifications of the project of which the major required materials to complete the structure such as cement, steel and brick work are as follows:
  1. *Cement:* The estimated cement consumption for the current project is estimated to be 2052 bags of cement for each floor (50 kgs each bag), 55% of which is consumed in the constructing the structure. The cement used in the building construction was been imported from Turkey by the local exporter; therefore the required cement for the construction was purchased by the local exporter.
  2. *Steel:* In a request to proceed with the building development the steel was acquired from one little steel fabricating office in the Region, Erbil Steel. Since the iron metal in the Region is low in ferric oxide (Fe2O3) content, piece press is best utilized at the office; subsequently, generally, the steel will be sent out from five unique nations. In this manner for the present development process around 5037 kgs of strengthened steel for each floor has been assessed.
  3. *Bricks:* The Aso Brick Factory's standard generation is 590 tons of green (unfired) items every day, or 138,000 standard-measure blocks every day. In this way, according to the prerequisite, the blocks will be transported from the Aso block producing unit, and it has been evaluated that 1881577 blocks are required for each floor.
- *Regulations:* Northern Iraq shares certain authoritative forces recorded in Article 114 of the Constitution (counting yet not restricted to traditions the executives, vitality generation and dissemination, natural, wellbeing and instructive strategy) with the government experts in these zones, yet need is given to the forces of the Kurdish specialists once worked out. Regardless of that, the most imperative government business laws, for example, the Civil Code, the Civil Procedure Law No. 83/1969, the Income Tax Law, the Labor Law, the Companies Law, the Commercial Law, the Commercial Agency Law, the Customs Law, and the Banking Law are connected in the Northern Iraq Region subject to specific adjustments by the Northern Iraq administrative expert. Right now it has been seen a

propensity of the Northern Iraq enactment to sanction separate business laws for the Northern Iraq Region, for example, the Competition Law No. 3/203.

Development contracts in Iraq are administered by Articles 864-890 of the ICC. These arrangements give the structure to the fundamental necessities for the "muqawala" (contract for works). Article 864 characterizes contracts for fills in as contracts in which one of the contracting parties attempts to play out specific works or administrations for thought which the other contracting party embraces to give. A fundamental temporary worker has three foremost commitments emerging from a development contract under Iraqi law:

1. Execution of the work allocated as per the arrangements of the construction contract between the gatherings.
2. Conveyance of the work away at culmination.
3. Risk to ensure the works upon conveyance.

Therefore according to the above mentioned laws and regulations the building project has been successfully eliminated.

- **Processing stage in implementing the project**
  - *Site Preparation:* All together for the magnificent projection of the present venture, the state of the undertaking site included subsurface and surface condition which has been explored and evaluated altogether. Normally in Northern Iraq particularly in the city Erbil locale the favored strategy for development is thrown set up cement. It is intriguing that the basic framework is for the most part conventional steel development. With building stature not being a planning constraint, in regard to amplifying a number of floors this may have calculated into the strategy picked. The site permits restricted nearby stopping and road stopping is accessible for flood stop. The encompassing territory is, for the most part, private and road stopping will give adequate parking spots amid development. Figure 4.15 representing the construction site of the residential building.

