ADDIS ABABA UNIVERSITY
ADDIS ABABA INSTITUTE OF TECHNOLOGY

Compare and Adapt Project Organization Structure and Key Project Management Practices for Construction of Railway Track, Bridge and Tunnel

(A Case Study on Awash – Weldia and Addis Ababa – Djibouti Railway Project)

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School of Civil and Environmental Engineering

This is to certify that the thesis prepared by Alexander Zeleke, entitled: Compare and Adapt Project Organization Structure and Key Project Management Practices for Construction of Railway Track, Bridge and Tunnel and submitted in partial fulfillment of the requirements for the degree of Master of Sciences (Civil and Environmental Engineering in Railway Systems) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Declaration

This thesis is my original and has not been presented for a degree in any other university, and that all sources of materials used for the thesis have been duly acknowledged.

Name: Alexander Zeleke

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Date: December, 2017

<u>Dedication</u>

I would like to dedicate this work to my family and Ethiopian Orthodox Church Sunday School.

Acknowledgment

First of all, I thank God for making it all possible.

I would like to express gratitude to my Advisor Prof. Dr.-Ing. Abebe Dinku, for his valuable advice, continuous encouragement and professional support and guidance.

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Abstract

There is an extensive effort by Ethiopian government to expand railway infrastructure throughout the nation. To achieve the strategy, the railway projects are contracted to foreign contractors due to lack of experience and knowledge of local contractors in railway construction. Therefore, this research is designed to identify this gap and build a nation capacity in railway construction management.

The main objectives of this research are to compare organization structure of Awash – Weldia railway project contractor and Addis Ababa – Djibouti railway project contractor. In addition this, to study project organization structure and assess key project management practices for construction of railway track, bridge and tunnel.

This study starts with literature review of relevant documents on project, project management, project organization and optimal project organizational structure. Furthermore, core processes of project management that are planning, execution and controlling processes are discussed in detail. Project management factors, key aspects of project management implementation and value and benefits of project management implementation are also part of literature review. Then, it assess controlling and evaluating method of the construction works. Finally, it gathers data through interview and desk study; and document construction process in railway track, bridge and tunnel.

Comparison of organizational structures shows Yapi Merkezi has a higher quality in terms of specialization, hierarchy of authority, professionalism, size, organizational technology, the environment and organization's culture than china railway group limited.

To efficiently organize local railway projects for construction of railway track, bridge and tunnel; ERC or local contractors' have to be organized in construction and technical office divisions. Under construction division there have to be five construction departments. Regarding key project management practices; method statements, a three week construction plan and request for inspection form are vital for smooth construction process.

Keywords: Project, Project Organization Structure, Key Project Management Practices.

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List of Abbreviations

ERC = Ethiopian Railway Corporation

DCC = Document Control Center

RFI = Request for Inspection

QA = Quality Assurance

QC = Quality Control

PM = Project Management

PMI = Project Management Institute

CSF_s = Critical Success Factors

UCI = International Union of Railway

AREMA = American Railway Engineering and Maintenance of Way Association

TMDCRT = Technical Manual for Design and Construction of Road Tunnels – Civil Elements

CREC = China Railway Group Limited

PMBOK = Project Management Book of Knowledge

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Chapter One – Introduction

1.1 Research Background

The construction industry is vital for the development of any nation and the physical development of construction projects such as buildings, roads, and railways is the measure of their economic growth. According to Ye et al. (2009), the construction industry is one of the most significant industrial contributors to the European economy in terms of gross product and employment. As a result, the success of a construction project is a fundamental issue to most governments, users and communities (Jaman and Margaret, 2012).

Construction of railway infrastructures are undergoing a renaissance in all sectors including Urban Rail, High Speed Rail, Heavy Haul and Intermodal Freight. Rail track network forms an essential part of the transportation system of a country and plays a vital role in its economy. It is responsible for transporting freight and bulk commodities between major cities, ports and numerous mineral and agricultural industries, apart from carrying passengers in busy urban networks. In recent years, the continual competition with road, air and water transport in terms of speed, carrying capacity and cost have substantially increased the frequency and axle load of the trains with faster operational speed. On one hand this implies continuous upgrading of track, and on the other, this imparts inevitable pressure for adopting innovative technology to minimize construction and maintenance costs (Buddhima, Wadud and Cholachat, 2011).

The railway track system is an important part of the transportation infrastructure of a country, and plays a significant role in sustaining a healthy economy. The annual investment of funds to construct and maintain a viable track system is enormous. The optimum use of these funds is a challenge which demands the best technology available (Ernest, 1995).

The railways formed an enormous stimulus to the political, economic and social development in the nineteenth and twentieth century. The railway systems are the proper means for massive passenger transport over short distances to and in within big conurbations. Trains can enter the cities via special tunnel routes, which open up the city centers and enable connections to be made (Coenraad, 2001). With this regard, the government of the Federal Democratic Republic of Ethiopia considers railway engineering as an integral part of development strategy and planned construction of about 2000km of standard gauge railway infrastructure.

As there is no meaningful local experience in railway construction and management; the plan to expand railway infrastructure is mainly dominated by foreign companies. While foreign contractors come with all the technology, however ERC and local contractors were not able learn and acquire what it takes to build mega railway projects. Therefore, this investigation directs to bring practical and implementable project organizational structure and key project management practices by adapting it from experienced international contractor which is currently operating in Ethiopia.

The study focuses on three railway construction activities; track, bridge and tunnel construction. A benchmark is all three require expertise in civil engineering and in cumulative share the highest percentage from the total cost of any railway project. For instance, in Addis Ababa – Djibouti railway project; construction of railway track, bridge and tunnel costs 3.6 billion US dollar which is 88 % of the total cost.

1.2 Statement of the Problem

Railway construction management is a recent input to Ethiopian Construction Engineering and almost all professionals have a very limited practical knowledge. Therefore, Ethiopian Railway Corporation and local contractors do not have efficient project organization structure and key project management practices for construction of new railway track, bridge and Tunnel.

1.3 Objectives

The general objectives of the thesis are:

I. To study project organization structure for construction of railway track, bridge and tunnel.
II. To assess key project management practices throughout organizational structure for construction of railway track, bridge and tunnel.
III. To compare organizational structures of two railway contractors and select the one with higher quality.

The specific objectives of the thesis are listed below. Objectives from Roman number “II” to “VII” are only done for chosen contractor and objectives from Roman number “III” to “VII” are based on a managerial processes shown in Figure 1.1:

I. To compare organizational structures of two railway contractors /Yapi Merkezi and China Railway Group Limited/ and select the one with higher quality.
II. To study project organization structure of the contractor for construction of railway track, bridge and tunnel.
III. To study work-flow of construction divisions' inside organizational structure of the contractor.
IV. To investigate method statements applied for construction of railway track, bridge and tunnel.
V. To study how construction tasks /plans/ are assigned and communicated inside project organization for construction of railway track, bridge and tunnel.
VI. To assess reporting /preparation of performance data/ for construction of railway track, bridge and tunnel.
VII. To investigate performance evaluation for construction of railway track, bridge and tunnel.

