ST. MARY'S UNIVERSITY

SCHOOL OF GRADUATE STUDIES

PREPROJECT PLANNING AND ITS PRACTICE IN BUILDING CONSTRUCTION PROJECTS: A CASE STUDY OF DEFENCE CONSTRUCTION ENTERPRISE

BY

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JANUARY 2020

ADDIS ABABA ETHIOPIA

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DECLARATION

I, the undersigned, declare that this thesis entitled "**Pre-project Planning and Its Practice in Building Construction Projects: A Case Study of Defence Construction Enterprise**" is my original work, prepared under the guidance of the research advisor. All sources of materials used for the thesis have been duly acknowledged. I further confirm that the thesis has not been submitted either in part or in full to any other higher learning institution to earn any degree.

KAHSAY TEKLE ____________________________

Name Signature

St. Mary's University **January 2020**

Addis Ababa

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LIST OF ABBREVIATIONS AND ACRONYMS

DCE – Defence Construction Enterprise

PDRI – Project Definition Rating Index

CII – Construction Industry Institution

EVA – Earned Value Analysis

BCWS – Budgeted Cost of Work Scheduled

PV – Planned Value

BCWP – Budgeted Cost of Work Performed

EV – Earned Value

ACWP – Actual Cost of Work Performed

AC – Actual Cost

WBS – Work Breakdown Structure

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ABSTRACT

In the contemporary world, preproject planning and practices are becoming very essential since managing projects has emerged to be complex and challenging from time to time. However, enough attention is not given, in Ethiopia to pre-project planning. Hence, this research aims to assess pre-project planning and its practice in building construction projects as a case study of Defence Construction Enterprise. Project Definition Rating Index (PDRI) is used as a tool to analyze the preproject planning and its practice in the building construction industry. The study design is descriptive research which explains well-defined and poorly defined PDRI score and developed a regression model that relates the PDRI score & project performance. Primary data is collected by using questionnaires and secondary data is collected by reviewing contract documents. A sample size of sixty-two (62) was selected following a simple purposive sampling and data was collected using self-administered questionnaires from professionals who directly participated in the construction of eleven building projects. The study revealed that building construction projects did well in defining PDRI scope elements relating to site information & business strategy in their pre-project planning stage which contributes a lot to the successful completion of the projects. On the contrary, the study showed that there was a limitation in identifying, quantifying, specifying and planning accurately different project risks, major engineering equipment, and material items. Besides, the research identified that there was poor constructability analysis in the sampled projects at the preplanning stage. Therefore, the research results provided a valuable source of information that supports better planning in the early stage of the project life cycle has a positive impact on the final project outcome.

Key Words: Preproject planning, PDRI Score, Project Performance

CHAPTER ONE

INTRODUCTION

1.1. BACKGROUND OF THE STUDY

Building construction is very complex, in its nature, since it interacts with a large number of parties such as clients, contractors, consultants, governmental regulators, and other stakeholders. Project performance of building construction is associated with several factors such as time, cost, quality, client satisfaction, productivity, and safety.

Most of our country's projects are completed over budget and take more time than their contractual duration. The inability to define the project scope – to identify the specific task to be performed and the goals that define the project deliverables is one of the main reasons for this project delay and cost overrun.

Some researches have been done to investigate the project planning practices of selected Ethiopian projects. But there is no research on pre-project planning – that from project initiation through project planning or project definition. This project definition will be addressed by using a project definition tool called Project Definition Rating Index (PDRI) developed by Construction Industry Institution (CII) – An American Institution.

Hence, this research investigates the pre-project planning and its practice as a case study in Defence Construction Enterprise.

Defence Construction Enterprise (DCE) is one of the companies that are undertaking different road, irrigation, and building construction projects.

Defence Construction Enterprise was established under the Ministry of Defense in 2010 by the Ethiopian Council of Minister's regulation NO 185/2010 as public enterprise and national defense as supervising authority of the enterprise. Before its establishment as an Enterprise, it was structured as an Engineering Department under the Ministry of National Defense responsible for the construction of Army Hospitals, Depots, Camps, and other infrastructure activities owned by the Ministry of National Defense. After its establishment, the building construction has mainly been undertaking various infrastructural projects to satisfy national defense infrastructural needs for the Armed forces. In parallel, it has also been engaged in infrastructure and building projects that have been undertaken in different parts of the country (DCE, 2020).

As shown in the organization structure, the enterprise has two cores and two support processes. It has twenty plus building construction projects which are operating at Addis Ababa, Debrezeit, Tigray, Afar, Bahirdar and Diredawa. Due to the geographical dispersion of projects, the data collection for the research was limited to Addis Ababa and Debrezeit completed construction projects.

This paper focuses on the preproject planning and its industry practice for building construction projects to have a better practice to meet the project's objectives. Moreover, the relationship between project performance and scope definition levels is also investigated in this research.

1.2. STATEMENT OF THE PROBLEM

Project failures have significant effect from economic, social as well as a political point of view of the nation. If the project scope is poorly defined and takes a longer time, it requires additional resources, and budgets and this increases labor, material, machinery and equipment cost. This, in turn, affects the budget of other projects and in general, it affects the economy of the country and results in dissatisfaction with society at large. Hence, pre-project planning should be given a huge emphasis to use scarce national resources as a nation. In addition to this, DCE – as a contractor, to improve the successes of projects, it has to give enough attention to pre-project planning.

How well pre-project planning is performed also affects the cost and schedule performance, operating characteristics of the facility, as well as the overall financial success of the project. (Gibson G. E., 1994) Although many pieces of research have been conducted on pre-project planning in many countries, across the globe, hardly any has been done in Ethiopia. Hence, due to projects inherent nature and variability in the capacity of nations, there is a need to research to fill these gaps (contextual research gap).

Therefore, this research focuses to evaluate pre-project planning practices at DCE building projects. Thus, the purpose of the study is on the identification of well & poorly defined PDRI scope elements in building projects to improve the successful completion of projects through the survey study of this research and finally contribute to the country's project management body of knowledge in pre-project planning practices.

1.3. RESEARCH QUESTIONS

1.3.1. General Questions

This research aims to find answers to the following general questions.

- What is the preproject planning practice of building construction projects?
- Is there any relation between preproject planning practice and the successful completion of building projects?

1.3.2. Specific Questions

In addition to the above listed general questions, this research also addresses the following specific questions. These are:

1) Which PDRI scope elements (factors) are usually well defined at DCE building projects?
2) Which PDRI scope elements are poorly defined at DCE building projects?
3) Is there any relationship between PDRI score and project cost/schedule performance?
4) What are the recommendations to enhance the successful completion of projects that should be performed in the early phases of a project?

1.4. OBJECTIVES OF THE STUDY

1.4.1. General Objective

To identify the critical PDRI scope elements – pre-project planning practices – that are influencing the performance of the construction of building projects in DCE and to determine the relationship between PDRI score and building project cost & schedule performance, if any.

1.4.2. Specific Objectives

The specific objectives are:

- To identify well-defined PDRI scope elements leading to the successful completion of building projects at DCE,
- To identify poorly-defined PDRI scope elements leading to the less-successful completion of building projects at DCE,
- To analyze the relationship between practicing PDRI score and the successful completion of projects,
- To make recommendations on how to enhance the successful delivery of building projects at the early phases of a project

1.5. SIGNIFICANCE AND SCOPE OF THE STUDY

1.5.1. Significance of the Study

One of the major sub-processes of the preproject planning process is the development of the project scope definition package. Project scope definition is the process by which projects are defined and prepared for execution. It is at this crucial stage where all risks associated with the project are analyzed and a specific project execution approach is defined. Success during the detailed design, construction, and start-up phases of a project is highly dependent on the level of effort expended during this scope definition phase (Gibson G. E., 1994).

A significant feature of the PDRI is that it can be utilized to fit the needs of almost any individual project, small or large. Elements that do not apply to a specific project can be zeroed out, thus eliminating them from the final scoring calculation.

Conducting this research helps DCE and other stakeholders to become aware of PDRI Scope elements that are affecting the successful accomplishment of building projects. Stakeholders such as clients, consultants, sponsors and contractors need to be able to analyze projects pre-project planning activities to make better decision making at the early phase of the project. Moreover, the decision at the early phase of the project helps to identify critical problems or errors and to take remedial measures before the problem propagates.

At the individual level, DCE employees especially cost breakdown analysts, project planners and project managers learn and implement PDRI scope elements that they should give enough attention to have successful building projects and in turn develop successful professional skills that will be involved daily.

1.5.2. Scope of the Study

The study covers eleven building construction projects constructed in Addis Ababa and Debrezeit. The research deals only with the actions & decisions performed at the project definition stage and their effect on project cost & schedule performance.

The study covers DCE's building projects and staff of DCE particularly involved in project planning, cost estimation, head office team leaders, project managers, and project team leaders. The researcher also used different project documents to analyze and evaluate project success. Moreover, questionnaires based on unweighted PDRI are used to collect the required data. Questionnaires were delivered by hand to staff for completion and collected after 5 or 6 working days.

1.6. LIMITATION OF THE STUDY

While performing statistical analysis (Regression analysis), it is important to recognize some limitations that might apply to the sample being tested. In this case, the researcher had some limitations concerning the sample population. The optimal sampling would come from a truly random sample; however, due to the process for collecting the data, the researcher was limited to only those who would volunteer the information and near Addis Ababa (Geographic constraint). Moreover, participants likely chose more successful projects to report, rather than less successful projects.

Additionally, participants were providing data months, and sometimes years after the fact and as such there is room for inaccurate data. Due to these limitations, broad generalization may not be applicable.

1.7. ORGANIZATION OF THE STUDY

This research is organized into five chapters (parts). Chapter one discusses the introduction that includes background, organization business facts, statement of the problem, objective of the study, significance of the study, the scope of the study and limitations of the study.

The second chapter deals with the review of related literature. Chapter three focused on the research methodology, data collection, and procedures, sample, and sampling techniques. Part four presents data analysis & interpretation. Lastly, the summary of findings, conclusions, and recommendations was presented in chapter five.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

The research topic focuses on pre-project planning and its practices in building construction projects: A Case of DCE. This section concentrates on summarising previous investigations, identifying gaps and inconsistencies in the literature and a summary of findings. The literature review covers the following areas: pre-project planning, PDRI for building projects, measurement of cost and schedule performance and summary of the research gap.

2.1. CONSTRUCTION PROJECT DEFINITION

Different regulatory institutions and researchers provide different definitions for the concept of a project. ((Lewis, 2001), p. 5) defines a project as a one-time job that has a definite starting point, definite ending point, clearly defined scope of work, a budget, and is multitasking in nature. ((Wysocki, 2003), p.3) dictates a project as a sequence of unique, complex, and connected activities having one goal or purpose and that must be completed by a specific time, within budget, and according to specification.

On the institutions' side, (PMBOK Guide, 2013) p.3) defines a project as a temporary endeavor undertaken to create a unique product, service, or result.

To summarize from the above definitions a project is nothing but a series of activities and tasks that:

- ✓ Have a specific objective to be completed within certain specifications
- ✓ Have a definite start and end dates
- ✓ Have funding (budget) limits (if applicable)
- ✓ Needs commitment to human resources and consumes nonhuman resources (i.e., money, people, equipment)
- ✓ Are multidiscipline (i.e., often involves different disciplines and professionals).

Project parameters are constraints that are so important to the success or failure of the project. According to (Wysocki, 2003) there are five constraints operate on every project, these are Scope, Quality, Cost, Time and Resources.

Scope

The scope is a statement that defines the boundaries of the project. It defines all the work required, and only the work required, objectively, to complete the project successfully. Analogically, the defining project scope is like drawing a map. In the map, the boundaries are drawn to indicate the stretch/ extent of a given territory; similarly, the project scope outlines the extent of project deliverables.

Quality

(PMBOK Guide, 2013) defines quality as “the degree to which a set of inherent characteristics fulfill requirements. Further quality can be described as product quality and process quality.