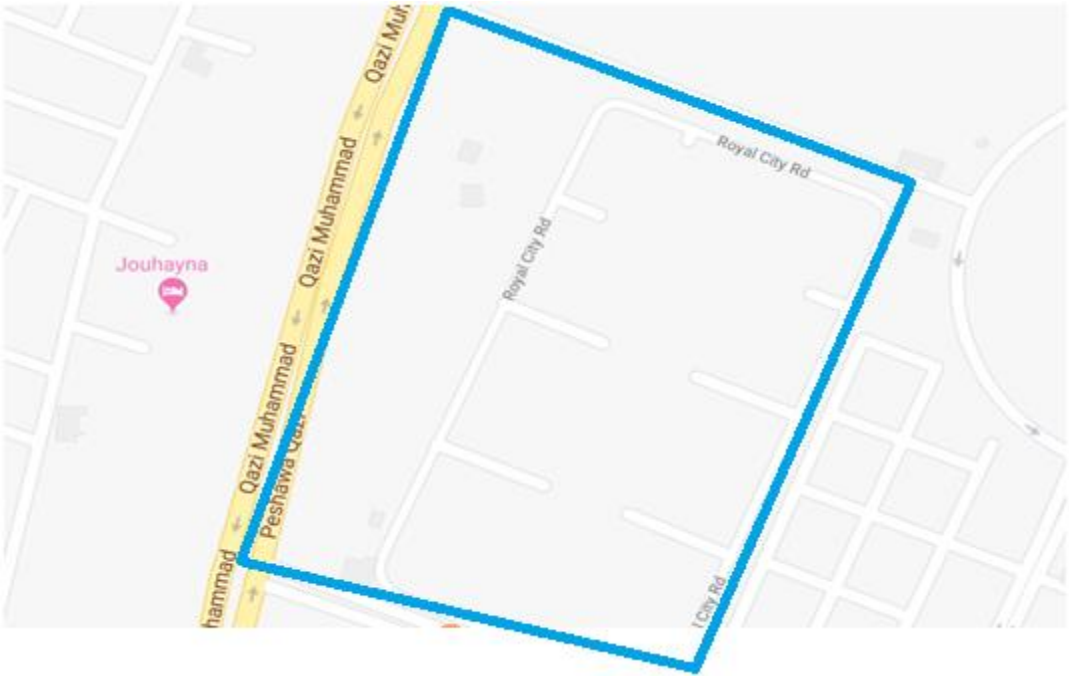


Figure 4.15: Construction site of the residential building company B (Google map)

Site appraisal included deciding the present and establishment of underground administrations indicate reasonable establishment rely upon the proposal of the geotechnical report, envision the dimension of groundwater, reviewing sum required for legitimate waste to push water far from the structure, regardless of whether the site is hard to uncover or not, ice entrance profundity. To manufacture the structure according to the plan, gauge the removal volume precisely, and give appropriate seepage, basic rises and format were been completed with significant exactness.

Figure 4.16: The structure of the residential building of company B (Photo by: Author)

- *Working programme:* The current project was designed by bearing the following rule so that project can be executed:
  1. Dates and durations were allocated to each task which has to be carried out.
  2. A critical path (the sequence of critical tasks upon which the overall duration of the programme is dependent).
  3. Tasks which can only be carried out after other tasks have been completed.
  4. Tasks which can be carried out simultaneously.
  5. The need for specific resources such as plant, services or materials and their lead time.
- *Construction Management:* The first undertaking was organized to be a design build with CM at risk by the customer. Through discussions with included gatherings, the undertaking has transformed into an increasingly customary design conveyance. The first conveyance technique was enabled the task to start improvement preceding consummation of all construction documents. To take into consideration culmination on time and fulfill the needs from the proprietor in the time wanted made a situation that would be best fit by the design build with CM at risk delivery method.
- *Project Schedule Summary:* The aggregate venture is booked to take 526 Days approx. The substructure is anticipated to most recent 162 days, the superstructure will take 262 days and the harsh in and complete course of events is 260 days. The last culmination is relied

upon to be May eighteenth, 2019. Gantt outline summary schedule as shown in Appendix 2.

4.4.3 Example 3: Construction company C

Organization C was established in the 1960s, working in the metropolitan territories of Erbil and Sulaymaniyah. Its profile incorporates townhouses homes, private and business structures. In 2010, the organization was related to one of the main construction organizations in the land development.

As indicated by the planning supervisor of company C, the way toward arranging and control starts when it is reported that another task will be assembled. The due date is the one set amid the possibility think about. With project proprietorship, the work area and typology, a gathering between the planning group and the designing group is made to characterize an arrangement of assault to work. The task is broke down all in all, from the building plan, through the earth moving issues, development succession, stream of exercises, climate conditions in that basic advances are performed, site coordination, work processes and materials, assets, simultaneousness administrations and different confinements that administer the undertaking all in all.

In the following stage, continues the arrangement of plans with the guidance of a computer program based Gantt chart. The evaluated length depends on the experience of the experts associated with the planning procedure. Once the arrangement is done, the benchmark is spared. The end date won't really coordinate the conveyance date set up, and might be delayed, however; there is no flexibility to change the production strategy.

The timetable is refreshed month to month, and the advance of work checked through correlations with the calendar and the financial plan. This progression defines the objectives to be accomplished in the following time frame, through investigation of requirements. Month to month targets is separated into week after week objectives, which are joined by the production group. Be that as it may, the week by week gatherings just discuss consistency with the set targets and objectives for the following time frame. There are not execution estimation frameworks.

The current construction project of the company C being a residential building consists of 13 floors on the land area about 635 square meters, and the construction project was started on November

17th 2017 and the project accomplishment date was set to May 16th 2019, therefore in order to accomplish the present construction project the company starts with the process stage by subsequently dived into two major phases being Designing Stage and Implementing Stage. The following subsections have briefly discussed these two stages in order to know the whole building construction process.