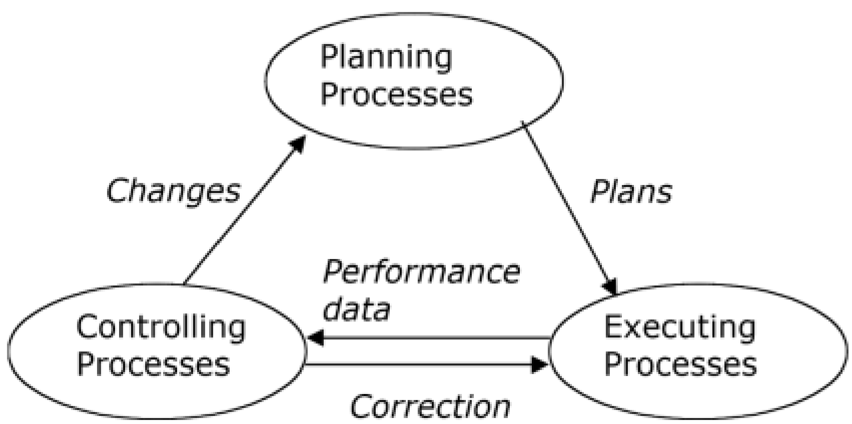

Figure 1.1: The Closed Loop of Managerial Processes in Project Management (Koskela and Howell, 2002)

1.4 Research Questions

1. Which organizational structure has higher quality; Yapi Merkezi or China Railway Group Limited organizational structure?
2. What is the project organization structure used by the contractor for construction of railway track, bridge and tunnel?

3. What is the work-flow of construction divisions' inside organizational structure of the contractor?
4. What are the method statements applied for construction of railway track, bridge and tunnel?
5. How construction tasks /plans/ are assigned and communicated inside project organization for construction of railway track, bridge and tunnel?
6. What are the contents of the report /performance data/ for construction of railway track, bridge and tunnel?
7. How construction performance is evaluated for construction of railway track, bridge and tunnel?

1.5 Significance of the Research

Thesis findings can help local contractors to adapt organization structure and key project management practices and join railway construction industry. Furthermore, the study provides Ethiopian Railway Corporation (ERC) a basic framework to create its own railway construction and maintenance department.

1.6 Scope and Limitation of the Research

The scope of the investigation is limited to the study of railway track, bridge and tunnel. Furthermore, this thesis only discusses organizational structure and key management practices for construction of railway track, bridge and tunnel.

1.7 Organization of the Research

The organization of the study is divided into six chapters, as follows:

- Chapter One: Introduction – It is an introductory part contains research background, statement of the problem, objectives, research questions, significance of the research, scope and limitation of the research, and organization of the research.
- Chapter Two: Literature Review – This section provides general description about project, railway track, bridge and tunnel.
- Chapter Three: Research Design and Methodology – This portion explains the plan used to undertake the research.

- Chapter Four: Comparison of Organizational Structures /Yapi Merkezi and China Railway Group Limited/ – This chapter presents comparison two organizational structures.
- Chapter Five: Adapted Project Organization Structure and Key Project Management Practices of the Case Study Analysis – This chapter presents adapted findings of a case study.
- Chapter Six: Conclusions and Recommendations – This chapter summarizes the main points of the thesis.

Chapter Two - Literature Review

2.1 Introduction

A professional activity of designing, structuring, scheduling, organizing, managing and controlling projects is usually called Project Management. It is clearly an interdisciplinary field requiring a scientific methodology and appropriate technical instruments. (Valadares, 1999)

While effective management, leadership and teamwork are more important success factors than structural details, the optimal organization can contribute significantly to project performance and efficiency. The organization's design should promote the team's dominant interfaces and preferred communication channels. Its' purpose is to ensure that project requirements are met. (Kevin, 2005)

This chapter presents the findings from different reviewed literatures on the subject of project, project management, project organization, and key project management practices. Besides, construction process and sequence for railway track, bridge and tunnel reviewed in detail.

2.2 Project

A Project is a temporary endeavor undertaken to create a unique product, service or result. The temporary nature of projects indicates that a project has a definite beginning and end. The end is reached when the project's objectives have been achieved or when the project is terminated because its objectives will not or cannot be met, or when the need for the project no longer exists. (PMI, 2013)

Today project work thus seems to have become increasingly common in all kinds of organizations. In most project management literature (Butler, 1973; Gaddis, 1959; Lundin, 1990; Pinto and Prescott, 1988) the project is usually defined as:

- A unique, once in a lifetime task;
- With a predetermined date of delivery;
- Being subject to one or several performance goals (such as resource usage and quality);
- Consisting of a number of complex and / or interdependent activities. (Johann, 1995)

2.2.1 Project Management

Project management has developed into a subject discipline alongside other management functions such as operations, information technology, or finance (Kenny, 2003) and the research literature in this discipline is growing (Besner and Hobbs, 2006; Thomas and Mullaly, 2007). Organizations are increasingly using PM as a tool to increase their productivity (Frame, 1995). The popularity of PM methodologies is confirmed by a partial longitudinal study conducted by Fortune et al. (2011) that reports a significant increase in 2011 from 2002 in the use of PM methodologies and tools within PM professionals. The literature suggests that multiple benefits can be achieved from having a mature PM system in place (Bryde, 2003a; Kwak and Ibbs, 2000) and that PM is more effective than traditional functional management (Avots, 1969; Munns and Bjeirmi, 1996).

i. Management

Management is intellectual work performed by people in an organizational context. It involves the coordination of human and material resources toward objective accomplishment (Fremont and James, 1988).

ii. Project Management

Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements. It is accomplished through five process groups. These five process groups are presented in Figure 2.1.

- Initiating Process Group: Those processes performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or phase.
- Planning Process Group: Those processes required to establish the scope of the project, refine the objectives, and define the course of action required to attain the objectives that the project was undertaken to achieve.
- Executing Process Group: Those processes performed to complete the work defined in the project management plan to satisfy the project specifications.
- Monitoring and controlling Process Group: Those processes required to track, review, and regulate the progress and performance of the project; identify any areas in which changes to the open are required; and initiate the corresponding changes.

- Closing Process Group: Those processes performed to finalize all activities across all process groups to formally close the project or phase (PMI, 2013).

iii. Work Breakdown Structure

A work breakdown structure is a logical hierarchical tree of all the tasks needed to complete a project as it is shown in Figure 2.1. The top of the tree is the project itself. The next layer or level down contains the main ‘work packages’. Levels below that progressively get more and more detailed until the bottom level is reached that shows all the smallest day-to-day tasks or project components.