Cost

Cost is the amount of resource exerted in the dollar amount or the budget that is required to deliver the project deliverables. It is one of the major parameters that are considered throughout the project management life cycle. The first consideration occurs at the project initiation stage.

Time

Clients specify a timeframe or deadline date within which the project must be delivered. Time is one of the triple constraints (time, cost and scope). To a certain extent, cost and time are inversely related to one another. The time a project takes to be completed can be reduced, but cost increases as a result.

Resources

Resources are assets, such as people, equipment, physical facilities, or inventory, that have limited availabilities, can be scheduled, or can be hired from an outside party. Some are fixed; others are variable only in the long term. In any case, they are central to the scheduling of project activities and the orderly completion of the project.

Researches show that construction projects have characters that differentiate them from other types of projects. According to (AbouRizk, 2010) construction projects differ from other projects in that construction projects have the following features

- ✓ Construction is typically undertaken at a fixed location or site, requiring a closer look at the logistical complexities involved. The building materials and resources required will have to be procured and taken to the site ahead of construction. Where the works are significant in scope, working space, traffic management, security, public health and safety, and the environmental impact of the operations will all have to be given consideration.
- ✓ In modern construction, the introduction of new materials and technologies, methods, and requirements for sustainable or green development, can all contribute toward increasing levels of risk and complexity. Thorough project planning, design, research, and procurement can aid in their reduction of risks and management.
- ✓ The uniqueness of construction projects also means that the external influences and constraints would be different, yet subject to change throughout the project timeline. These can include rates of technological change, sources of financing, market forces, climate change, politics, and changing client requirements.
- ✓ The timelines of construction projects are typically measured in years. Accordingly, clients would typically be required to have prepared and formalized at a very early stage, a design and budget. With some projects, the finer details and points are not fully worked out until after the works have commenced, thereby negatively impacting cost, quality, and timelines for the completion of activities.
- ✓ Finally, the different stakeholders of the project organization might have conflicting commercial business interests and against achieving the aims and objectives of the project. For example, contractors may focus more on profit maximization and less on the other parameters of project success. Clients on the other will seek to have the asset delivered in the shortest time possible, at the lowest cost, with the highest quality. Consultants, based on their contractual arrangements, may seek to also maximize their incomes, by limiting their time on the project. This situation offers a very complex

landscape that has to be navigated and optimized systematically which often is difficult and doesn't work to the best advantage of the project itself.

2.2. PREPROJECT PLANNING

A preproject plan expresses the objectives, processes & requirements of the project in terms of Project Scope, Project Schedule, Resource Requirement, Project cost estimation, Project Quality and Project Risk Management.

A project goes through several different phases, which is often referred to as the project life cycle (PLC). (Archibald, 1976) describes the project life cycle as follows:

> "The project life cycle has an identifiable start and endpoints, which can be associated with a time scale. A project passes through several distinct phases as it matures. The life cycle includes all phases from point of inception to the final termination of the project. The interfaces between phases are rarely clearly separated, except in cases where proposal acceptance of formal authorization to proceed separates the two phases".

Different studies have shown that the success of a project is highly dependent on the efforts exerted on the detailed understanding of all the tasks that are executed from project initiation through the project implementation to project closeout and after project delivery services. The stage from project initiation through project planning is called project definition. Even though different literature describes different PLC stages, the researcher used the following four major PLC stages and process as shown in figure 1 (Westland, 2006).

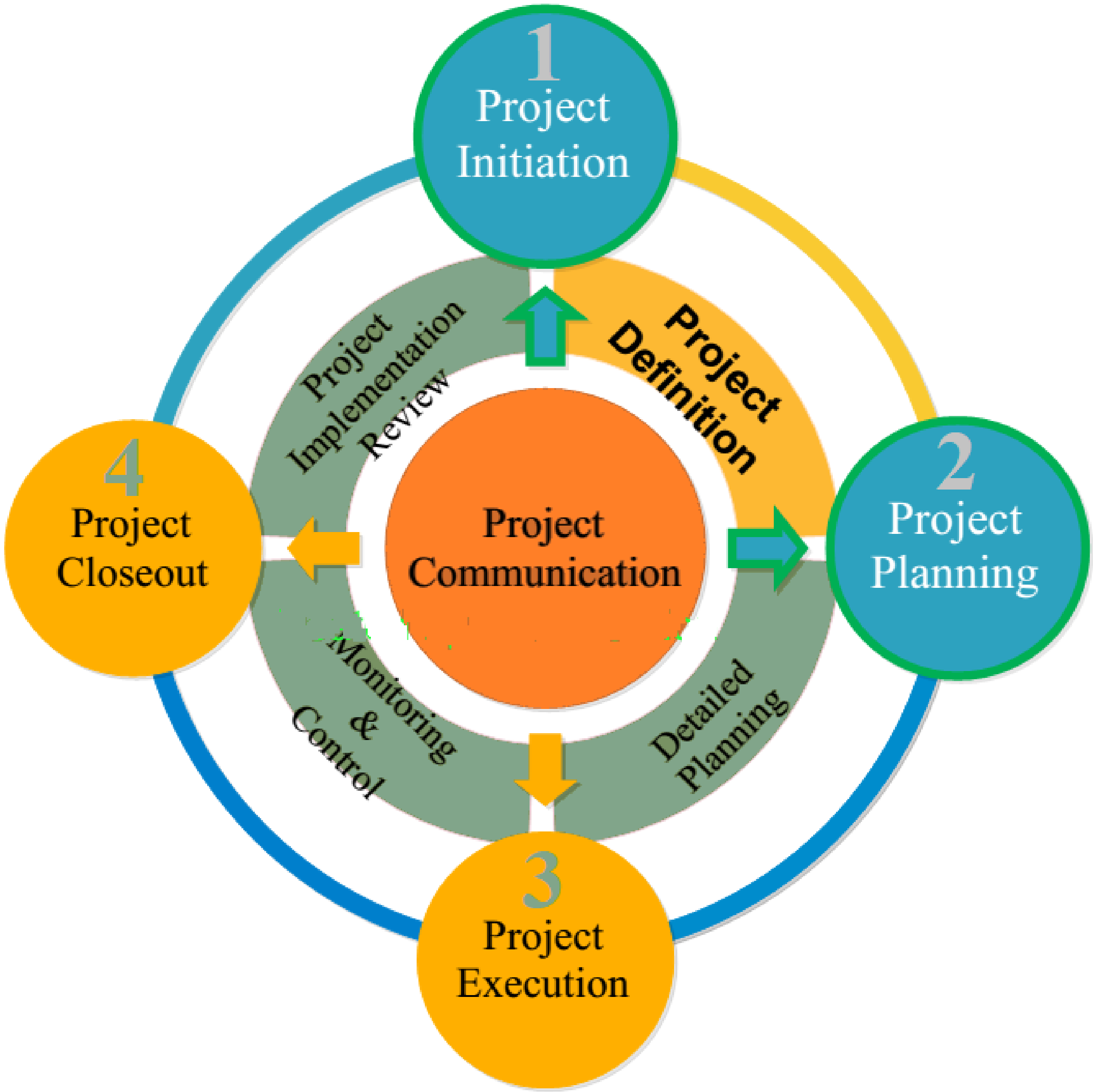

Figure 1: Project Life Cycle and Processes Source: (Westland, 2006)

According (Westland 2006), these projects phases are defined and explained as follows:

1. Project Initiation:

The first phase of a project is called the initiation phase. During this phase, a business problem or opportunity is identified and a business case providing various solution options is defined. Next, a feasibility study is conducted to investigate whether each option addresses the business problem and a final recommended solution is then put forward. Once the recommended solution is approved, a project is initiated to deliver the approved solution. Terms of reference are completed outlining the objectives, scope, and structure of the new project, and a project manager is appointed. The project manager begins recruiting a project team and establishes a project office environment. Approval is then sought to move into the detailed planning phase.

2. Project Planning:

According to (Westland, 2006), once the scope of the project has been defined in terms of reference, the project enters the detailed planning phase. This involves creating a:

- project plan outlining the activities, tasks, dependencies, and timeframes;
- resource plan listing the labor, equipment and materials required;
- a financial plan identifying the labor, equipment and materials costs;
- quality plan providing quality targets, assurance and control measures;
- risk plan highlighting potential risks and actions to be taken to mitigate those risks;
- acceptance plan listing the criteria to be met to gain customer acceptance;
- communications plan to describe the information needed to inform stakeholders;
- procurement plan identifying products to be sourced from external suppliers.

At this point, the project is planned in detail and is ready to be executed.

3. Project Execution:

The third phase involves implementing the detailed plans created during the project planning phase. While each plan is being executed, a series of management processes are undertaken to monitor and control the deliverables that are being delivered by the project. This includes identifying change, risks, and issues, reviewing deliverable quality and measuring each deliverable produced against the acceptance criteria. Once all of the deliverables have been produced and the customer has accepted the final solution, the project is ready for closure.

4. Project closure:

The final phase of the project life cycle is project closure. It involves releasing the final deliverables to the customer, handing over project documentation to the business, terminating supplier contracts, releasing project resources and communicating the closure of the project to all stakeholders.

The last remaining step is to undertake a post-implementation review to quantify the level of project success and identify any lessons learned for future projects to all project stakeholders.

Pre-project planning is the project phase encompassing all the tasks between project initiation to detailed design. The development of a project scope definition package is one of the major tasks in the pre-project planning process. Project scope definition is the process by which projects are defined and prepared for execution. It is at this crucial stage where risks associated with the project are critically analyzed and the specific project execution approach is defined. (Yu-Ren Wang, 2006)

Pre-project planning is "… the process of developing sufficient strategic information with which owners can address risk and decide to commit resources to maximize the chance for a successful project." (Construction Industry Institute (CII), 1995) It is at this early planning stage that significant decisions are made by the project team.

Significant decisions are made by the project team during the early planning phase of capital facility project developments. The process of pre-project planning constitutes a comprehensive framework for detailed project planning and includes scope definition. Project scope definition, the process by which projects are selected, defined and prepared for definition, is one key practice necessary for achieving excellent project performance (Merrow, 1994) and is a key element in the pre-project planning process. How well pre-project planning is performed will affect cost and schedule performance, operating characteristics of the facility, as well as the overall financial success of the project. (Gibson G. E., 1994)

Inadequate or poor scope definition, which negatively correlates to the project performance, is among the most problems affecting a construction project (G.E. Gibson, 1996). The result of a poor scope definition is that the final project costs can be expected to be higher because of the inevitable changes;

- which interrupt project rhythm,
- cause rework,
- increase project time, and
- lower productivity as well as
- the morale of the workforce.

Success during the detailed design, construction, and start-up phases of a project highly depend on the level of effort expended during the scope definition phase as well as the integrity of the project definition package (G.E. Gibson, 1996). Therefore, it is important to investigate the relationship between pre-project planning and project success with real data from the industry. To measure the pre-project planning efforts for each construction project, a scope definition tool, Project Definition Rating Index (PDRI) is incorporated in this research to evaluate the completeness of project scope definition.

2.3. PROJECT DEFINITION RATING INDEX FOR BUILDING PROJECTS

2.1.1. Development

Initial development work on the PDRI for building projects began in June 1997 at the University of Texas using the PDRI for Industrial Projects as a basis. This effort included input and review from approximately 30 industry experts, as well as extensive use of literature sources for terminology and key scope element refinement (O'Reilly, 1997). The 12 members, CII PDRI for Buildings Research Team, constituted in February 1998, refined and streamlined the list of PDRI elements and their descriptions, starting with the draft of 71 elements to the final draft in December 1998.

A complete list of the PDRI's three sections, 11 categories, and 64 elements is shown in Appendix C. The 64 elements in the PDRI for Building Projects are arranged in a score sheet format and supported by 38 pages of detailed descriptions and checklists.