Figure 4.17: Project example for construction company C

4.4.3.1 Designing stage of project

Design process goes through some phases like inputs, process and outputs to complete each task.

- **Inputs:** Basically in order to carry out the building construction project the inputs of the production process of the construction has been initialized were the key factors such as:
  - *Production policy and planning:* are set, in order to carry out this process the designing and consulting team were assigned the tasks related to building production policy, planning and strategies along with the criteria which were required, a team of engineers and architects discuss the production process that how to initiate the geometric state of the building, pick the required materials and roughly cost. The meanings of the extent of work and the relating work periods of the regulation for architects, designing consultants and engineers were mete out.
  - *Product performance value:* Insufficiency happens in detail periodically, for instance, if the comprehension among architects is deficient. Designers add relating particulars to the

building configuration to finish it. The structure should be satisfied adequately, however it has been seen that the work which was relegated to the architects and structural designing consultant and advisory group has been effectively cultivated the assignment given about the material, planning and estimation of the present building development. The prerequisites for the present construction project was been consequently structured.

- *Regulations:* All laws and regulations for the construction of residential building are taken into account according to the law posed by the local government. The design varies in detail depending on project size and type. There were no changes or additions during the further project development; the building design is usually very dedicated and consistent.
- *Building Program:* Construction is a creation of a complex calculated arrangement of individuals, apparatus, instruments, and materials, which can conceivably cause pointless costs, a more extended development period and lower quality amid the usage. In this way, the organization investigated the controls which were presented by the legislature and gave the adolescent business and furthermore to the individuals who claim the development apparatuses so as to meet the necessity and furthermore the building production systems compasses to the conclusive stage.

- **Processing stage:** Once the input of the designing stages was initialized then management has set the process that how the construction work needs to be accomplished was focused, and thus the concerned key factors are subjected in the processing stage as mentioned below.
  - *Function analyzes and synthesis:* The construction procedure is generally viewed as finished in the wake of being completed once, so the site the board winds up capable to design the genuine interest for staff and assets in detail, to react in the present moment to unexpected occasions by unconstrained compensatory measures and to assess the effect of such occasions on contract claims. Additionally, the construction planning was adjusted to each material which is required for the building production independently. Because of the uniqueness of the task, an abnormal state of mechanization would not end up being compelling and gathering and coordination forms are regularly performed principally physically.
  - *Cost analyses:* There is typically a high time and cost weight amid the planning stage and also amid the development time frame. These abatements the ideal opportunity for a top to

bottom plan stage, yet then again, it requires an all arranged construction execution, which conclusive is a contention. Consequently, it was broke down on the present construction project for each individual case, to what degree a gain in productivity can be normal with extra costs amid the arranging stage. Therefore the procurement team was assigned the task to estimate the cost of the materials required, and eventually the teams has successfully determined the cost estimated report.

- *Optimizing:* Experiences from different project managing the production, that a devoted production of assembling forms empowers critical chances if the required information premise can be made and improved, henceforth the assembling arranging can begin with the initial steps of item structure and ought to expect to embrace further subtleties later. The legitimacy of assembling arranging builds as indicated by the dimension of detail of the item structure and prompts a dependable portrayal of the production procedure toward the end by enhancing the material required and by empowering the production and planning stage. Therefore the present residential building project has been optimized the designing and planning stage.

- **Outputs:** When the process phase is finished then it come the outputs
  - *Detailed application project:* Amid the key arranging the present building development process has been depicted generally. The primary proclamations about allotment of assets and process terms were changed at this stage. These announcements have improved with subtleties conveyed by later details and changed over into a correct asset distribution plan. This aided, to diminish the quantity of surprising occurrences essentially. In this manner, the individual procedures are composed as far as utilization of assets and timing. Accordingly, a general smooth building development generation process is in the focal point of enthusiasm rather than the inclinations of the individual gatherings.
  - *Technical and administrative specifications:* In the building development program put an extraordinary interest on the private and business structures for clear and compact determinations. Clear, brief particulars are fundamental in accomplishing quality and effectiveness in each building development. Along these lines, particulars characterize singular duties, estimation, and installment techniques, and give the correspondence between the customer and the contractual worker.