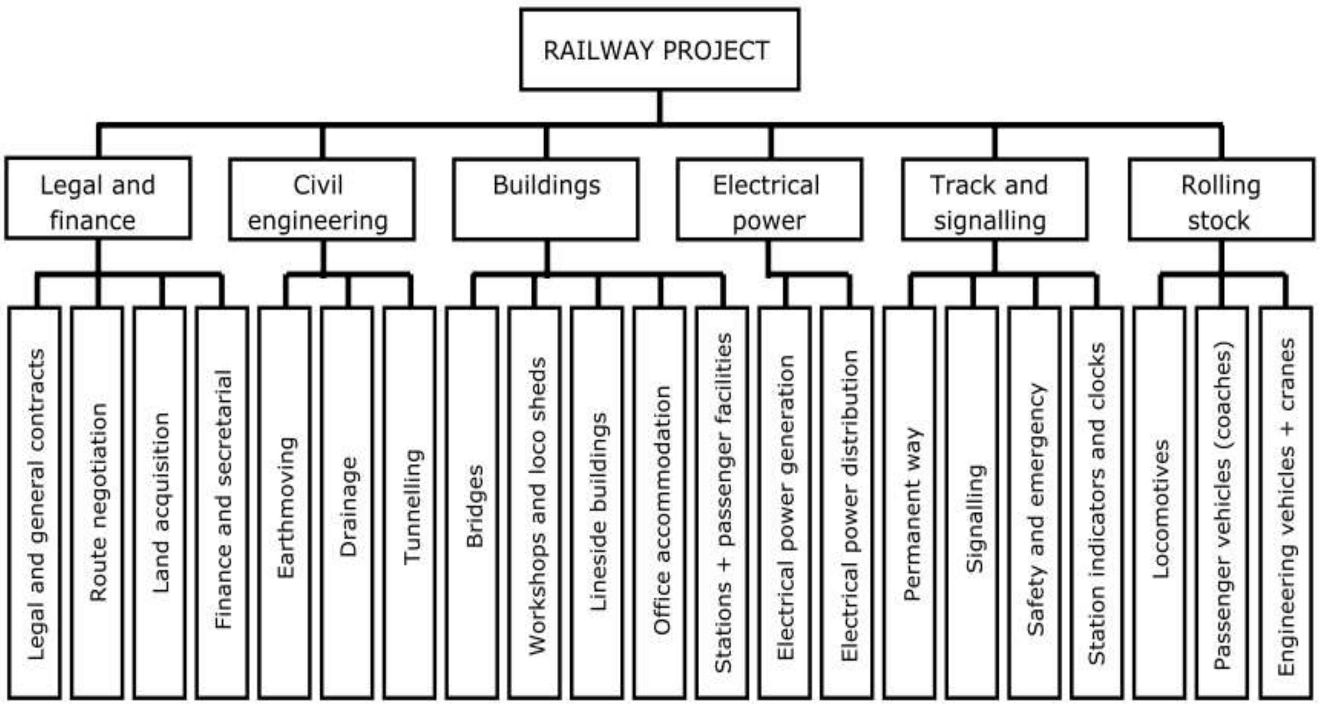

Figure 2.1: Work Breakdown for a Project to Build a New Railway (Dennis, 2007).

2.2.2 Project Organization

I. Introduction

Organizations are (1) social entities that (2) are goal-directed, (3) are designed as deliberately structured and coordinated activity systems, and (4) are linked to the external environment (Richard, 2010).

An organization is a tool used by people to coordinate their actions to obtain something they desire or value; that is, to achieve their goals. An organization is a response to and a means of satisfying some human need (Gareth, 2012).

The key element of an organization is not a building or a set of policies and procedures; organizations are made up of people and their relationships with one another. An organization exists when people interact with one another to perform essential functions that help attain goals. Recent trends in management recognize the importance of human resources, with most new approaches designed to empower employees with greater opportunities to learn and contribute as they work together toward common goals (Richard, 2010).

Organizations exist to do the following:

1. Bring together resources to achieve desired goals and outcomes
2. Produce goods and services efficiently
3. Facilitate innovation
4. Use modern manufacturing and information technologies
5. Adapt to and influence a changing environment
6. Create value for owners, customers, and employees
7. Accommodate ongoing challenges of diversity, ethics, and the motivation and coordination of employees (Richard, 2010).

Organization creates value at three stages: input, conversion, and output. Each stage is affected by the environment in which the organization operates. Inputs include human resources, information and knowledge, raw materials, and money and capital. The way the organization uses human resources and technology to transform inputs into outputs determines how much value is created at the conversion stage. The amount of value the organization creates is a function of the quality of its skills, including its ability to learn from and respond to the environment (Gareth, 2012).

The result of the conversion process is an output of finished goods and services that the organization releases to its environment, where they are purchased and used by customers to satisfy their needs. The organization uses the money earned from the sale of its output to obtain new supplies of inputs, and the cycle begins again. An organization that continues to satisfy people's needs will be able to obtain increasing amounts of resources over time and will be able to create more and more value as it adds to its stock of skills and capabilities (Gareth, 2012).

II. Organization Theory and Design

Organization theory is a way to see and analyze organizations more accurately and deeply than one otherwise could. The way to see and think about organizations is based on patterns and regularities in organizational design and behavior (Richard, 2010).

Organizational theory is the study of how organizations function and how they affect and are affected by the environment in which they operate (Gareth, 2012).

III. Organization Configuration

From organization design researchers, one framework proposed by Henry Mintzberg suggests that every organization has five parts as shown in Figure 2.2 (Richard Daft, 2010).

1. Technical Core – includes people who do the basic work of the organization. This part actually produces the product and service outputs of the organization. This is where the primary transformation from inputs to outputs takes place.
2. Technical Support – helps the organization adapt to the environment. Technical support employees such as engineers, researchers, and information technology professionals scan the environment for problems, opportunities, and technological developments. Technical support is responsible for creating innovations in the technical core, helping the organization change and adapt.
3. Administrative Support – is responsible for the smooth operation and upkeep of the organization, including its physical and human elements. This includes human resource activities such as recruiting and hiring, establishing compensation and benefits, and

employee training and development, as well as maintenance activities such as cleaning of buildings and service and repair of machines.

4. Management – is a distinct function, responsible for directing and coordinating other parts of the organization. Top management provides direction, planning, strategy, goals, and policies for the entire organization or major divisions. Middle management is responsible for implementation and coordination at the departmental level. In traditional organizations, middle managers are responsible for mediating between top management and the technical core, such as implementing rules and passing information up and down the hierarchy.

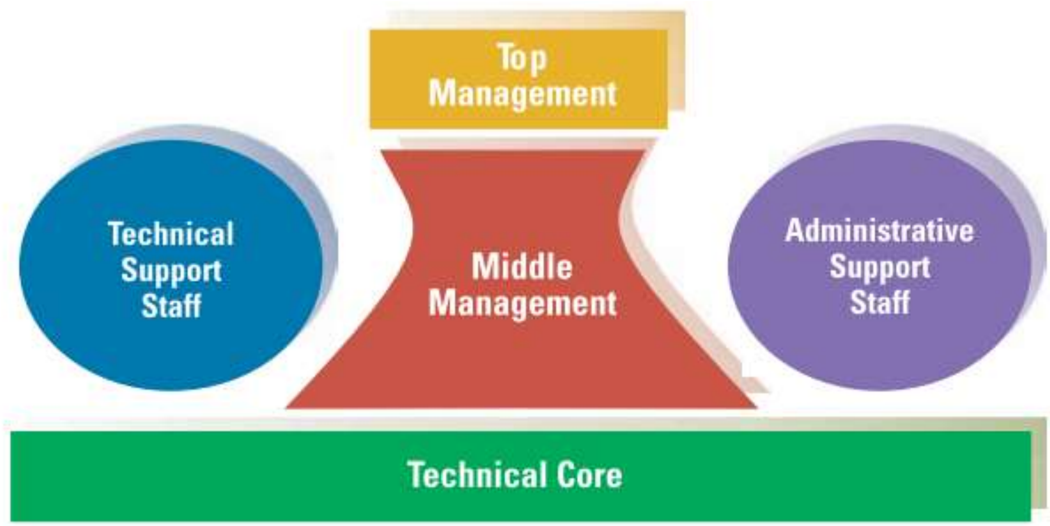

Figure 2.2: The Structuring of Organizations by Henry Mintzberg (Richard, 2010)

IV. Organization Structure

Organizational structure is the formal system of task and authority relationships that control how people coordinate their actions and use resources to achieve organizational goals. The principal purpose of organizational structure is one of control: to control the way people coordinate their actions to achieve organizational goals and to control the means used to motivate people to achieve these goals (Gareth, 2012).