As developed, the PDRI for Building Projects is a user-friendly checklist that identifies and precisely describes each critical element in a project scope definition package to assist project managers in understanding the scope of work. It provides a means for an individual or team to evaluate the status of a building project during pre-project planning with a score corresponding to the project's overall level of definition. The PDRI helps stakeholders of a project quickly analyze the scope definition package and predict factors that may impact project risk specifically about buildings. (Construction Industry Institute (CII), 1999); (Cho C. S., 2000) As illustrated in Figure 2, the PDRI for building projects are designed for use at varying times during the project's lifecycle before detailed design and development of construction documents.

According to (Construction Industry Institute (CII), 1999), this tool applies to multi-story or single-story commercial, institutional, or light industrial, such as Offices, Schools (classrooms), Medical facilities, Research and laboratory facilities, Institutional buildings, Stores/shopping centers, Dormitories, Apartments, Hotels/motels, Parking structures, Warehouses, etc...

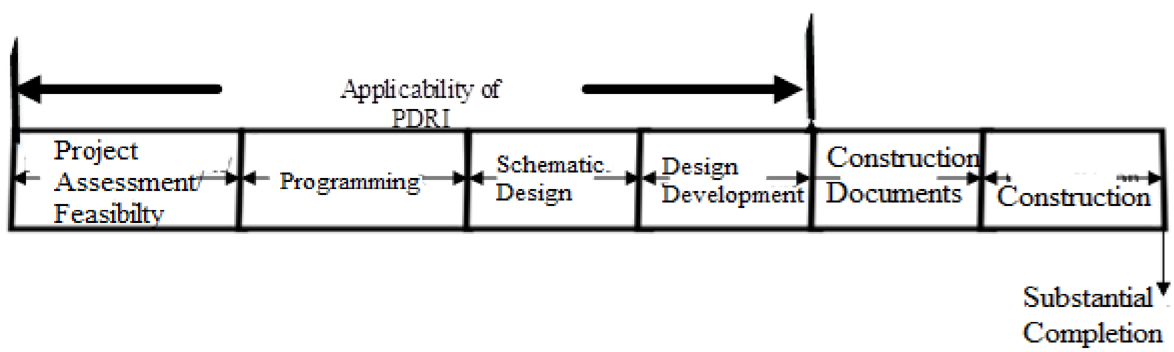

Figure 2: Applicability of PDRI in Project Life Cycle, Typical Building Project

(Source: (Cho C. S., 2001))

2.1.2. PDRI Sections, Categories, and Elements

2.1.2.1. SECTION I. BASIS OF PROJECT DECISION

According to (Construction Industry Institute (CII), 1999), this section consists of information necessary for an understanding of the project objectives. The completeness of this section determines the degree to which the project team will be able to achieve alignment in meeting the project's business objectives. This section includes Business Strategy, Owner Philosophies, and Project Requirement broad categories.

Moreover, these categories include elements such as building use, Business Justification, Business Plan, Economic Analysis, Facility requirement, future expansion/ alteration Considerations, Site Selection Considerations, and Project Objectives Statement.

To explain some of these elements in detail;

- Economic Analysis dictates to develop an economic model that determines the viability of the project. The developed model should include all relevant risks, analyze them and outline its solution fully.
- Reliability Philosophy: is a brief description of the project's intent in terms of reliability. These include a list of the general design principles to be considered to achieve optimal/ideal operating performance from the facility.
- Maintenance Philosophy: describes a list of the general design principles applied to meet the building maintenance requirements. This evaluation includes the life cycle cost analysis of buildings.
- Operating Philosophy: describes a brief list of the general design issues that are considered to support routine operations, for example, operating schedule/hours.
- Design Philosophy: are design requirements such as design life, design life, aesthetic requirements, compatibility with master plan, environmentally sustainable design (internal/external), quality of life that are should be defined at the conceptual stage of the project.

- Value-Analysis Process is a structured value analysis approach that should be in place to consider the design and material alternatives in terms of their cost-effectiveness. These items impact the economic viability of the project and should be given enough attention.

2.1.2.2. SECTION II. BASIS OF DESIGN

According to (NASA Pre-Project Planning Team, 2000) This section consists of space, site, and technical design elements that should be evaluated to fully understand the basis for the design of the project. This section includes Site Information, Building Programming, Building/Project Design Parameters and equipment broad categories.

Moreover, these categories include thirty-three elements. These are Site Layout, Site Surveys, Civil/Geotechnical Information, Governing Regulatory Requirements, Environment Assessment, Utility Sources with Supply Conditions, Site Life Safety Considerations, Special Water and Waste Treatment Requirement, Program Statement, Building Summary Space List, Overall Adjacency Diagrams, Stacking Diagrams, Growth and Phased Development, Circulation and Open Space Requirements, Functional Relationship Diagrams/ Room by Room, Loading/ Unloading/ Storage Facilities Requirements, Transportation Requirements, Building Finishes, Room Data Sheets, Furnishings, Equipment & Built-ins, Window Treatment, Civil/Site Design, Architectural Design, Structural Design, Mechanical Design, Electrical Design, Building Life Safety Requirements, Constructability Analysis, Technological Sophistication, Equipment List, Equipment Location Drawings and Equipment Utility Requirements.

To explain some of these elements in detail;

- Governing Regulatory Requirements: these requirements are the local, state, and federal government permits necessary to construct and operate the facility. A work plan should be in place to prepare, submit, and track permit, regulatory, re-zoning, and code compliance for the project.
- Room Data Sheets: defines the specific requirements for each room considering its functional needs. These requirements include critical dimensions, technical requirements (e.g., fireproof, explosion resistance, X-ray, etc.), furnishing requirements, equipment requirements, audio/visual (A/V) data and communication provisions, lighting

requirements, utility requirements, security needs including access/hours of operation, finish type, environmental issues, acoustics/vibration requirements, and Life-safety.

- Window Treatment: defines any special fenestration window treatments for energy and/or light control that should be noted to have proper use of natural light. Some examples include blocking of natural light, glare-reducing windows, exterior louvers, interior blinds, and others.
- Constructability Analysis: this element asks a question like if there is a structured approach for constructability analysis in place. This would include examining design options and details of construction that minimize construction costs while maintaining standards of safety, quality, and schedule.

Elements of constructability during pre-project planning include constructability program in existence, Construction knowledge/experience used in project planning, early construction involvement in contracting strategy development, developing a construction-sensitive project schedule, considering major construction methods in basic design approaches, developing site layouts for efficient construction, early identification of project team participants for constructability analysis, Usage of advanced information technologies and others.

- Equipment Location Drawings: are drawings that identify the specific locations/arrangements of equipment that are applicable to implement the proper execution of the project.

2.1.2.3. SECTION III. EXECUTION APPROACH

Section three explains the elements that should be evaluated fully to understand the requirements of the client's execution strategy. This section includes Procurement Strategy, Deliverables, Project Control, and Project Execution Plan broad categories.

Moreover, these categories include fourteen elements. These are CADD/Model Requirements, Documentation/Deliverables, Project Quality Assurance and Control, Project Cost Control, Project Schedule Control, Risk Management, Safety Procedures, Project Organization, Owner Approval

Requirements, Project Delivery Method, Design/Construction Plan & Approach and Substantial Completion Requirements.

To explain some of these elements in detail;

- Identify Long Lead/Critical Equipment and Materials: this is the process of identifying engineered equipment and material items with lead times that will impact the design for receipt of vendor information or impact the construction schedule with long delivery times.
- Procurement Procedures and Plans:

Procurement procedures and plans include specific guidelines, special requirements, or methodologies for accomplishing the purchasing, expediting, and delivery of equipment and materials required for the project.

Evaluation criteria include: Identifies who will perform procurement, listing of approved vendors, if applicable, client or contractor purchase orders, reimbursement terms and conditions, guidelines for supplier alliances, single source, and competitive bids, guidelines for engineering/construction contracts, tax strategy, definition of source inspection requirements and responsibilities, definition of traffic/insurance responsibilities, definition of procurement status reporting requirements, additional/special owner accounting requirements, definition of spare parts requirements, local regulations (e.g., tax restrictions, tax advantages, etc.), incentive/penalty strategy for contracts and others.

2.1.3. Advantage of PDRI

The PDRI is quick and easy to use. It is a "best practice" tool that will provide numerous benefits to the building industry (Gibson G. E., 1997). A few of these include:

- ❖ A checklist that a project team can use for determining the necessary steps to follow in defining the project scope
- ❖ A listing of standardized scope definition terminology throughout the building industry
- ❖ An industry standard for rating the completeness of the project scope definition package to facilitate risk assessment and prediction of escalation, the potential for disputes, etc.

- A means to monitor progress at various stages during the front-end planning effort
- A tool that aids in communication and promotes alignment between owners and
- design contractors by highlighting poorly defined areas in a scope definition package
- A means for project team participants to reconcile differences using a common basis for project evaluation
- A training tool for organizations and individuals throughout the industry
- A benchmarking tool for organizations to use in evaluating completion of scope definition versus the performance of past projects, both within their organization and externally, to predict the probability of success on future projects.

2.1.4. Weighted PDRI

The PDRI provides a means for an individual or team to evaluate the status of a construction project during pre-project planning with a score corresponding to the project's overall level of definition. The PDRI helps the stakeholders of a project to quickly analyze the scope definition package and to predict factors that may impact project risk specifically about industrial and building projects. (Cho C. S., 2000)

For illustration purposes, Section I – Category A of the PDRI for Building Projects (both elements and their weights) is shown in Table 1. This is one category of eleven (11) in the PDRI for buildings and encompasses eight of sixty-four (64) scope definition elements. (Cho C. S., 2001)

Table 1 PDRI for Building Projects, Category A

SECTION I - BASIS OF PROJECT DECISION							
CATEGORY Element	Definition Level						Score
	0	1	2	3	4	5	
A. BUSINESS STRATEGY (Maximum=214)							
A1. Building Use	0	1	12	23	33	44	
A2. Business Justification	0	1	8	14	21	27	
A3. Business Plan	0	2	8	14	20	26	
A4. Economic Analysis	0	2	6	11	16	21	
A5. Facility Requirements	0	2	9	16	23	31	
A6. Future Expansion/Alteration Consideration	0	1	7	12	17	22	
A7. Site Selection Considerations	0	1	8	15	21	28	
A8. Project Objective Statement	0	1	4	8	11	15	

Source: (Cho C. S., 2001)

Definition Level

0 = Not Applicable
1 = Complete Definition
2 = Minor Deficiencies
3 = Some Deficiencies
4 = Major Deficiencies
5= Incomplete/Poor Definition

2.2. MEASUREMENT FOR PERFORMANCE OF BUILDING PROJECTS

2.2.1. Earned Value Analysis

One of the schedule and cost performance measurement techniques is the Earned Value Analysis (EVA). According to (Lewis, 2001), the Earned Value Analysis compares the cumulative value of the budgeted cost of work performed (earned) at the originally allocated budget amount, to both the budgeted cost of work scheduled (planned) and to the actual cost of work performed(actual).

Budgeted cost of work scheduled (BCWS) or planned value (PV): Planned value is the budgeted cost for the work scheduled to be completed on an activity or work breakdown structure component up to a given point in time. It shows what is planned for execution.

Budgeted cost of work performed (BCWP) or earned value (EV): Earned value is the budgeted amount for the work completed on the scheduled activity or work breakdown structure component during a given period.

Actual cost for the work performed (ACWP) or actual cost (AC): Actual cost is the total cost incurred in accomplishing work on the scheduled activity or WBS component during a given period. The PV, EV and AC values are used in combination to provide performance.

- Schedule variance (SV) is the deviation from work planned. It is the difference between earned value and planned value. When SV is negative, the project is late.
- Cost variance (CV) is cost deviations from the budget. It is the difference between earned value and planned value. When the CV is negative, the project is faced with a cost overrun.

Time overrun can be defined as the difference between the actual completion time and the estimated completion time and is measured in the number of days as explained by (Choudhury, 2004).

Cost overrun is defined as an excess of actual cost over budget. Cost overrun is also sometimes called "cost escalation," "cost increase," or "budget overrun", (Zhu, 2004).