- *Cost Estimation Reports:* Once the work obligations are distinguished, an audit of the estimation and installment techniques are guaranteed that the succession of each gathering activities were recognized and further it has been educated at the season of assertion and the agreements were marked between the customer and the temporary workers that any time of time it will be engaged to meddle with the estimation of the work quality and amount. The premise of installment for the work mirrors the obligation and fulfillment definitions incorporated into the work portrayal. The aggregate undertaking has a financial plan of $12 million and building cost of $8 million. The real building expense per square foot was determined to be $130; the assessments made in my exploration seem, by all accounts, to be high. I feel that the explanation behind this distinction in expense can be advocated. The genuine building cost considers didn't meet the comforts. Along these lines the cost estimation report which were given by the acquirement group was been investigated by the all gatherings who were associated with the present development venture.

4.4.3.2 Implementation stage of the project

After the design stages are finished then the implementation part start through the phases of inputs, process and outputs.

Figure 4.18: Site working of construction company C (Photo by: Author)

- **Inputs:** The outputs of design stage became the inputs of implementation stage which are:
  - *Detail application process:* Once the designing phase has been successfully drawn then a detailed application process as an output of the construction project has been implemented for instance the detailed drawings of the project were submitted to the governmental authorities to get the permission to start the building construction process along with all the contractors and parties who are involve in the construction with the contracts and agreements in detailed. Addition to this a list of materials and the machineries which are required a detail report along with the cost analysis has been furnished by the procurement team.
  - *Specifications:* In order to accomplish the current project the procurement team has furnished a detail specifications of the project of which the major required materials to complete the structure such as cement, steel and brick work are as follows:

1. *Cement:* The estimated cement consumption for the current project is estimated to be 2228 bags of cement for each floor (50 kgs each bag), 58% of which is consumed in the constructing the structure along with the 7997 cft of sand, 1230 cft of aggregate of 10 mm, and 2256 cft of aggregate of 20 mm. The cement used in the building construction was been imported from Turkey by the local exporter; therefore the required cement for the construction was purchased by the local exporter.
2. *Steel:* In order to continue the building construction the steel was purchased from one small steel manufacturing facility in the Region, Erbil Steel. Therefore for the present construction process about 5468 kgs of reinforced steel for each floor has been estimated.

Figure 4.19: Steel working for construction company C (Photo by: Author)

3. *Bricks:* There is new block production line being built up in the Koya zone among Mosul and Erbil; gear and hardware are being introduced. The new industrial facility will create block with the crude materials found adjacent in the Makhmour territory. Thusly according to the necessity the blocks will be transported from this new assembling plant, and it has been assessed that 197121 block are required for each floor.

- *Regulations:* Northern Iraq shares certain administrative forces recorded in Article 114 of the Constitution (counting yet not restricted to traditions the executives, vitality creation

and conveyance, natural, wellbeing and instructive approach) with the government experts in these zones, however need is given to the forces of the Kurdish specialists once worked out. The most vital government business laws, for example, the Civil Code, the Civil Procedure Law No. 83/1969, the Income Tax Law, the Labor Law, the Companies Law, the Commercial Law, the Commercial Agency Law, the Customs Law, and the Banking Law are connected in the Northern Iraq Region subject to specific adjustments by the Northern Iraq administrative expert. As of now, it has been seen an inclination of the Northern Iraq enactment to establish separate business laws for the Northern Iraq Region, for example, the Competition Law No. 3/203.

- Development contracts in Iraq are represented by Articles 864-890 of the ICC. These arrangements give the structure to the primary necessities for the "muqawala" (contract for works). Article 864 characterizes contracts for fills in as contracts in which one of the contracting parties embraces to play out specific works or administrations for thought which the other contracting party attempts to give. A principle temporary worker has three chief commitments emerging from a development contract under Iraqi law:
  1. Execution of the work allocated as per the arrangements of the construction contract between the gatherings.
  2. Conveyance of the work away at culmination.
  3. Risk to ensure the works upon conveyance.

  Therefore according to the above mentioned laws and regulations the building project has been successfully eliminated.

- **Processing stage in Implementing the Project**
  - *Site Preparation:* All together for the astounding projection of the present venture, the state of the undertaking site included subsurface and surface condition which has been researched and evaluated altogether. Commonly in Northern Iraq particularly in the city Erbil locale the favored technique for development is thrown set up cement. It is fascinating that the auxiliary framework is basically conventional steel development. With building stature not being a plan impediment, in regard to expanding number of floors this may have calculated into the strategy picked. The site permits constrained nearby stopping and road stopping is accessible for flood stopping. The encompassing zone is generally private and

road stopping will give adequate parking spots amid development. Figure 4.20 representing the construction site of the residential building.