There are three key components in the definition of organization structure:

1. Organization structure designates formal reporting relationships, including the number of levels in the hierarchy and the span of control of managers and supervisors.
2. Organization structure identifies the grouping together of individuals into departments and of departments into the total organization
3. Organization structure includes the design of systems to ensure effective communication, coordination, and integration of efforts across departments (Richard, 2010).

These three elements of structure pertain to both vertical and horizontal aspects of organizing. For example, the first two elements are the structural framework, which is the vertical hierarchy. The third element pertains to the pattern of interactions among organizational employees. An ideal structure encourages employees to provide horizontal information and coordination where and when it is needed (Richard, 2010).

Organization structure is reflected in the organization chart. The organization chart is the visual representation of a whole set of underlying activities and processes in an organization. It can be quite useful in understanding how a company works. It shows the various parts of an organization, how they are interrelated, and how each position and department fits into the whole (Richard, 2010).

V. Types of Project Organizational Structures

There are four basic models of organizational structures for project management (PMI, 2013).

A. Functional organization

The classic functional organization, shown in Figure 2.3, is a hierarchy where each employee has one clear superior. Staff members are grouped by specialty, such as engineering, production and marketing at the top level. Specialties may be further subdivided into focused functional units, such as electrical, mechanical and materials engineering. Each department in a functional organization will do its project work independently of other departments (PMI, 2013).

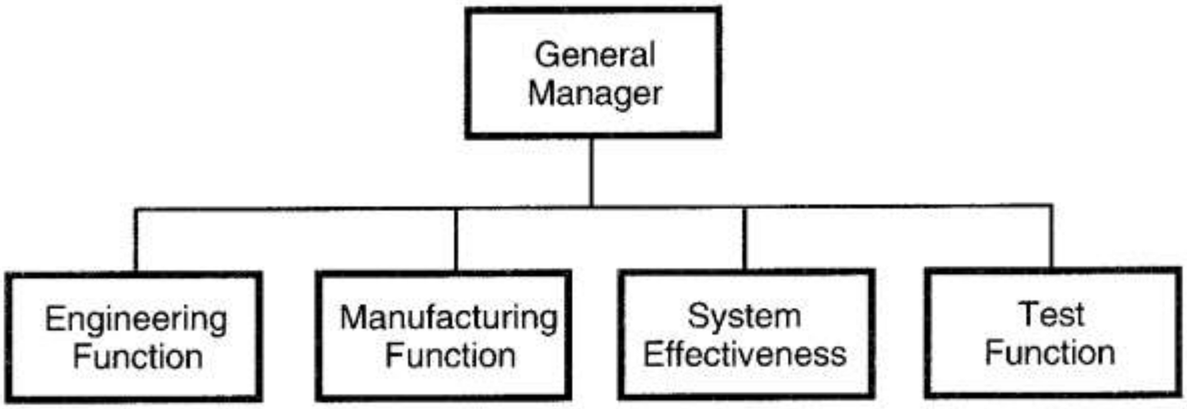

Figure 2.3: Functional Organization (Kevin, 2005)

B. Projectized organization

At the opposite end of the spectrum to the functional organization is the projectized organization, shown in Figure 2.4. In a projectized organization, team members are often gathered. Most of the organization's resources area involved in project work, and project managers have a great deal of independence and authority. Virtual collaboration techniques are often used to accomplish the benefits of colocated teams. Projectized organizations often have organizational units called departments, but they can either report directly to the project manager or provide support services to the various projects (PMI, 2013).

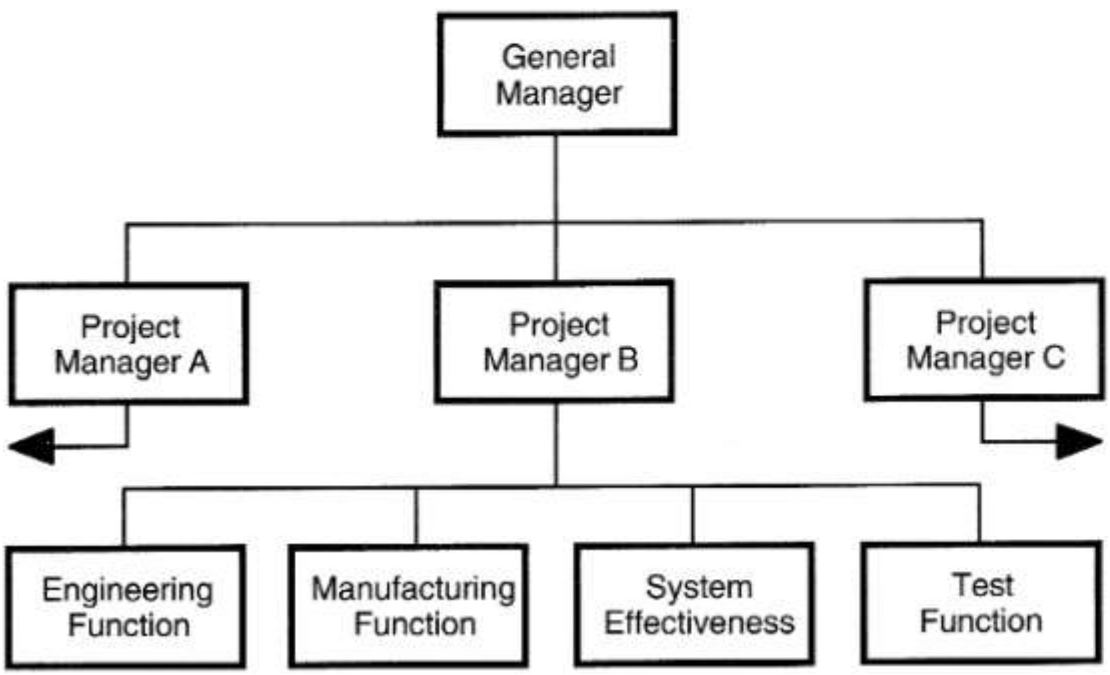

Figure 2.4: Projectized Organization (Kevin, 2005)

C. Matrix organization

Matrix organizations, as shown in Figure 2.5, reflect a blend of functional and projectized characteristics. Matrix organizations can be classified as weak, balanced, or strong depending on the relative level of power and influence between functional and project managers. Weak matrix organization maintain many of the characteristics of a functional organization, and the role of the project manager is more of a coordinator or expediter. A project expediter works as staff assistant and communications coordinator. The expediter cannot personally make or enforce decisions. Project coordinators have power to make some decisions, have some authority, and report to a higher-level manager. Strong matrix organizations have many of the characteristics of the projectized organization, and have full-time project managers with considerable authority and full-time project administrative staff. While the balanced matrix organization recognizes the need for a project manager, it does not provide the project manager with the full authority over the project and project funding (PMI, 2013).