Cost overrun is defined as the change in contract amount divided by the original contract award amount. This calculation can be converted to a percentage for ease of comparison, (Jackson, 2002).

The relationship between project performance and scope definition levels are investigated in this research. To accomplish this, previous projects were first divided into two groups, successful and less-than-successful projects, based on their performance (cost and schedule growth). Projects with less than zero percent cost/schedule growth were grouped as successful cost/schedule projects whereas other projects were grouped as less-than-successful cost/schedule projects.

The element scope definition level means for these two groups of projects were calculated and compared with each other to see if there is any significant relationship between the scope definition level and project performance. Statistical significance tests (i.e., t-test) were first conducted to identify if there is a statistical difference between the means for these two groups.

For any scope element, if the value of the effect size obtained from the sample project data is greater than 0.8, the difference of definition level averages between the two performance groups is determined significant for that element. (J.S. Milton, 2003)

2.3. SUMMARY OF FINDINGS OF LITERATURE REVIEW

Planning has long been a subject of discussion in the building industry. Many guides have been developed and much knowledge resides with experienced practitioners (Cherry 1999; ASCE 2000). However, early planning in many cases is not performed well in the building industry. Consequently, the building sector suffers from poor or incomplete scope definition, frequently experiencing considerable changes that result in significant cost and schedule overruns (Cho C. S., 2000). Because of these problems, there existed a need for a better method of assisting in defining project scope.

Hence, PDRI tool was developed to analyze the status of a project definition

1. Before clients procure the construction of the project,
2. For contractors before they fill the bid and
3. For project managers, it helps to understand the scope of the project.

Moreover, it helps stakeholders to quickly analyze the tool and identify the risks and their mitigations.

In this regard, the researcher analyzed the PDRI practice in DCE and its relationship with project performance (Schedule and Cost). The conceptual framework for this research is shown in Figure 3.

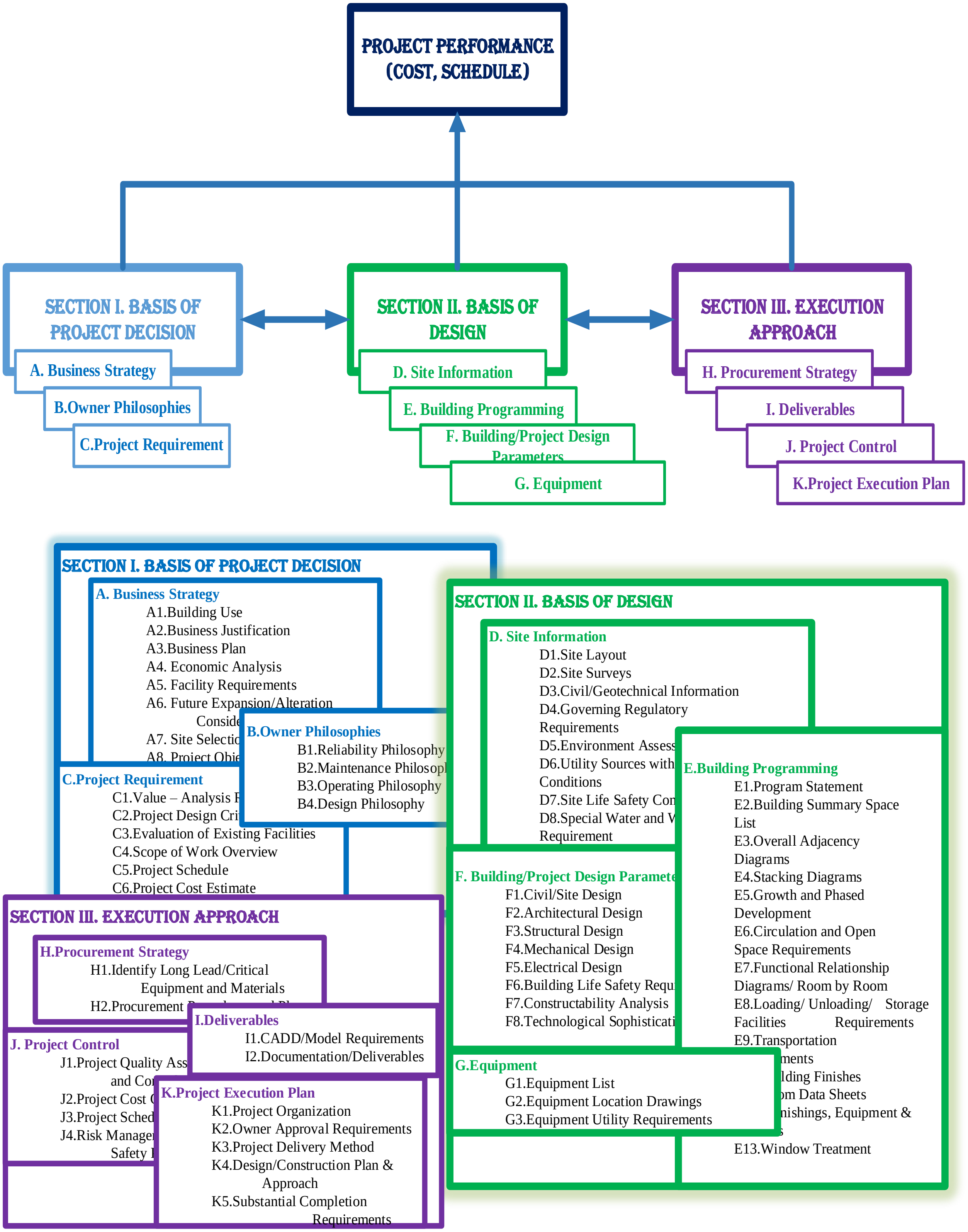

Figure 3 Conceptual Framework *(Source: Researcher 2019)*

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

This chapter describes a review of the various approaches to data collection and analysis adopted in conducting this research; it explains the type of research strategy implemented, the method of data collection and the methodology used in carrying out this research. It includes the research design & approach, sampling design, sources of data source and collection method, method of data analysis, reliability of the instruments and ethical considerations are presented.

3.1. RESEARCH DESIGN AND APPROACH

Any researcher can use diverse strategies in his/her research – and/or more than one design at a time – that means different research designs may be employed both at a time, one or two at a time for a single research program. Therefore, Descriptive design was used to describe the analysis of the collected data and to find relationships between PDRI Score and their influence on project performance.

Creswell and Borrego described three research approaches: such as qualitative, quantitative and mixed methods (Creswell, 2013). Based on the character of the research questions, here, in this study, a mixed approach is used with a larger extent of positivists (quantitative). Within this general positivist framework, elements of the phenomenological (qualitative) approach also have been incorporated to provide alternative insight and to identify the most & least applied PDRI score elements.

Research design is the structuring of investigation aimed at identifying variables and their relationship to one another. This is used to obtain data to enable the researcher to test a hypothesis or answer research questions. It is an outline or scheme that serves as a guide to the researcher in his/her effort to generate data for his/her study.

Thus, the research methodology outlines the approach that was used to collect data from respondents such as questionnaires and document reviews. The data collection method was used as the basis for interpretation and explanation of the study.

Through the questionnaire survey and document reviewing, information related to project basics, pre-project planning practice and project performance are collected. The PDRI score obtained from the survey is a good indicator of the level of pre-project planning for each project. Two project performance aspects are of particular concern for this research: cost and schedule performance. Cost performance and schedule performance are measured by cost and schedule growth/variation. In the survey, respondents were asked to provide estimated costs at the start of construction document development as well as the actual costs after construction completion. Total cost growth measures total project cost growth as a percentage of the initial predicted project cost. Cost performance was measured by project Cost Growth as shown in Eq. (1):

$$Cost\ Growth = \frac{Final\ Cost - Initial\ Estimated\ Cost}{Initial\ Estimated\ Cost} \ldots .\ (1)$$

The total project duration used to calculate project schedule growth was measured from the start date of construction document development to the date of substantial completion in days. The following equation was used for computing project schedule performance as shown in Eq. (2):

$$Schedule\ Growth = \frac{Final\ Schedule - Initial\ Estimated\ Schedule}{Initial\ Estimated\ Schedule} \ldots .\ (2)$$

The single variable regression model is selected for this research to investigate the relationship between the pre-project planning and project performance using PDRI scores and cost/schedule growth.

3.2. SAMPLING DESIGN

The data collection was accomplished through a series of retrospective case studies. The scope definition tool, Project Definition Rating Index (PDRI) is used as a survey instrument in this case study to measure the pre-project planning practices in the industry. Data from 11 building projects, builds that are completed since DCE’s establishment, is collected and used to investigate the early planning practices in the building construction industry.

Furthermore, the survey method covered the questionnaire method and document review of the building projects and triangulated it. The survey method provides standardized answers and allows easy comparison and generalization; and also, researchers control the process and allow increasing the speed of data collection (Creswell, 2013).

This study was conducted using data collected from project managers and team leaders. The two data collection instruments that were used are structured questionnaires, and project documentation.

The questionnaires were self-administered. It helped to explain to the DCE staff the essence of the research and to assure them that it will purely be applied for academic purposes only. Respondents were assured that all information provided by them would be confidential and not used for any other purpose except that which is stated and also assure the respondents of anonymity. The questionnaire was distributed to respondents in a purposive manner (purposive sampling) – those that worked on those completed projects with no discrimination to sex.

3.2.1. Sample and sampling techniques

3.2.1.1. Sampling Population

The population of this study is the building construction projects that are completed. The sampling frame of this study is all project managers & team leader at head office and projects who have a first degree and above and has worked directly in these eleven building projects.

Table 2 Sampling Population

S.N	Positions	Subtotal
1	Project Managers	13
2	Middle managers at Projects	46
3	Middle managers at Head office	14
	Total	73

(Source: Own 2019)

3.2.1.2. Sampling Techniques

Purposive sampling (also known as judgment, selective or subjective sampling) is a non-probabilistic sampling method and it occurs when "elements selected for the sample are chosen by the judgment of the researcher. Researchers often believe that they can obtain a representative sample by using a sound judgment, which will result in saving time and money (Black, 2010)."

The proposed sampling technique for this population is purposive sampling where the respondents were selected based on the criteria of being attendant in the early stages of the project.

3.2.1.3. Sample Size

According to (Bryman, 2004)the decision about the sample size is not a straight forward one as it depends on several considerations: so, there is no definitive answer. (VanVoorhis, 2007) propose rules of thumb for the sample size of linear regressions is 50 to 300 samples which suggested that different statistical procedures require different numbers of sample size. The pragmatic issues are based on (Bryman, 2004)considerations that in most cases, determining sample size is related to time and cost resources.

(Yamane, 1967) suggested a simplified formula for calculation of sample size from a population which is an alternative to Cochran's formula. According to him, for a 95% confidence level and p= 0.5 – where p is the estimated proportion of an attribute that is present in the population – the size of the sample (n) should be

$$n = \frac{N}{1+N(e)^2} \dots (1)$$

where, N is the population size and

e is the level of precision.

Using this formula for a population of N=73, with ±5% precision. Assuming 95% confidence level and p =0.5, we get the sample size as

$$n = \frac{73}{1 + 73(.05)^2} = 61.73 \cong 62$$

Based on the above guidelines, the sample size planned to be used in this research is believed to be sufficient to be treated as parametric.

3.3. SOURCES OF DATA AND DATA COLLECTION

For the analysis, both primary and secondary data were used. Primary data represents data obtained first hand by the researcher on the variable of interest for the specific purpose of study, while secondary data is collected from sources already existing in the concerned organizations or by stakeholders of the project to be studied that is DCE. Data were collected using two methods such as structured questionnaire and secondary data by reviewing major project documents such as contractual letters, Bill of quantity and specification, and drawings.

3.4. DATA ANALYSIS TECHNIQUES

The part of descriptive statistics such as mean is used while analyzing and ranking the different factors that affect the performance of the construction project in positive or negative ways. Moreover, the study uses graphs, tables and other components which are also very important to analyze the collected data.