Figure 4.20: Construction site of the residential building company C (Google map)

Site appraisal included deciding the present and establishment of underground administrations determine appropriate establishment rely upon the proposal of geotechnical report, foresee the dimension of groundwater, reviewing sum required for legitimate waste to push water far from the structure, regardless of whether the site is hard to exhume or not, ice entrance profundity. To manufacture the structure according to the plan, gauge the removal volume precisely, and give reasonable seepage, auxiliary heights and design were been done with significant exactness.

Figure 4.21: The structure of the residential building for company C (Photo by: Author)

- *Working programme:* The current project was designed by bearing the following rule so that project can be executed:
    1. Dates and durations were allocated to each task which has to be carried out.
    2. A critical path (the sequence of critical tasks upon which the overall duration of the programme is dependent).
    3. Tasks which can only be carried out after other tasks have been completed.
    4. Tasks which can be carried out simultaneously.
    5. The need for specific resources such as plant, services or materials and their lead time
- *Construction Management:* The first undertaking was orchestrated to be a design build with CM at risk by the customer. Through discussions with included gatherings, the task has transformed into a progressively conventional design bid build conveyance. The first

conveyance technique has enabled the task to start improvement preceding finishing of all construction documents. To take into consideration finishing on time and fulfill the needs from the proprietor in the time wanted to make a situation that would be best fit by the design build with CM at risk delivery method.

- *Project Schedule Summary:* The aggregate task is booked to take 518 Days approx. The substructure is anticipated to most recent 148 days, the superstructure will take 276 days and the harsh in and complete course of events is 260 days. Last fruition is required to be May sixteenth, 2019. Gantt chart summary schedule as shown in Appendix 3.

4.5 Analysis of Results

Information gathered in each organization was contrasted examined and thought about and the presumptions introduced in the literature review. The researchers outlined in Table 4.2 the outcomes got for every unit of examination in connection to the fundamental affirmations found in the literature review of (Ballard, 1994; Ballard & Howell, 2003; Coelho, 2003; Moura, 2008). Each one of these researchers worked on different theory and chooses criteria to evaluate building production.

- Ballard, (1994) theory for different criteria are:
  - *Production planning:* The primary undertaking in any work is to creation framework structure, which reaches out from worldwide association to the plan of activities; from choices with respect to who is to be engaged with what jobs to choices in regards to how the physical function will be practiced. A few terms are by and by being utilized to allude to this phase of generation. With regards to development, the idea of work organizing has been utilized to allude to generation framework plan.
  - *Cost estimation:* Whether a property proprietor or a contractual worker, it need to have a reasonable and precise figure of how much a building task will cost and to what extent it will take before it start. Each development venture has an interesting arrangement of factors, from the points of interest of the site to the building's plan and how tight the work advertises is for craftsmen at the time and in the place it require them. Belittling and overestimating can both have negative results.

- *Time estimation:* Estimate terms for every action, and decide what number of work days is required. It may need to counsel temporary workers or other venture colleagues for help with this undertaking.
- *Quality:* Design fabricate offer the likelihood for development to understand its item improvement potential. Conventional structure offer form parallels large scale manufacturing's inefficient successive strategy, making it basically difficult to accomplish worldwide enhancement and to stay away from sub improvement. Plan fabricate up to this point has been imagined and rehearsed as an elective obtainment strategy supported by proprietors who wish to move hazard onto the structure construct group.
- *Obstructions:* The expulsion of structures and obstacles incorporates expelling and discarding anything not assigned or allowed to stay on the option to proceed, with the exception of hindrances to be evacuated under other contract things. Migration of a structure includes moving it to another area indicated by the division and rebuilding to unique condition with all associations appropriately made, all as per the agreement and plans.
- *Project Organization:* It recommend that development is basically a planned procedure, however, one in which the offices planned are established set up, and in this way require site gathering. Understanding the structure procedure is imperative for making both stodgy and dynamic development lean, yet is particularly essential for the last mentioned. Unpredictability, vulnerability, and snappiness are initially met in a plan, the organizing and the executives of which can either compound those attributes, when generally considered and executed or can contain and adjust to them through practices, for example, those upheld
- *Construction techniques***:** While item and process configuration can be institutionalized for standard items, for non standard items it is important to institutionalize at the dimension of arranging and control. As it were, it is important to create standard strategies for arranging and dealing with the plan and establishment of one of a kind office.