In Figure 2.5, solid (hire/fire management) vertical lines and dotted (task assignment or borrow/return) horizontal lines. The most common form of matrix has the team members connected to project managers by dotted lines and connected to their functional managers by solid lines. These structures combine the best aspects of the pure functional and pure projectized organization forms, as demonstrated by their relative strengths (Kevin, 2005).

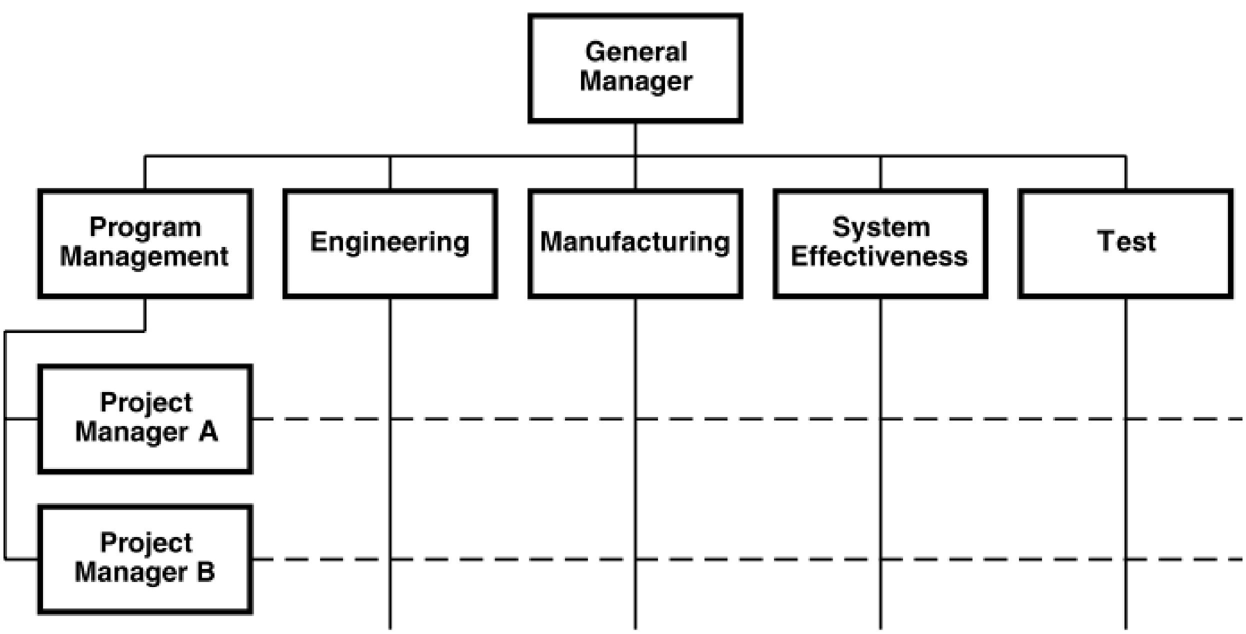

Figure 2.5: Matrix Organization (Kevin, 2005)

D. Composite organization

Many organizations involve all these structures at various levels, often referred to as a composite organization, as shown in Figure 2.6. For example, even a fundamentally functional organization may create a special project team to handle a critical project. Such a team may have many of the characteristics of a project team in a projectized organization. The team may include full-time staff from different functional departments, may develop its own set of operating procedures, and may even operate outside of the standard, formalized reporting structure during the project. Also, an organization may manage most of its projects in a strong matrix, but allow small projects to be managed by functional departments (PMI, 2013).

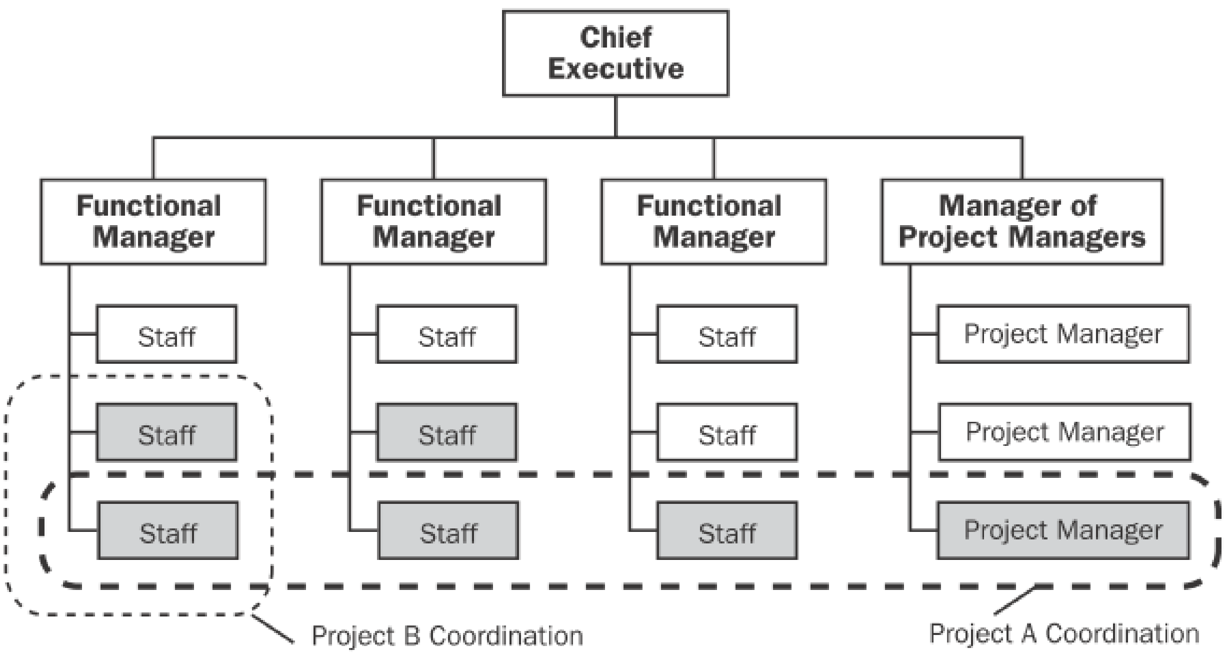

Figure 2.6: Composite Organization (PMI, 2013)

VI. Factors Affecting Organization Structure Selection

Organization can also be defined as group of people who must coordinate their activities in order to meet organizational objectives. The coordination function requires strong communications and a clear understanding of the relationships and interdependencies among people. Organizational structures are dictated by such factors as technology and its rate of change, complexity, resource availability, products and/or services, competition, and decision-making requirements. It is must to keep in mind that there is no such thing as a good or bad organizational structure; there are only appropriate or inappropriate ones (Ehab, Hossam and Waleed, 2013).

Ehab, Hossam and Waleed (2013), reported fifteen factors that are affecting organization structure selection and are listed below;

1. Project size (budget)
2. Project length (time)
3. Project location
4. Complexity of the project (type)
5. Unique aspects of the project
6. Level of technology
7. Organizational size
8. Clear location of responsibility
9. Ease and accuracy of communication
10. Effective cost control
11. Ability to provide good technical supervision
12. Assigning authority
13. The choice of project management authority structure
14. Selecting the size of each units and work groups
15. Adding the planning and monitoring system

VII. Optimal Project Organizational Structure

Increase in construction project scale and complexity induces difficulty in project control. The scope of work, contents, and interfaces among different levels of the project team will certainly be increased. The key element for smooth execution of a huge construction project is a suitable project organizational structure, which will improve the efficiency of communication between different groups of project members. The duration of a construction project is quite long and during this period, coordination between different members of the construction team is vital for smooth project execution (Min-Yuan, Cheng-Wei and Horng-Yuh, 2007).