Furthermore, the relationship between the dependent variable, project cost and schedule performance and the independent variables project definition rating index (PDRI) which includes weighted index for business strategy, owner philosophies, project requirement, site information, building programming, building/project design parameters, equipment, procurement strategy, deliverables, project control, and project execution plan, are expressed as a linear combination of the independent variables plus an error term.

Following (Greene, 2019), the linear regression model is specified as:

$$Y_c\ (X) = \ a_0 + a_1 X + \varepsilon \ldots \ldots \ldots \ldots . . (3)$$

$$Y_s\ (X) = \ b_0 + b_1 X + \varepsilon \ldots \ldots \ldots \ldots . . (4)$$

Where,

Y (c) = Cost performance

X = Project Definition Rating Index (PDRI)

Y (s) = Schedule performance

Where the α's and β's are coefficients of independent variables, X's are column vectors for the independent variables in this case; project definition rating index (PDRI), while ε is a vector of errors of prediction. The error was assumed to be normally distributed with an expected value of zero and a common variance.

To do so, the study uses IBM SPSS 25 which was released in August 2017 by Microsoft Corporation, as the most suitable for descriptive statistics and quantitative analysis.

3.5. RELIABILITY OF THE INSTRUMENTS

Cronbach's alpha is a coefficient (a number between 0 and 1) that is used to rate the internal consistency (homogeneity) or the correlation of the items in a test. A good test is one that assesses different aspects of the trait being studied. Cronbach's alpha will generally increase as the intercorrelations among test items increase and is thus known as an internal consistency estimate of the reliability of test scores. Because intercorrelations among test items are maximized when all items measure the same construct, Cronbach's alpha is widely believed to indirectly indicate the degree to which a set of items measures a single construct (Gleam & Rosemary, 2003).

(George, 2010) provide the following rules of thumb: -

>0 .9	Excellent,	> 0.6	Questionable,
> 0.8	Good,	> .5	Poor, and
> 0.7	Acceptable,	< .5	Unacceptable

If correlations between items are too low, it is likely that they are measuring different traits and therefore should not all be included in a test that is supposed to measure one trait.

For these fields, the values of Cronbach's Alpha analyzed by different researchers were in the range above 0.70 and this range is considered high; the result ensures the reliability of each field of the questionnaire. Moreover, the questionnaire has the option of not applicable to be inclusive of all options.

Thereby, it can be said that the questionnaire is valid, reliable, and ready for distribution for the population sample.

3.6.ETHICAL CONSIDERATIONS

Due consideration was given to obtain consent from each participant about their participation in the study. It was strictly conducted voluntarily. The researcher tried to respect participants' rights and privacy. The findings of the research were presented without any alteration from the outcome of the research.

Also, the researcher gave full acknowledgments to all the reference materials used in the study.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, AND INTERPRETATION

This chapter provides an analysis of data collected from the survey and secondary data sources such as documents. The results are presented in tables and graphs to highlight the major findings. They were also presented in two categories –

I. Factors affecting significantly the performance of the project whether positively or negatively based on the average value of each weighted PDRI index factor.
II. Regression model of the project's cost (budget) and schedule performance to PDRI score.

The raw data was coded, evaluated and tabulated to depict the results of factors influencing the cost and schedule performance of building construction projects in Defence construction enterprise.

4.1. DATA PRESENTATION

4.1.1. **Demography of the Respondents**

Since the general characteristics of the respondents are very important to get insights into the overall study, the researcher starts by seeing the demographic nature of the respondents. It is believed in many existing works of literature that demographic variables like educational level, Job position and experience do have an impact on project cost & schedule performance.

In all, sixty-two (62) questionnaires were administered to the employee of DCE and fifty-five (55) were completed and returned to the researcher. These findings were carefully analyzed and the responses well-presented using statistical tools to give it a pictorial view of PDRI score and its effect on project performance.

Education is principal in enabling the respondents to conceptualize issues related to project cost and schedule performance. It was established from the study that more than 2/3 of the respondents have a bachelor’s degree and the remaining have post-graduate degrees.

Table 3 shows that the majority of respondents working in Defence Construction Enterprise have bachelor's degree qualifications. This implies that they are capable of conceptualizing and responding authoritatively on issues and practices of preproject planning. Thus, the profile of the respondents working in Defence Construction Enterprise is summarized by the following table.

Table 3 Sample Demographics

Variables	Category	Frequency	Percentage
Educational Qualification	Certificate/Diploma	-	0.0%
	Bachelor Degree (BSc. /BA)	39	70.9%
	Master's Degree (MSc. /MA)	16	29.1%
	Doctorate Degree	-	0.0%
Job Position	Project Manager	10	18.2%
	Middle managers	10	18.2%
	Experts	35	63.6%
Work Experience	0-5 Years	12	21.8%
	5-10 Years	32	58.2%
	> 10 years	11	20.0%
Department	Head Office	9	16.4%
	Project	46	83.6%

Source: Survey Data, 2019

Table 3 and figure 4 show the educational background of the respondents in the study area. Accordingly, 70.9% of the respondents are degree holders and 29.1% obtained their second degree.

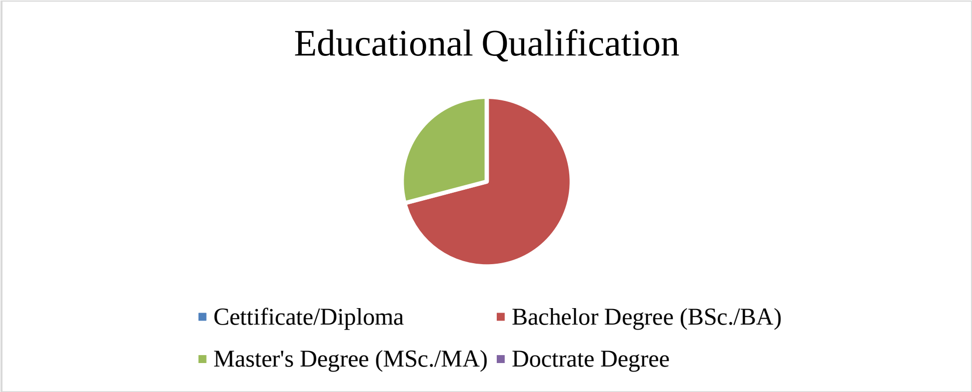

Figure 4 Educational Qualification *(Source: Survey data)*

Besides, as shown in Table 3 and Figure 5, 18.2% of the respondents are project managers, 18.2% middle managers and 63.6% are experts such as office engineers, construction engineers, project planners and project cost analyzers.

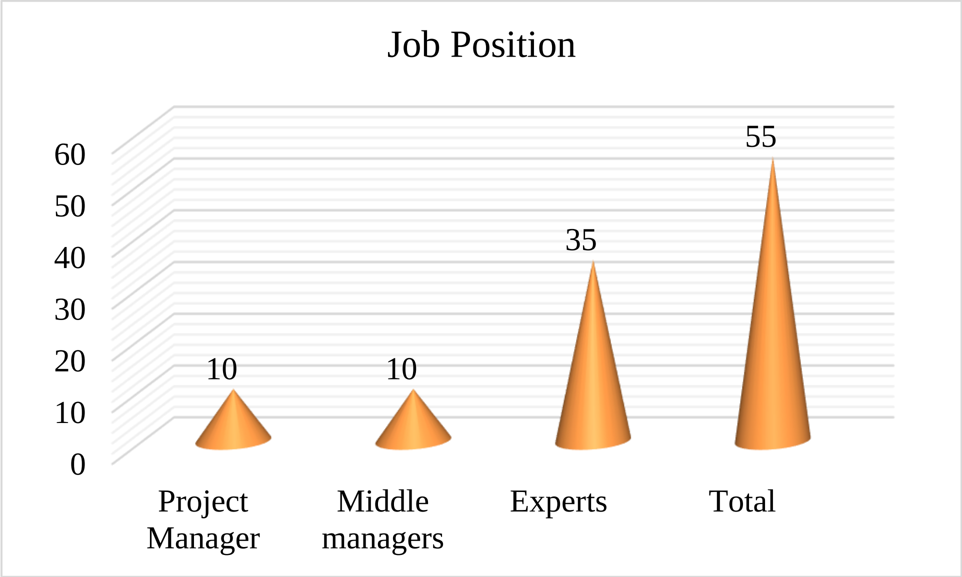

Figure 5 Job Position *(Source: Survey data)*

Moreover, as shown in Table 3 and Figure 6 most of the respondents (80%) have 5 years and above years of experience that implies the respondents have the skills and knowledge to understand reply questionnaire objectively.

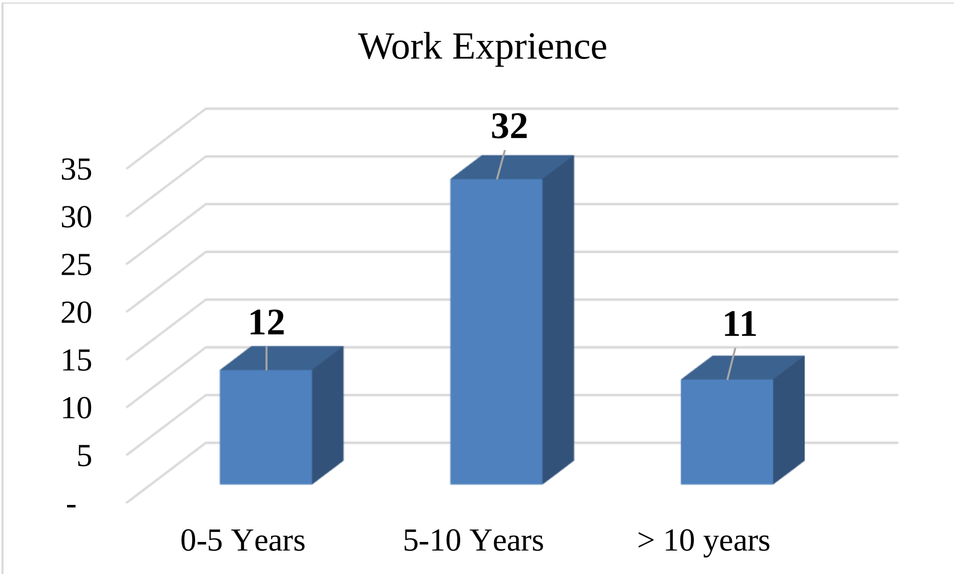

Figure 6 Work Experience *(Source: Survey data, 2019)*

Finally, 83.6% of the respondents were from project sites as shown in Figure 7.

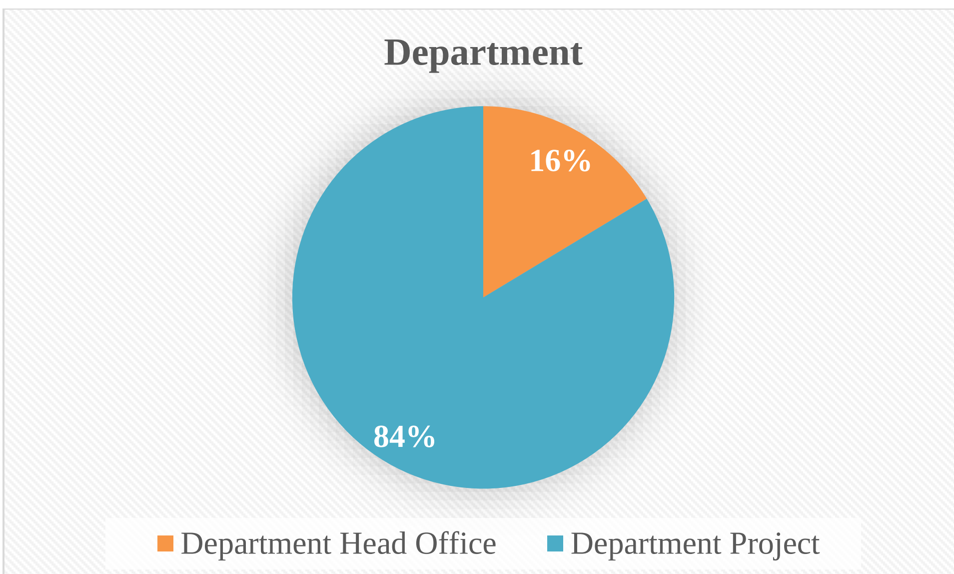

Figure 7 Department *(Source: Survey data, 2019)*

4.2. ANALYSIS AND INTERPRETATION

4.2.1. Descriptive statistics of the Variables

In the PDRI survey questionnaires, specific questions, as shown in appendix A, were intended to obtain historical and "after the fact" project information. The questionnaires included questions regarding project basics (location, type, budget, and schedule), operating information, and scope definition evaluation using a PDRI score sheet.