- Ballard & Howell (2003) theories of criteria are:
  - *Production planning:* In outline, development is basically the structure and get together of articles settled set up, and therefore has, pretty much, the qualities of a site generation, exceptional item, and impermanent groups. Making development lean has no less than two sections:
    a. Claiming from development what really has a place with contemporary item producing and limiting development's characteristics so as to exploit lean methods created in assembling, and
    b. Developing lean procedures sufficient to dynamic development, the rest of opposes the main methodology. A common test for both is coordination of the pro installers who involve the cutting edge, and through whom designing and creation aptitude is best connected.
  - *Obstructions:* The expulsion of structures and impediments incorporates evacuating and discarding anything not assigned or allowed to stay on the option to proceed, with the exception of hindrances to be expelled under other contract things. Movement of a structure includes moving it to another area determined by the division and reclamation to unique condition with all associations legitimately made, all as per the agreement and plans.
  - *Quality:* The architect/constructor firms of the modern division have gone the most distant toward this path. For example, the building part in the U.S. has just barely started to outline creation (plan, get, introduce) forms. The mechanical segment's lead appears to be found on their control of the whole procedure, rather than the extraordinary discontinuity in the building segment. This is currently changing as authorities gather as one to seek after plan construct openings. This social solidarity is an essential for process mapping and streamlining that can expand client esteem and limit squander.

- Coelho(2003) theory for criteria are:
  - *Production planning:* The line of balance (LOB) is an apparatus for venture arranging and control that gives incredible permeability to the streams of work in a building site. The LOB portrays data identified with when, where and what exercises are done whenever and also action clump size, pace, and cushions between various groups. Other than making work processes progressively straightforward to those dealing with a venture, this

instrument can fill in as a way to mimic and talk about various choices and procedures to grouping exercises over the long haul.

- *Quality:* Development adventures are always foreseen that would make an amicability between cost, time and quality. It is possible to have a high bore and insignificant exertion, any way to the burden of time, and afterward again to have a high gauge and a fast endeavor, yet to a detriment. High bore isn't commonly the basic focus for the client; in any case, it is basic to a productive endeavor. An appropriate component of significant worth could be settled in the midst of all times of the improvement adventure. Astoundingly, improvement and approving are two fundamental stages where the errand could influence by its operability, availability, steadfastness, and reasonableness of an office.
- *Obstructions:* Contractors and others responsible for building locales must oversee work with the goal that individuals can move securely around the site. Your site ought to be kept in a spotless and precise condition in order to diminish the shot of damage through slips and excursions. Everybody can make a commitment to lessening slips and treks nearby.

- Moura (2008) theory for different criteria are:
  - *PERT:* To limit the hazard mistake emerging because of utilizing fragmented chronicled information and all the while expanding the adequacy of assessing the span of the venture, most undertaking directors with delight utilize the PERT strategy (Program Evaluation and Review Technique) to appraise the length of individual errands of the task based on three halfway estimations esteems: idealistic, reasonable and skeptical.
  - *CPM:* Undoubtedly, the most imperative foundation for evaluating any task achievement is to accomplish the arranged principle objective inside planned time, under the expected expenses and comparing to built up venture quality parameters.

For the examination two types of keys have been used:

1. Applied (+)
2. Not applied (-)

Table 4.2: Comparing of results with the main criteria of the literature review

Authors	Criteria	Company A	Company B	Company C
Ballard (1994)	Production planning	+	-	+
	Cost estimation	+	-	+
	Time estimation	+	-	+
	Quality	+	-	-
	Obstructions	-	-	-
	Project organization	+	+	+
	Construction techniques	+	+	+
	Cost planning	+	+	+
Ballard & Howell (2003)	Production planning	+	+	+
	Obstructions	-	-	-
	Quality	+	+	+
Coelho (2003)	Production planning	+	+	+
	Quality	+	-	+
	Obstructions	+	+	+
Moura (2008)	PERT	+	+	+
	CPM	-	-	-

4.6 Examination Results of Case Studies

The work have been done in previous chapters, literature review of different theories and using building production system as a tool, three construction companies from Erbil Northern Iraq evaluated in different criteria. The below criteria have been determined from the information gathered from building production system stages which are detailed application project; specifications; cost estimation reports; time estimation; work quality; construction technique (Man power); construction technique (Machine); safety; and site preparation & organization.