The organization of the construction team can be divided into two different types:

A. Administration Control Team: The main job of the administration control team is to handle the daily management work of all activities related to the construction work.
B. Construction Execution Team: The execution team is composed of the members involved in field construction work, such as the main contractor, intermediate contractor and specialty contractor. They work on a contract basis and their positions in the organizational structure are defined according to their assignment in the construction work and the organization chart established by Work Breakdown Structure (WBS) (Min-Yuan, Cheng-Wei and Horng-Yuh, 2007).

A construction project requires team spirit, therefore team building is important among different parties. Team effort by all parties to a contract-owner, architect, construction manager, contractor, and subcontractors is a crucial ingredient for the successful completion of a project (Hassan 1995). Furthermore, Chua et al. (1999) defined project participants as the key players for success of a construction project, including project manager, client, contractor, consultants, subcontractor, supplier, and manufacturers.

The project manager is another key stakeholder in a construction project and his competence is a critical factor affecting project planning, scheduling, and communication (Belassi and Tukel 1996). Variables under this factor consist of the skills and characteristics of project managers, their commitment, competence, experience, and authority (Chua et al. 1999).

2.2.3 Key Project Management Practices

I. Project Integration Management

It includes the processes and activities to identify, define, combine, unify and coordinate the various processes and project management activities within Project Management Process Groups. In the project management context, integration includes characteristics of unification, consolidation, communication, and integrative actions that are crucial to controlled project execution through completion, successfully managing stakeholder expectations and meeting requirements. Project Integration Management includes making choices about resource allocation, making trade-offs among competing objectives and alternatives, and managing the interdependencies among the project management Knowledge Areas (PMI, 2013).

Project Integration Management processes area explained as follows:

1. Develop Project Charter – The process of developing a document that formally authorizes the existence of a project and provides the project manager with the authority to apply organizational resources to project activities.
2. Develop Project Management Plan – The process of defining, preparing, and coordinating all subsidiary plans and integrating them into a comprehensive project management plan. The project's integrated baselines and subsidiary plans may be included within the project management plan.
3. Direct and Manage Project Work – The process of leading and performing the work defined in the project management plan and implementing approved changes to achieve the project's objectives.
4. Monitor and Control Project Work – The process of tracking, reviewing, and reporting project progress against the performance objectives defined in the project management plan.
5. Perform Integrated Change Control – The process of reviewing all changes requests; approving changes and managing changes to deliverables, organizational process assets, project documents, and the project management plan; and communicating their disposition.
6. Close Project or Phase – The process of finalizing all activities across all of the Project Management Process Groups to formally complete the phase or project (PMI, 2013).

II. Theory of Project Management Processes

The PMBOK Guide divides project management processes into initiating, planning, execution, controlling and closing processes. Let us concentrate on the core processes of planning, execution and controlling. A central idea is that these processes form a closed loop as shown in Figure 1.1: the planning processes provide a plan that is realized by the executing processes, and variances from the baseline or requests for change lead to corrections in execution or changes in further plans.

A. Theory of Planning

The planning of projects is thoroughly described from the point of view of different knowledge areas in the PMBOK Guide. The planning processes are structured into core processes and facilitating processes. There are ten core processes: scope planning, scope definition, activity definition, resource planning, activity sequencing, activity duration estimating, cost estimating, schedule development, cost budgeting and project plan development. The output from these processes, the project plans, make up an input to the executing processes.

The planning processes dominate the scene in the PMBOK Guide: in addition to the ten planning processes, there is only one executing process and two controlling processes. The emphasis is on planning, with little offered on executing especially.

Comparison to theories in the general field of operations reveals that the perspective is that of management-as-planning (Johnston & Brennan 1996). Here, it is assumed that the organization consists of a management part and an effector part. Management at the operations level is seen to consist of the centralized creation, revision and implementation of plans. This approach to management views a strong causal connection between the actions of management and outcomes of the organization. By assuming that translating a plan into action is the simple process of issuing "orders", it takes plan production to be essentially synonymous with action.

B. Theory of execution

How is the project plan executed? On this aspect, the PMBOK Guide is puzzlingly brief-worded. The only direct reference to the actual interface between plan and work is with regard to work authorization system, which is presented by five sentences:

> A work authorization system is a formal procedure for sanctioning project work to ensure that work is done at the right time and in the proper sequence. The primary mechanism is typically a written authorization to begin work on a specific activity or work package. The design of the work authorization system should balance the value of the control provided with the cost of that control. For example, on many smaller projects, verbal authorizations will be adequate.

The underlying theory of execution turns out to be similar to the concept of job dispatching in manufacturing where it provides the interface between plan and work. This concept can be traced back to Emerson (1917). The basic issue in dispatching is allocating or assignment of tasks or jobs to machines or work crews, usually by a central authority. According to a modern definition, job dispatching is a procedure that uses logical decision rules to select a job for processing on a machine that has just come available (Bhaskaran & Pinedo 1991).

Obviously, dispatching consists of two elements: decision (for selecting task for a workstation from those predefined tasks that are ready for execution), and communicating the assignment (or authorization) to the workstation. However, in the case of project management, that decision is largely taken care in planning, and thus dispatching is reduced to mere communication: written or oral authorization or notification to start work. Here, the underlying theory seems to be the classical theory of communication (Shannon & Weaver 1949), where a set of symbols (voice or written speech) is transmitted from sender to receiver.

C. Theory of controlling

The PMBOK guide divides the core process of controlling into two sub-processes: performance reporting and overall change control. Based on the former, corrections are prescribed for the executing processes, and based on the latter, changes are prescribed for the planning processes.

Here we consider only performance reporting, based on performance baseline, and associated corrections to execution. They clearly correspond to the cybernetic model of management control (thermostat model) that consists of the following elements (Hofstede 1978):

- There is a standard of performance
- Performance is measured at the output (or input)
- The possible variance between the standard and the measured value is used for correcting the process so that the standard can be reached.

This thermostat model is identical to the feedback control model as defined in modern control theory (Ogunnaike & Ray 1994).

III. Project Management Factors

A number of attributes will affect project management factor as shown in Figure 2.7. It includes the communication system, control mechanism, feedback capabilities, planning effort, organization structure, safety and quality assurance program, control of subcontractors' works, and finally the overall managerial actions (Albert, David and Ada, 2010).