In the survey, participants were asked to fill out the unweighted PDRI score sheet for their pre-project planning evaluation and they were asked to think back to a point before Construction Document development. Based on the evaluator's perception of how well one scope element has been decided, only one definition level (0, 1, 2, 3, 4, or 5) for that element was chosen.

Definition level

1 stand for complete definition,

2 for minor deficiencies,

3 for some deficiencies,

4 for major deficiencies and

5 for incomplete or poor definition

0 for not applicable.

The data collected from the actual projects represented project scope definition levels and were used for analyzing the characteristics of past early decision-making practices. This investigation focused on the identification of poorly defined and well-defined PDRI scope elements for building projects.

To come up with the scores of the variable, items under each dimension of the result are aggregated to one column as shown in appendix B – Table 9, 10 & 11 – and Figure 8.

Accordingly, all independent variables mean score is between one (mean value for site layout) and 4.4 (mean value for constructability Analysis, Risk management & Identify Long Lead/Critical Equipment and Materials).

Tables 9, 10 and 11 can be summarized and graphed as in figure 8 as a bar chart of mean value versus frequency.

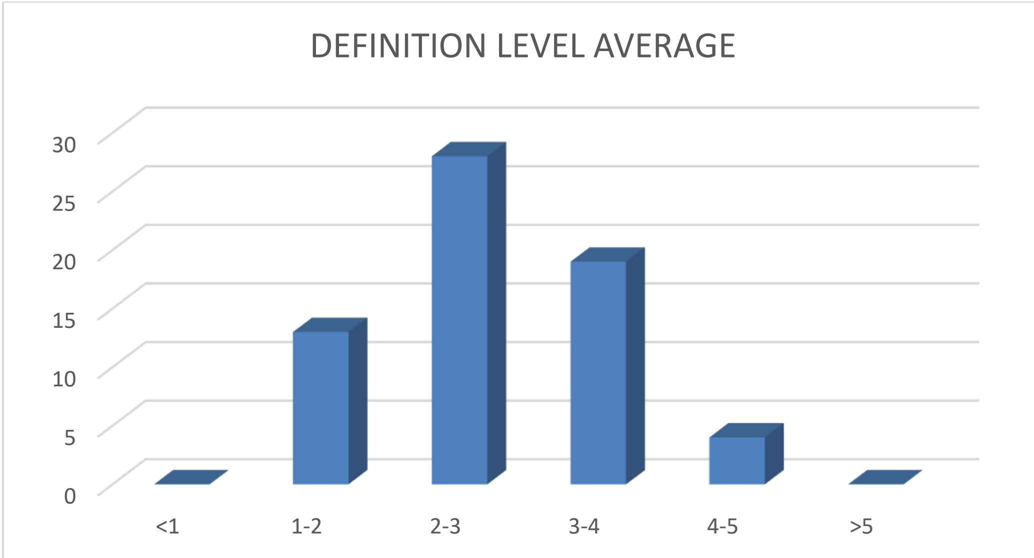

Figure 8 Definition Level Mean Value *(Source: Survey Data, 2019)*

After receiving the survey responses, definition levels were averaged and the total number of projects was counted for each of the 64 elements in the building PDRI. The mean definition levels were calculated for the 64 scope elements as shown in Table 9 – 11 and then compared with each other to determine which elements were well-defined and which were poorly-defined for the sampled projects as per the three sections.

From the result presented in Table 9, using the mean values of the definition levels and 20/80 rule to select the most well-defined and poorly defined PDRI score elements of section I are sorted & presented in Table 4.

The result confirms that the PDRI score elements that describe the sampled project's strategic objective, building functions, the owner's needs, and expectations are relatively clearly defined whereas the project cost, schedule, design and material alternative based on economic models are poorly-defined in the early stage of the project.

Table 4 Result: Section I - Basis of Project Decision (Ranked)

SECTION I - BASIS OF PROJECT DECISION: CATEGORY ELEMENT	DEFINITION LEVEL AVERAGE
A6. Future Expansion/Alteration Consideration	1.4
A1. Building Use	1.7
A2. Business Justification	1.7
A3. Business Plan	1.7
.	.
.	.
.	.
C6. Project Cost Estimate	2.9
C5. Project Schedule	3.2
C1. Value – Analysis Requirement	3.5
A4. Economic Analysis	3.6

(Source: Survey data, 2019)

From the result presented in Table 10, the mean values of the definition levels can be sorted and get the most well-defined and poorly defined PDRI score elements of section II as presented in Table 5.

The result shows that the PDRI score elements that describe the sampled projects site layout, site surveys, government regulatory requirements and all space requirements for the entire project are relatively clearly defined whereas the project Constructability Analysis, Window Treatment, detail description of equipment list & location drawing are poorly-defined in the early stage of the project.

Table 5 Result: Section II - Basis of Design (Ranked)

SECTION II - BASIS OF DESIGN: CATEGORY ELEMENT	DEFINITION LEVEL AVERAGE
D1. Site Layout	1
E3. Overall Adjacency Diagrams	1.5
D2. Site Surveys	1.7
D4. Governing Regulatory Requirements	1.7
E2. Building Summary Space List	1.7
E4. Stacking Diagrams	1.8
.	

.	
.	
E10. Building Finishes	3.7
E11. Room Data Sheets	3.7
F4. Mechanical Design	3.7
G2. Equipment Location Drawings	3.8
E13. Window Treatment	4
F7. Constructability Analysis	4.4

(Source: Survey data, 2019)

Similarly, From the result presented in appendix B, Table 11, the mean values of the definition levels can be sorted and get the most well-defined and poorly defined PDRI score elements of section III as presented in Table 6.

The result shows that the PDRI score elements that describe the sampled projects Quality assurance and quality control procedures, cost and schedule control procedures are relatively clearly defined whereas the project risks identification, quantification, and mitigation management actions and procurement procedures and guidelines of the sampled projects are poorly-defined before the commencement of construction.

Table 6 Result: Section III - Execution Approach (Ranked)

SECTION III - EXECUTION APPROACH: CATEGORY ELEMENT	DEFINITION LEVEL AVERAGE
K2. Owner Approval Requirements	1.7
K3. Project Delivery Method	2.1
K1. Project Organization	2.4
.	.
.	.
.	.
H2. Procurement Procedures and Plans	4
H1. Identify Long Lead/Critical Equipment and Materials	4.4
J4. Risk Management	4.4

(Source: Survey data, 2019)

Next, Table 7 presents a list of 13 scope definition elements with mean definition levels less than 2 the elements which defined relatively well and Table 8 represents a list of 15, using 20/80 rule, scope definition elements greater than 3 (which corresponds to some deficiencies).

Table 7 Result: Well-Defined Building Scope Element (Ranked)

CATEGORY ELEMENT	DEFINITION LEVEL (MEAN)
D1. Site Layout	1.00
A6. Future Expansion/Alteration Consideration	1.36
E3. Overall Adjacency Diagrams	1.46
E2. Building Summary Space List	1.66
A1. Building Use	1.71
A2. Business Justification	1.71
A3. Business Plan	1.71
A5. Facility Requirements	1.71
A8. Project Objective Statement	1.71
D2. Site Surveys	1.71
D4. Governing Regulatory Requirements	1.71
K2. Owner Approval Requirements	1.71
E4. Stacking Diagrams	1.82

(Source: Survey data, 2019)

Table 7 lists scope elements with average definition levels lower than 2.0. Definition level 2 means that the scope definition only has minor deficiencies for this particular scope element. Generally, these surveyed construction projects did well in defining scope elements relating to site information and business strategy in their pre-project planning process.

Table 8 Result: Poor-Defined Building Scope Element (Ranked)

CATEGORY ELEMENT	DEFINITION LEVEL AVERAGE
D3. Civil/Geotechnical Information	3.33
F8. Technological Sophistication	3.33
J1. Project Quality Assurance and Control	3.38
C1. Value – Analysis Requirement	3.53
I2. Documentation/Deliverables	3.53
A4. Economic Analysis	3.63
E10. Building Finishes	3.73
E11. Room Data Sheets	3.73
F4. Mechanical Design	3.73
G2. Equipment Location Drawings	3.83
E13. Window Treatment	3.98
H2. Procurement Procedures and Plans	4.04
F7. Constructability Analysis	4.44
H1. Identify Long Lead/Critical Equipment and Materials	4.44
J4. Risk Management	4.44

(Source: Survey data, 2019)

The list above identified the poor scope definition practice from the surveyed building projects. The worst-defined scope elements are

- Element J4, Risk Management: in these building projects, major project risks were not properly identified, quantified, and management actions are taken to mitigate problems developed. Relevant elements may include design risks, construction risks, and management risks.
- Element H1, Identify Long Lead/Critical Equipment and Materials: in these building projects, major engineering equipment, and material items with lead times that impact the design for receipt of vendor information or impact the construction schedule with long delivery times were not properly planned.

- Element F17, Constructability Analysis:

CII defines constructability as, "the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives. Maximum benefits occur when people with construction knowledge and experience become involved at the very beginning of a project."

In these sampled projects, extensive design options and details of construction that minimize construction costs while maintaining standards of safety, quality, and schedule were not managed in the preplanning project stage.

- Element H2, Procurement Procedures, and Plans:

In these sampled projects, procurement procedures and plans such as specific guidelines, special requirements, or methodologies for accomplishing the purchasing, expediting, and delivery of equipment and materials required for the project were not performed in the preplanning stage.

The results of well-defined scope elements relating to site information and business strategy resemble the results of pre-project planning and its practice in industry (Yu-Ren Wang, 2006) on the contrary, the findings of this research – identify long lead/critical equipment and materials, constructability analysis and risk management – is different from the findings of above-mentioned paper – program statement project objective statement and scope of work overview more than others.

4.2.2. **Regression Analysis**

Regression analysis is used to predict one variable from another by using an estimated line that summarizes the relationship between two or more variables. When data is obtained and compiled into data sets, the information can be graphed using a scatterplot. The independent variable or X is the data that is assumed to predict behavior in the independent variable Y. Using the data sets obtained, a researcher can graph the data that is independent along the X-axis and the corresponding dependent data on the Y-axis.

The coefficient of determination, R^2, is a statistic that is widely used to determine how well a regression fits the data. R^2 represents the fraction of variability in the dependent variable, y, that can be explained by the variability in the independent variable, x. In other words, R^2 explains how much of the variability in the dependent variable can be explained by the fact that they are related to the independent variable. Eq. (4.1) shows how the coefficient of determination, R^2, is calculated (George, 2010).

$$R^2 = \frac{S_{yy} - SSE}{S_{yy}} \ where \ S_{yy} = \sum(y_i - \bar{y})^2, \ \ SSE = \sum(y_i - b_0 - b_1 x_i)^2 \ldots\ldots \text{ Eq. (4.1)}$$

Using the PDRI score as the independent variable and cost/ schedule growth for each project as the dependent variable, a simple linear regression analysis can be performed to examine the relationship between the independent variable (PDRI score) and the dependent variable (cost/schedule growth). First, a scatter plot of the PDRI score and Cost Growth is constructed and the best fit line is then calculated and plotted on the scatter plot. For this research analysis, the linear regression analysis is performed using SPSS 25.0. For these projects, the ANOVA results show that Significant F equals 0.03, which is less than 0.05 and indicates that the linear relationship is statistically significant. That is, there is a linear relationship between the PDRI score and Cost Growth for the surveyed building projects. To examine how the obtained linear regression equation represents the data, two sets of parameters, R and R^2 are calculated.