Example of construction company A: While construction company A was examined, chosen criteria taken in consideration. Table 4.3 shows the examination in which (+) used as applied and (-) used as not applied:

Building type: Residential building

Number of floors: 23 floors

Start date: December 23rd 2017

Finish date: April 25th 2019

Table 4.3: Examination of construction company A

NO	Criteria	Description	Examination
1.	Detailed application project	Detailed project application was done such to avoid obstruction or any other kind of problems which affects the production system of building.	+
2.	Specification	Specifications were clearly mentioned and were allocated to the concern departments	+
3.	Cost estimation report	Cost estimation report which was designed by the consultants and the procurement team has satisfied the client. And meet the requirements of building construction.	+
4.	Time estimation	Estimated time to finish the construction project, detailed report designed by the management. for instance the super structure from the ground level was flagged before the time interval assigned but some other work did not finished in expected time because of the weather and delay in materials arrival on the construction site.	-
5.	Site preparation & organization	Site preparations and organization of the machineries which were required were on time as scheduled. The organization satisfied the requirement of the construction project.	+
6.	Work quality	The quality parameters were monitored closely and it satisfies the project.	+
7.	Construction technique (Man power)	Labor or the man power required for the construction project, the contractors and the sub contractors were involved in this project and also all the parties who were involved in this project therefore there was no obstructions neither any disputes among the parties.	+
8.	Construction technique (Machine)	The required machineries or the technology required has met the requirement as per the specifications allocated.	+
9.	Safety	Safety measures which are required for the production of building construction ,but it has been observed that many of the worker while working on top floors of the construction site wear not wearing the safety equipment.	-

Example of construction company B: While construction company B was examined, chosen criteria taken in consideration. Table 4.4 shows the examination in which (+) used as applied and (-) used as not applied:

Building type: Residential building

Number of floors: 10 floors

Start date: October 12th 2017

Finish date: May 18th 2019

Table 4.4: Examination of construction company B

NO	Criteria	Description	Examination
1.	Detailed application project	Detailed project application was done to avoid obstruction, but it has been observed that the contractors were not satisfied with the project application as it was not clear enough hence it has resulted obstruction.	-
2.	Specification	Specifications were clearly mentioned and were allocated to the concern departments.	+
3.	Cost estimation report	Cost estimation report which was designed by the consultants was not in expectation of the client and the requirements of building construction, because there was rise in the material cost and resulted cost did not meet as per scheduled.	-
4.	Time estimation	Detailed report designed by the management and the work which was carried out did not meet as per schedule, for instance the super structure from the ground level was flagged few days behind the time interval assigned this is due to the rise in cost of the material such as cement which did not arrive on time, that resulted in the loss of time and did not meet as per scheduled.	-
5.	Site preparation & organization	Site preparations and organization of the material or the machineries which were required were on time as scheduled.	+
6.	Work quality	Quality of work did not satisfy and it has been noticed that the quality of work was bad. This is due to the rise in cost of the material hence the company has compromised on the quality parameters in order to meet the estimated cost.	-
7.	Construction technique (Man power)	The contractors were involved in this project with enthusiasm and also all the parties who were involved in this project therefore there was no obstructions	+
8.	Construction technique (Machine)	The required machineries or the technology required has not met the requirement as per the specifications allocated. This is because there was no crane tower installed till the construction process reached 7th floor, the techniques used did not meet as per scheduled.	-
9.	Safety	Safety measure which were required for the production of building construction but not taken to consideration. It has been noticed that the labor was working without safety helmets and safety belts.	-

Example of construction company C: While construction company C was examined, chosen criteria taken in consideration. Table 4.5 shows the examination in which (+) used as applied and (-) used as not applied:

Building type: Residential building

Number of floors: 13 floors

Start date: November 17th 2017

Finish date: May 16th 2019

Table 4.5: Examination of construction company C

NO	Criteria	Description	Examination
1.	Detailed application project	Detailed project application was done not good enough according to expectation the production system of building it didn't meet the requirement. This is because the application was just as formal way without any specific details mentioned.	-
2.	Specification	Specifications were not clearly mentioned and were not allocated to the concern departments of the constructions. The designs collected by the consultant were not allocate to the construction supervisor and this has resulted in delay	-
3.	Cost estimation report	Cost estimation report which was designed by the consultants and the procurement team has satisfied the client and meet the requirements of building construction.	+
4.	Time estimation	The estimated time to finish the construction project the detailed report designed by the management and the work which was carried out did not meet as per schedule, this is due to change in the structural design.	-
5.	Site preparation & organization	Site preparations and organization of the material or the machineries which were required were on time as scheduled hence the organization satisfied the requirement of the construction project.	+
6.	Work quality	Quality of work did not satisfy because the labors were working without proper construction equipments and regulations	-
7.	Construction technique (Man power)	Construction labor or the man power required for the construction project there was no obstructions.	+
8.	Construction technique (Machine)	Construction technique for the project required machineries and the technology that meet the requirement as per the specifications allocated.	+
9.	Safety	Safety measure such as safety belts or hanging belts were not taken as an important concern.	-

4.7 Conclusion of the Chapter

This chapter has introduced the construction management operations of three different construction companies from the study area of Erbil city located in Northern Iraq, along with geographical and economical information for Northern Iraq; by using observation method and interviewing project managers.