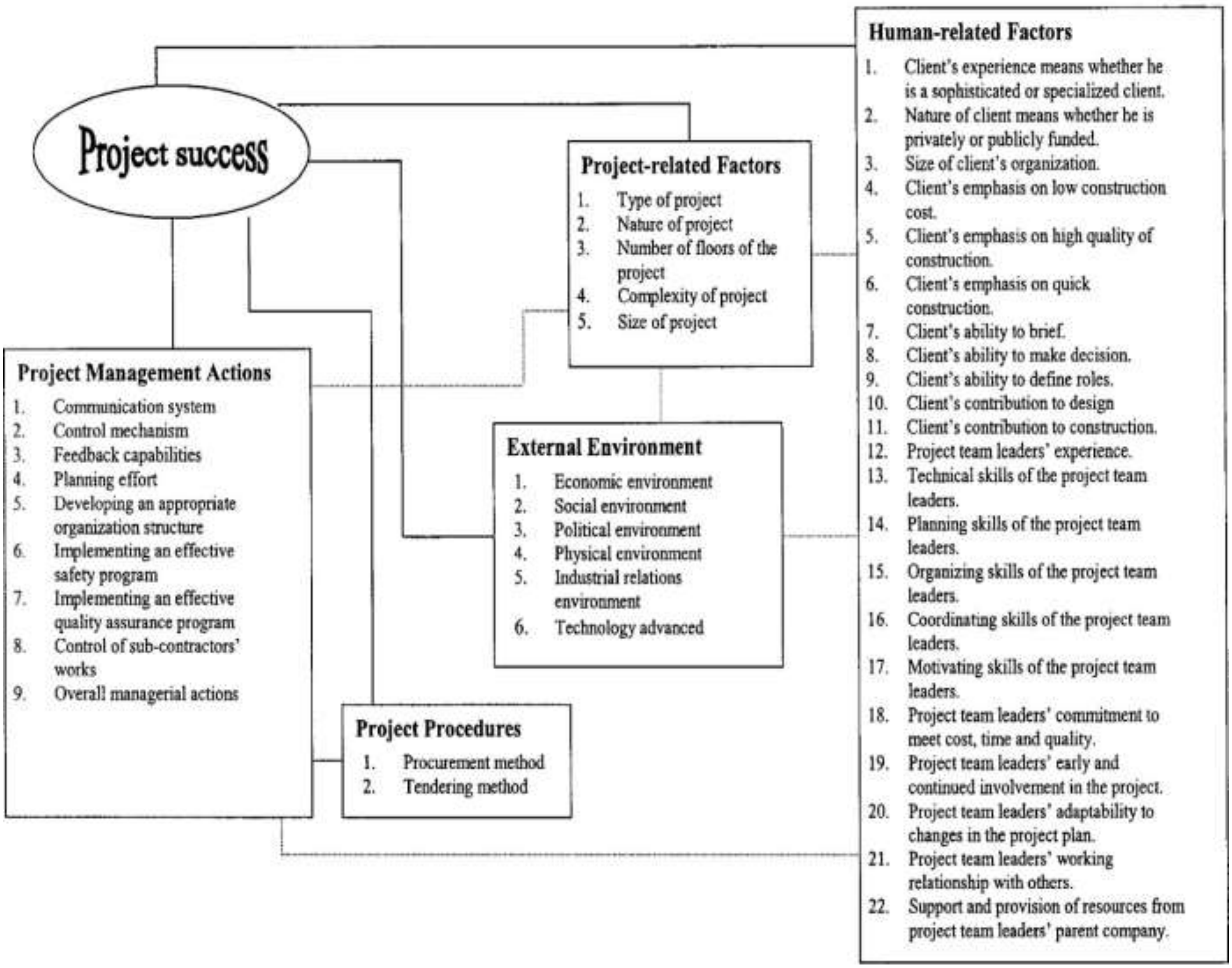

Figure 2.7: Factors Affecting Project Success (Albert, David and Ada, 2010)

IV. Key Aspects of Project Management Implementation

Investigation of six case study organizations which have established their own project management systems, and have taken measures to continuously improve their project management practices and capabilities were made. From analysis of the interview transcripts, 11 aspects of project management were identified to be most important for all the organizations to achieve better project performance and to improve their project management practices and capabilities (Ping, Maoshan and Jia, 2009).

More specifically, the 11 key aspects include:-

1. Well established and user-friendly project management processes, procedures, guidelines and templates;
2. Senior management support to project management teams and efforts to continuously improve the organization's project management capabilities;
3. Clearly defined project manager role and responsibility;
4. Attention to and effective stakeholder management;
5. Effective resource planning and allocation management;
6. Effective procurement and contract management, such as bidding plan, bidding documents compilation, contract negotiation, and management;
7. Attention to and efforts for team building and creation of a cohesive team culture;
8. Effective training, on both internal management systems and advanced management concepts and practices;
9. Customized and easily followed software tools;
10. Effective governance processes and structure, in particular for large complex projects; and
11. Competent project managers.

V. Value and Benefits of Project Management Implementation

Projects and project management implementation are highly valued in all the six organizations, all these six case study organizations have continuously put efforts to improve their project management practices and capabilities, and they are now all satisfied with the contribution of projects and current project management practices to their organizational development and success (Ping, Maoshan and Jia, 2009).

From the interviews, 12 aspects of qualitative value and benefits of project management implementation to their organization were identified and listed below, which were then confirmed and ranked in the surveys. It is also worth mentioning that most of the 136 survey respondents ranked 4 agree or 5 strongly agree for each of the 12 types of value and benefits and none ranked 1 strongly disagree or 2 disagree (Ping, Maoshan and Jia, 2009).

1. Better project control /control of cost, time, quality and safety/
2. Better organizational reputation
3. Increased efficiency / profitability
4. Greater project transparency
5. More stakeholder / client satisfaction
6. Increased competitiveness / increased number of projects
7. More effective communication
8. Better multi-project co-ordination
9. Improved resource utilization
10. Improved organizational culture
11. More staff satisfaction
12. Greater innovation

2.3 <u>Railway Track</u>

2.3.1 <u>Introduction</u>

The purpose of a railway track structure is to provide safe and economical train transportation. This requires the track to serve as a stable guideway with appropriate vertical and horizontal alignment. To achieve this role each component of the system must perform its specific functions satisfactorily in response to the traffic loads and environmental factors imposed on the system (Ernest, 1995).

Two discrete subsystems are distinct in a ballasted track structures; superstructure and subgrade.

The superstructure is composed of:

- The rails, which support and guide the train wheels
- The sleepers (also called ties, principally in North America) with their fastenings, which distribute the loads applied to the rails and keep them at a constant spacing.
- The ballast, usually consisting of crushed stone. It should ensure the damping of most of the train vibrations, adequate load distribution and fast drainage of rainwater.
- The subballast, consisting of gravel and sand. It protects the subgrade top from the penetration of ballast stones, while at the same time further distributing external loads and ensuring the quick drainage of rainwater.

In the subgrade the following are distinguished:

- The base, which in the case of the track laid along a cut consists of on-site soil, while in the case of an embankment is composed of soil transported to the site.
- The formation layer, used whenever the base soil material is not of appropriate quality (Profillidis, 2006).

2.3.2 <u>Track Structure Components</u>

I. Subgrade

Railway subgrade is particularly important in ensuring that track quality reaches the standard necessary for the safe and comfortable operation of trains (Profillidis, 2006).

II. The Rail

Rails support and guide the wheels of the train vehicles. Steel industry has a variety of products for rail profiles, which are classified either according to International Union of Railway (based on tensile strength) or according to European standards (based on hardness) (Profillidis, 2006).

III. Sleepers – Fastenings

Sleepers are the track components positioned between rails and ballast. The first material used for sleepers was wood. Its scarcity and sensitivity led to the introduction of steel sleepers around 1880, which were widely used for a long time since 1990, advances in concrete technology have led to the use of concrete sleepers, distinguished in:

- Twin-block reinforced-concrete sleepers – consisting of two trapezoidal reinforced-concrete sections joined by a connecting bar as shown in Figure 2.8.