Firstly, the linear correlation coefficient, R, measures the strength and the direction of a linear relationship between two variables. The value of R ranges between −1 and +1. An R-value close to +1 indicates that two variables have a strong positive linear correlation. The obtained R-value for this particular model is 0.854 and 0.841 for schedule and cost growth respectively, which indicate a relationship that as values for PDRI scores increase, the values for cost & schedule growth increase as well.

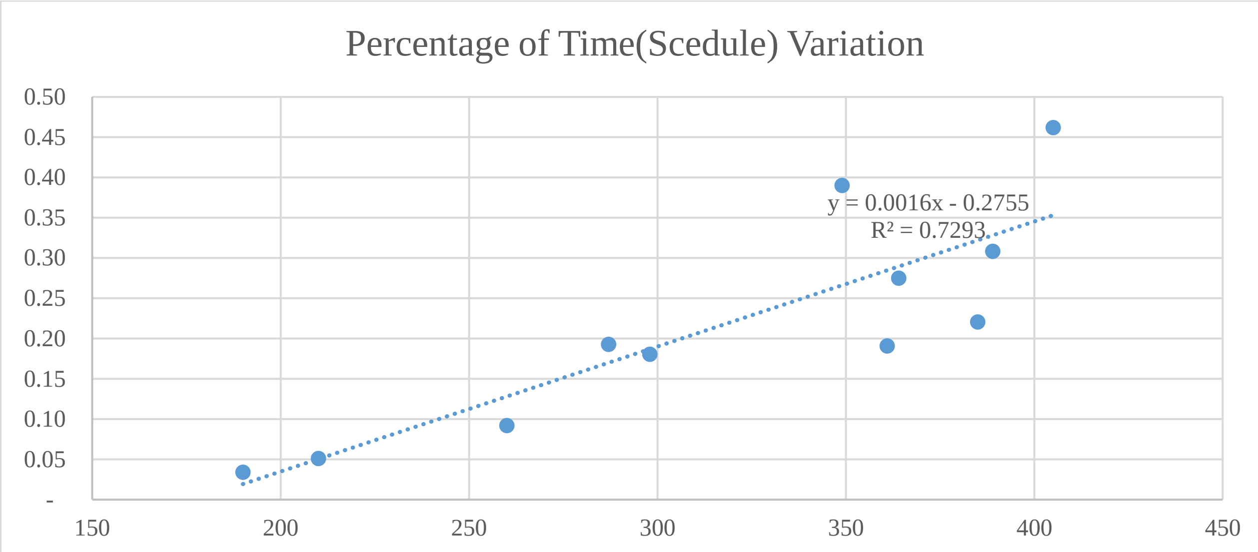

Figure 9 Schedule Performance vs. PDRI Score *(Source: Survey data 2019)*

Secondly, the coefficient of determination, R^2, records the proportion of variation in the dependent variable (cost and schedule growth) explained or accounted for by variation in the independent variable (PDRI score). For this particular model, the obtained R^2 equals 0.73 and 0.71 which indicates that 73% and 71 % of the variation in project schedule and cost growth, respectively, can be explained by the variation in PDRI scores. Fig. 4.4 – schedule growth – and Fig. 4.5 – cost growth – shows the schedule variation scatter plot and regression results for the sampled building projects.

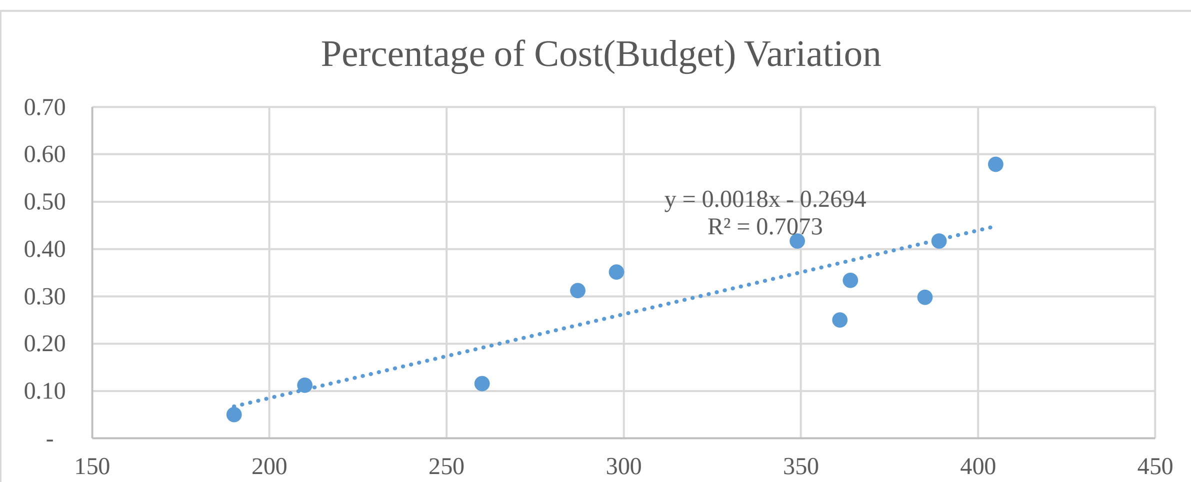

Figure 10 Cost Performance vs. PDRI Score *(Source: Survey data 2019)*

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter discusses the main findings and interpretations given in chapter four. A lot of findings emerged from the study following the presentation and analysis of data. Therefore, a summary of findings, conclusions, and recommendations is based on the objectives of this study as well as the recommendations of the researcher.

5.1. SUMMARY OF FINDINGS

The study was based on the project definition rating index rating developed by CII affecting building construction projects cost as well as schedule performance in Defence Construction Enterprise. It investigated the practices of preproject planning & whether pre-project decision making influences building project cost and schedule performance using the PDRI score. Based on the objectives of the research stated, the following summaries were made about the findings:

- These surveyed projects showed the preproject planning practice has some deficiencies in defining the PDRI elements.
- These surveyed construction projects did well in defining scope elements relating to site information and business strategy in their pre-project planning process which contributes a lot to the successful completion of the projects.
- On the contrary, major project risks such as design risks, construction risks, and management risks were not properly identified, quantified, and preventive and mitigative actions were not planned and taken to ease problems in the pre-construction stage.
- The other poorly-defined PDRI score – with a mean value of 4.4 – was the inability to identify, quantify, specify and plan accurately major engineering equipment and material items that need long lead time or materials and equipment in the critical paths that impact the design for receipt of vendor information or impact the construction schedule with long delivery times were not properly planned.
- The third poorly-defined PDRI score, with a mean value of 4.4, the element was constructability analysis – extensive design options and details of construction methodology that minimize construction costs and facilitates the completion time of the

projects while maintaining standards of safety and quality were not well managed in the preplanning project stage.

- The next poorly-defined PDRI score – with a mean value of slightly greater than 4 – was project-specific procurement procedures and plans such as specific guidelines, special requirements, or methodologies for accomplishing the purchasing, expediting, and delivery of equipment and materials required for the project were not performed in the preplanning stage.

5.2. CONCLUSIONS

This research studies the pre-project planning of building construction projects and investigates its relationship with project success (measured by cost and schedule growth). Questionnaire surveys are used to obtain information related to the status of pre-project planning and project performance.

Based on the collected data, this research first identified the well and poorly defined PDRI score elements and then developed correlation and regression models to predict the project performance (Cost and Schedule Growth individually) using the PDRI score. Data collected from a total of 11 building projects are used for the regression model development.

These models show a positive relationship between PDRI score and cost/schedule growth for this particular sample of projects. The results indicate that projects with better pre-project planning are more likely to have better project performance at completion. However, it should be noted that these projects are not randomly selected and models are expected to be more representative with more project data input (from different time, region and with a larger number of projects).

5.3. RECOMMENDATIONS

This paper presents a practical approach for the industry to monitor its pre-project planning practice and link it with project performance. Based on the research findings, the following recommendations should be put into practice by the Enterprise for better construction project performance.

- Project stakeholders – DCE, consultants, and clients – are advised to score the projects using PDRI scores to improve the successful implementation of building projects in the pre-project stage of the project since preproject planning has a positive relationship with project success.

- From these findings, project stakeholders are advised to give enough attention to risk management, constructability analysis, and project procurement practices to minimize the cost and time overrun of building projects.
- Project managers and other related professionals should evaluate the PDRI score & predict the project performance & correct the poorly defined elements ahead of the commencement of the project.

Finally, it is recommended that the industry practitioners can apply the presented models as the first step in the modeling process of unknown relationship. Using the same set of original data one can apply more flexible models with two or more descriptive variables using the same software. The results can be used to improve their pre-project planning process and the chance to achieve project success.

5.3.1. Directions for Further Researches

This study investigated pre-project planning in building construction projects in DCE. From the study it is clear that there is much scope for further research in the following areas:

- The study is concentrated on projects that reside in and around Addis Ababa. Hence, the impact of geographical variation on pre-project planning needs further study.
- The investigation is a case study on DCE building projects and mostly the clients are governments. To have a good building construction industry, this study should be repeated in different contractors, governmental and private contractors, and private clients.
- The researcher used regression analysis to analyze the relationship between PDRI Score and Cost and schedule performance. So, other analyzing methods such as Artificial Neural Network might be applied.

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APPENDIX A

SAINT MARRY UNIVERSITY

PROJECT MANAGEMENT GRADUATE PROGRAM

QUESTIONNAIRE FOR SURVEY

TITLE: "Pre-project planning & its practice in building construction projects: A case study of Defence Construction Enterprise"

Dear Respondent,

The purpose of this questionnaire is to collect information for the study that assesses Pre-project planning & its practice in construction projects by taking Defence Construction Enterprise as a case study. The study is a requirement for achieving a master's degree. Your response to each question is indispensable for the effectiveness of this study. The student researcher would like to assure you that your response to the questionnaire would be kept confidential and it has no intention except for academic purposes. Please don't write your name or any personal identifier on the questionnaire. For any clarification needed, please contact me on the below telephone number.

Thank you in advance.

Sincerely Yours

Thank you for your assistance

Kahsay.T Mobile: +251-911-663-570

Instructions: Please refer/consider/ the projects in Defence Construction Enterprise that you are participated in and answer the following question. For each of the questions, please tick[x] in the provided space the most suitable answer using the given scale. Please also answer all the questions to enhance the objectivity of the research.

PART I: PERSONAL DETAILS OF THE RESPONDENT

Q.1) Sex: Male ☐ Female ☐

Q.2) Age: 20-30 ☐ 31-40 ☐ 41-50 ☐ Above ☐

Q.3) What is your level of educational?

1st Degree ☐ Master's Degree ☐

Other (Specify)_____________

Q.4) How long have you been working with the organization?