The research survey has shown that all the three companies have a different level of success in construction project this is due to the production strategy, for instance company A has worked on the necessary, key performance indicators, and important aspects such as time estimation, cost estimation also consideration the quality parameters but whereas the other companies did not meet the production strategy criteria which in return had proved there was lose of time and behind the schedule time. Hence this proves that level of success differed from company to another company. As the research proved that all the 3 companies has meet the laws and regulations according to the requirement in order to avoid obstructions, but while it comes to the software tools or the strategies choices by company A has shown the modern technologies along with the construction management criteria were followed but where as other 2 companies did not meet the criteria and were following the traditional methods.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

To build up a total structure or a framework for building production system in construction industry of Northern Iraq ended up with the construction projects that are being executed by the three construction companies from the Erbil city. The thesis introduced, the building production system and the execution project management strategies, are imperative pieces that must be incorporated into a production procedure system. Furthermore, examination has been made on design and implementation stages of building production system to understand stages more in detail and to create a framework to lead any construction project.

5.2 Conclusions

The fundamental logical commitment in this thesis is the proposed order network for production system by governing the literature review and the three construction companies located in the city Erbil of Northern Iraq. The combination framework can be utilized as a base for production methodology thinking in the construction industry. By situating diverse production frameworks in the characterization grid and afterward utilize the characterized execution project management software tools framework relative contrasts between the capacity of various building production systems to convey producing yields can be uncovered. The order system and the characterized Northern Iraq construction industry can be utilized to explain how the plan of a construction system influences in different ways.

Addition to this the production procedure inquire about by concentrating the projects some portion of the building procedure network, exemplified by the construction industry that regularly is let well enough alone for the degree in different examination. Learning about project based production system delivering items at a settled position is helpful in construction companies that normally utilize that kind of production frameworks. This exploration likewise adds to construction industry inquire about, by adjusting the customary production technique hypothesis to a construction industry setting. By applying construction methodology hypotheses on a construction industry

setting circumstances and end results relations concerning the production capacity can be clarified legitimately.

Another point is the characterized KPIs (Key Performance Indicators) for estimating quality, time and cost. KPIs can be utilized to assess distinctive construction frameworks keeping in mind the end goal to perceive how the attributes of the construction framework influence the capacity to convey producing.

The organization network can assist organizations with working with production methodology in an organized and to picture the connection between the market system and the production capacity of the firm. Information gathered in each organization was examined, thought about and by observation the construction companies from the city Erbil presumptions introduced. However, to comprehend this altogether the lattice must be supplemented with a section breaking down the production frameworks relative capacity to convey fabricating yields at aggressive levels. To do this, KPIs for estimating Delivery, Cost, Quality and Flexibility have been characterized. The order network joined with the KPIs can help organizations in their work with the building production system. The connection among item, process qualities and execution can be valuable when outlining another idea for production of multifamily habitations or while enhancing an effectively existing idea. For a production framework to be effective it must be intended to meet the requests from the focused on showcase in a suitable way. The characterized KPIs can likewise be helpful for construction organizations by and large in their work with nonstop enhancements and to catch up execution after some time.

5.3 Recommendations

As showed before the exploration exhibited in this thesis does not consider all the fundamental parts of an entire building production system structure. In this segment the accompanying proposals for additionally investigate are given:

- For the assembling product time, cost and quality the characterized KPIs are clear and approved observationally. For adaptability, the KPIs are more unpredictable. There is a need to explore how to gauge process adaptability facilitate for the structure to be finished.

- Another issue that ought to be explored additionally is the execution assessment part of the system. From a production procedure viewpoint, it is valuable to have the capacity to look at the relative capacity of various production systems to perform in various zones of rivalry. From a scholarly viewpoint, it is to perceive how the situation in the grouping framework influences the capacity of the production framework to perform. It should be possible by either, mapping and estimate construction frameworks and contrast their relative capacity with perform, or to complete an examination of a production framework that move starting with one position in the grid then onto the next. In such a case it is to perceive how the change influences the capacity of the production framework to perform by estimating the capacity to convey fabricating yields when the change has been executed. To have the capacity to do this the KPIs characterized.
- For the building production procedure structure to be finished, other choice classes ought to be examined to perceive how they influence both each other and the capacity of the building production system framework to perform.

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APPENDICES