<=5 years ☐ 6-10 years ☐ >= 10 years ☐

Q.5) What is your position? _____________________________

SECTION I - BASIS OF PROJECT DECISION							
CATEGORY ELEMENT		DEFINITION LEVEL					
		0	1	2	3	4	5
A. BUSINESS STRATEGY							
	A1. Building Use						
	A2. Business Justification						
	A3. Business Plan						
	A4. Economic Analysis						
	A5. Facility Requirements						
	A6. Future Expansion/Alteration Consideration						
	A7. Site Selection Considerations						
	A8. Project Objective Statement						
B. OWNER PHILOSOPHIES							
	B1. Reliability Philosophy						
	B2. Maintenance Philosophy						
	B3. Operating Philosophy						
	B4. Design Philosophy						
C. PROJECT REQUIREMENT							
	C1. Value – Analysis Requirement						
	C2. Project Design Criteria						
	C3. Evaluation of Existing Facilities						
	C4. Scope of Work Overview						
	C5. Project Schedule						
	C6. Project Cost Estimate						
SECTION II - BASIS OF DESIGN							
D. SITE INFORMATION							
	D1. Site Layout						
	D2. Site Surveys						
	D3. Civil/Geotechnical Information						
	D4. Governing Regulatory Requirements						

	D5. Environment Assessment						
	D6. Utility Sources with Supply Conditions						
	D7. Site Life Safety Considerations						
	D8. Special Water and Waste Treatment Requirement						
E. BUILDING PROGRAMMING							
	E1. Program Statement						
	E2. Building Summary Space List						
	E3. Overall Adjacency Diagrams						
	E4. Stacking Diagrams						
	E5. Growth and Phased Development						
	E6. Circulation and Open Space Requirements						
	E7. Functional Relationship Diagrams/ Room by Room						
	E8. Loading/ Unloading/ Storage Facilities Requirements						
	E9. Transportation Requirements						
	E10. Building Finishes						
	E11. Room Data Sheets						
	E12. Furnishings, Equipment & Built-ins						
	E13. Window Treatment						
F. BUILDING/PROJECT DESIGN PARAMETERS							
	F1. Civil/Site Design						
	F2. Architectural Design						
	F3. Structural Design						
	F4. Mechanical Design						
	F5. Electrical Design						
	F6. Building Life Safety Requirements						
	F7. Constructability Analysis						
	F8. Technological Sophistication						
G. EQUIPMENT							
	G1. Equipment List						
	G2. Equipment Location Drawings						

	G3. Equipment Utility Requirements						
SECTION III - EXECUTION APPROACH							
H. PROCUREMENT STRATEGY							
	H1. Identify Long Lead/Critical Equipment and Materials						
	H2. Procurement Procedures and Plans						
I. DELIVERABLES							
	I1. CADD/Model Requirements						
	I2. Documentation/Deliverables						
J. PROJECT CONTROL							
	J1. Project Quality Assurance and Control						
	J2. Project Cost Control						
	J3. Project Schedule Control						
	J4. Risk Management						
	J5. Safety Procedures						
K. PROJECT EXECUTION PLAN							
	K1. Project Organization						
	K2. Owner Approval Requirements						
	K3. Project Delivery Method						
	K4. Design/Construction Plan & Approach						
	K5. Substantial Completion Requirements						

APPENDIX B

TABLES OF SUMMARY OF RESULTS

Table 9 Summary of the Result of the Questionnaire for Section I

Section I - Basis of Project Decision (Result)

CATEGORY ELEMENT	DEFINITION LEVEL AVERAGE
A. BUSINESS STRATEGY	
A1. Building Use	1.7
A2. Business Justification	1.7
A3. Business Plan	1.7
A4. Economic Analysis	3.6
A5. Facility Requirements	1.7
A6. Future Expansion/Alteration Consideration	1.4
A7. Site Selection Considerations	2.1
A8. Project Objective Statement	1.7
B. OWNER PHILOSOPHIES	
B1. Reliability Philosophy	2.7
B2. Maintenance Philosophy	2.7
B3. Operating Philosophy	2.1
B4. Design Philosophy	2.4
C. PROJECT REQUIREMENT	
C1. Value – Analysis Requirement	3.5
C2. Project Design Criteria	2.7
C3. Evaluation of Existing Facilities	2.4
C4. Scope of Work Overview	2.6
C5. Project Schedule	3.2
C6. Project Cost Estimate	2.9

(Source: Survey data 2019)

Table 10 Summary of the Result of the Questionnaire for Section II

Section II - Basis of Design (Result)

CATEGORY ELEMENT	DEFINITION LEVEL AVERAGE
D. SITE INFORMATION	
D1. Site Layout	1
D2. Site Surveys	1.7
D3. Civil/Geotechnical Information	3.3
D4. Governing Regulatory Requirements	1.7
D5. Environment Assessment	3
D6. Utility Sources with Supply Conditions	2.7
D7. Site Life Safety Considerations	2.1
D8. Special Water and Waste Treatment Requirement	2.9
E. BUILDING PROGRAMMING	
E1. Program Statement	2.1
E2. Building Summary Space List	1.7
E3. Overall Adjacency Diagrams	1.5
E4. Stacking Diagrams	1.8
E5. Growth and Phased Development	2.4
E6. Circulation and Open Space Requirements	2.4
E7. Functional Relationship Diagrams/ Room by Room	2.1
E8. Loading/ Unloading/ Storage Facilities Requirements	2.6
E9. Transportation Requirements	2.4
E10. Building Finishes	3.7
E11. Room Data Sheets	3.7
E12. Furnishings, Equipment & Built-ins	3.2
E13. Window Treatment	4
F. BUILDING/PROJECT DESIGN PARAMETERS	
F1. Civil/Site Design	2.7
F2. Architectural Design	2.1
F3. Structural Design	2.7
F4. Mechanical Design	3.7
F5. Electrical Design	3.1

F6. Building Life Safety Requirements	2.4
F7. Constructability Analysis	4.4
F8. Technological Sophistication	3.3

G. EQUIPMENT (Maximum=36)	
G1. Equipment List	2.6
G2. Equipment Location Drawings	3.8
G3. Equipment Utility Requirements	2.1

(Source: Survey data 2019)

Table 11 Summary of the Result of the Questionnaire for Section III

SECTION III - EXECUTION APPROACH (Result)

H. PROCUREMENT STRATEGY	
H1. Identify Long Lead/Critical Equipment and Materials	4.4
H2. Procurement Procedures and Plans	4

I. DELIVERABLES	
I1. CADD/Model Requirements	2.9
I2. Documentation/Deliverables	3.5

J. PROJECT CONTROL(Maximum=62)	
J1. Project Quality Assurance and Control	3.4
J2. Project Cost Control	3
J3. Project Schedule Control	3
J4. Risk Management	4.4
J5. Safety Procedures	3.2

K. PROJECT EXECUTION PLAN	
K1. Project Organization	2.4
K2. Owner Approval Requirements	1.7
K3. Project Delivery Method	2.1
K4. Design/Construction Plan & Approach	3.1
K5. Substantial Completion Requirements	2.4

(Source: Survey data 2019)

APPENDIX C

WEIGHTED PDRI

Weighted PDRI (Source: (Construction Industry Institute (CII), 1999))

SECTION I - BASIS OF PROJECT DECISION						
CATEGORY ELEMENT	DEFINITION LEVEL					
	0	1	2	3	4	5
A. BUSINESS STRATEGY (Maximum=214)						
A1. Building Use	-	1	12	23	33	44
A2. Business Justification	-	1	8	14	21	27
A3. Business Plan	-	2	8	14	20	26
A4. Economic Analysis	-	2	6	11	16	21
A5. Facility Requirements	-	2	9	16	23	31
A6. Future Expansion/Alteration Consideration	-	1	7	12	17	22
A7. Site Selection Considerations	-	1	8	15	21	28
A8. Project Objective Statement	-	1	4	8	11	15
CATEGORY A TOTAL						**214**
B. OWNER PHILOSOPHIES (Maximum=68)						
B1. Reliability Philosophy	-	1	5	10	14	18
B2. Maintenance Philosophy	-	1	5	9	12	16
B3. Operating Philosophy	-	1	5	8	12	15
B4. Design Philosophy	-	1	6	10	14	19
CATEGORY B TOTAL						**68**
C. PROJECT REQUIREMENT (Maximum=131)						
C1. Value – Analysis Requirement	-	1	6	10	14	19
C2. Project Design Criteria	-	1	7	13	18	24
C3. Evaluation of Existing Facilities	-	2	7	13	19	24
C4. Scope of Work Overview	-	1	5	9	13	17
C5. Project Schedule	-	2	6	11	15	20
C6. Project Cost Estimate	-	2	8	15	21	27
CATEGORY C TOTAL						**131**
SECTION I - TOTAL						**413**

Weighted PDRI (Construction Industry Institute (CII), 1999)

SECTION II - BASIS OF DESIGN							
D. SITE INFORMATION (Maximum=109)							
	D1. Site Layout	-	1	4	7	10	14
	D2. Site Surveys	-	1	4	8	11	14
	D3. Civil/Geotechnical Information	-	2	6	10	14	19
	D4. Governing Regulatory Requirements	-	1	4	8	11	14
	D5. Environment Assessment	-	1	5	9	12	16
	D6. Utility Sources with Supply Conditions	-	1	4	7	10	13
	D7. Site Life Safety Considerations	-	1	2	4	6	8
	D8. Special Water and Waste Treatment Requirement	-	1	3	6	8	11
CATEGORY D TOTAL							**109**
E. BUILDING PROGRAMMING (Maximum=162)							
	E1. Program Statement	-	1	5	9	12	16
	E2. Building Summary Space List		1	6	11	16	21
	E3. Overall Adjacency Diagrams		1	3	6	8	10
	E4. Stacking Diagrams		1	4	7	10	13
	E5. Growth and Phased Development		1	5	8	12	15
	E6. Circulation and Open Space Requirements		1	4	7	10	13
	E7. Functional Relationship Diagrams/ Room by Room		1	3	5	8	10
	E8. Loading/ Unloading/ Storage Facilities Requirements		1	2	4	6	8
	E9. Transportation Requirements		1	3	5	7	9
	E10. Building Finishes		1	5	8	12	15
	E11. Room Data Sheets		1	4	7	10	13
	E12. Furnishings, Equipment & Built-ins		1	4	8	11	14
	E13. Window Treatment		-	2	3	4	5
CATEGORY E TOTAL							**162**

F. BUILDING/PROJECT DESIGN PARAMETERS (Maximum=122)							
	F1. Civil/Site Design	-	1	4	7	11	14
	F2. Architectural Design	-	1	7	12	17	22
	F3. Structural Design	-	1	5	9	14	18
	F4. Mechanical Design	-	2	6	11	15	20
	F5. Electrical Design	-	1	5	8	12	15
	F6. Building Life Safety Requirements	-	1	3	5	8	10
	F7. Constructability Analysis	-	1	4	8	11	14
	F8. Technological Sophistication	-	1	3	5	7	9
CATEGORY F TOTAL							**122**
G. EQUIPMENT (Maximum=36)							
	G1. Equipment List	-	1	5	8	12	15
	G2. Equipment Location Drawings	-	1	3	5	8	10
	G3. Equipment Utility Requirements	-	1	4	6	9	11
CATEGORY G TOTAL							**36**
SECTION II - TOTAL							**429**

Weighted PDRI (Construction Industry Institute (CII), 1999)

SECTION III - EXECUTION APPROACH							
H. PROCUREMENT STRATEGY (Maximum=25)							
	H1. Identify Long Lead/Critical Equipment and Materials	-	1	4	7	10	14
	H2. Procurement Procedures and Plans	-	1	3	6	9	11
CATEGORY H TOTAL							**25**
I. DELIVERABLES (Maximum=11)							
	I1. CADD/Model Requirements	-	-	1	2	3	4
	I2. Documentation/Deliverables	-	1	2	4	6	7
CATEGORY I TOTAL							**11**
J. PROJECT CONTROL(Maximum=62)							
	J1. Project Quality Assurance and Control	-	1	3	4	6	8
	J2. Project Cost Control	-	1	4	7	10	13
	J3. Project Schedule Control	-	1	4	8	11	14
	J4. Risk Management	-	1	6	10	14	18
	J5. Safety Procedures	-	1	3	5	7	9
CATEGORY J TOTAL							**62**
K. PROJECT EXECUTION PLAN (Maximum=60)							
	K1. Project Organization	-	1	3	5	8	10
	K2. Owner Approval Requirements	-	1	4	6	9	11
	K3. Project Delivery Method	-	1	5	8	12	15
	K4. Design/Construction Plan & Approach	-	1	4	8	11	15
	K5. Substantial Completion Requirements	-	1	3	5	7	9
CATEGORY K TOTAL							**60**
SECTION III - TOTAL							**158**