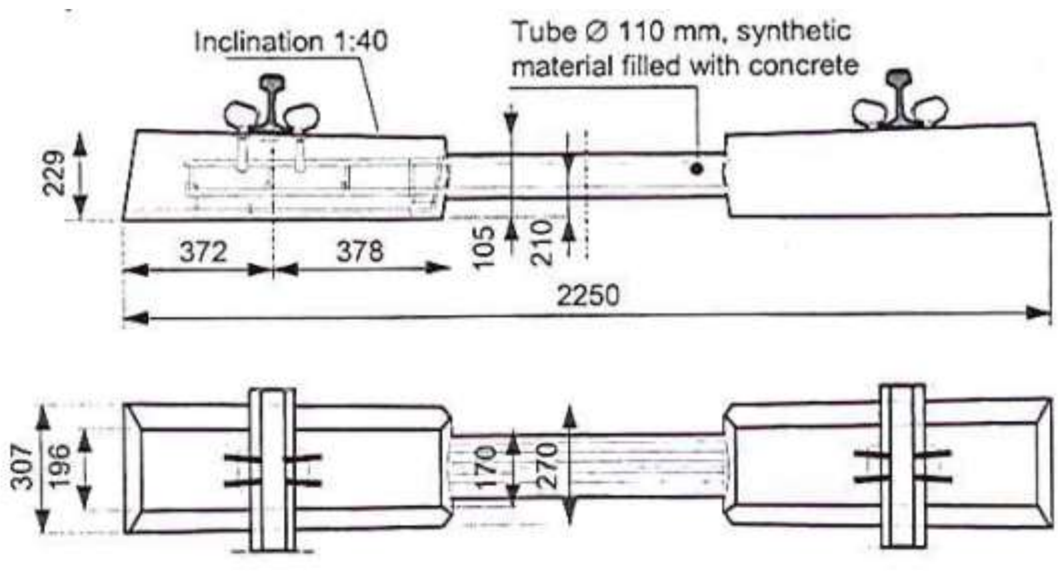

Figure 2.8: Reinforced Twin Block Sleeper (Coenraad, 2001)

- Monoblock prestressed-concrete sleepers – which can be pre-tensioned or post-tensioned, prestressed one is shown in Figure 2.9 (Profillidis, 2006).

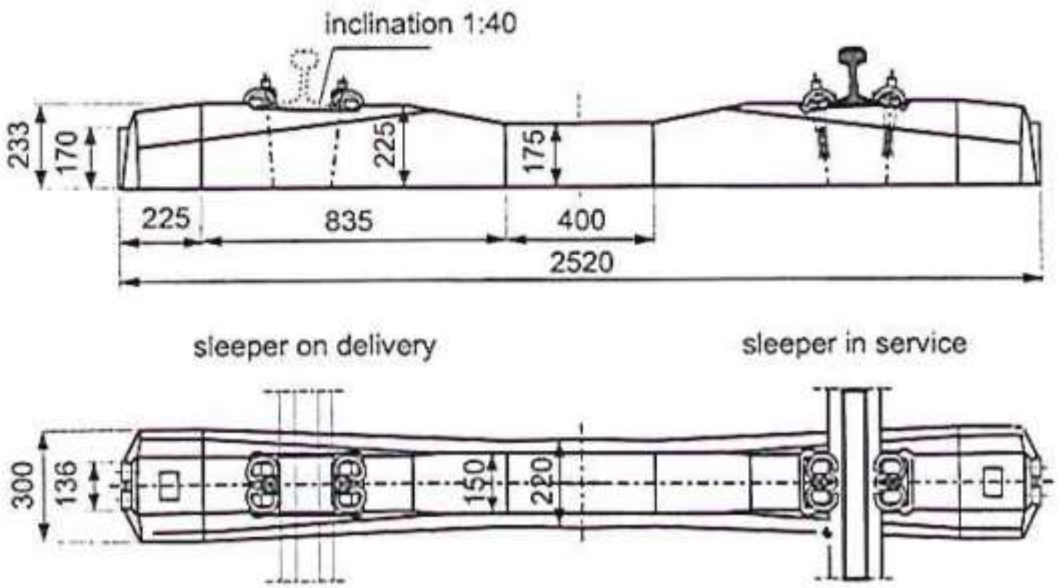

Figure 2.9: Prestressed Monoblock Sleeper (Coenraad, 2001)

IV. Ballast

The term ballast denotes the layer of crushed stone on which the sleepers rest. Furthermore, the ballast fills the space between sleepers as well as at some distance (called ballast shoulder) beyond the sleepers' ends (Profillidis, 2006).

2.3.3 Construction Stages

Track structure has over six major construction stages. (Queensland Government, Department of Transport and Main Roads, 2016).

Stage one – Embankment, bridge and tunnel construction

Rail alignment will be built on earth embankment which will form the rail foundation. Bridges and culverts are needed to carry the rail line over existing roads and water courses and station facilities. Tunnel facilitate underground passage.

Stage two – Laying concrete sleepers

Concrete rail sleepers are placed along the rail alignment as a base support for the rail. Sleepers are positioned by a front end loader with a sleeper 'grab' attachment which picks up a set of sleepers and lays them in the configuration for the rail tracks to then be attached.

Stage three – Laying the rail tracks

The steel rail is placed on top of the concrete sleepers and clipped into place by either a track mountable machine or by hand. The rail is then welded together using 'flash butt-welding' which melts two rail pieces together forming a seamless rail track.

Stage four – Ballast

Ballast is a specific type of rock used for supporting the sleepers and rail track, keeping them in place while trains run. A ballast machine rides the new tracks and places the ballast over the sleepers and between the tracks.

Stage five – Settling the rail

A track mountable machine called a tamping machine rides along the new track, lifting the tracks, to then vibrate the ballast into place. It then sets the track into its final position. This method is repeated numerous times to ensure the rail line settles and is ready for operation.

Stage six – Installing over-head equipment

Masts are installed along the rail alignment to support the equipment which provides electricity to operate trains. Signaling structure are also installed along the rail route.

2.4 Railway Bridge

2.4.1 Introduction

A bridge is a structure used to carry loads over an opening, which may take the form of a valley or stream, a road or railway. The loads mentioned in this definition includes locomotives and rolling stock for a railway bridge (Colin and Peter, 2000).

2.4.2 Major Bridge Components

I. Substructure

The substructure consists of abutments and piers and includes the foundations supporting them. The substructure transmits to the underlying soil the forces comprising the dead load of the superstructure and substructure, the live load effect of passing traffic, and the forces from wind, water, etc. The substructure will generally consist of pile foundations, spread footings, piers and abutments and/or any combination of the three.

Pile – Today most railway bridge foundations begin with driven piles or caissons. Piles may support some other footing component such as piers or tower legs or they may continue to become part of the bent as in trestle construction.

Piling may be placed in two general classifications:

1. A bearing/friction pile, which is a timber, concrete or a steel structure element, is driven, jetted or otherwise embedded on end into the ground to support a load.
2. A sheet pile, which forms a continuous interlocking line of timber, concrete or steel piles, is driven close together to form a wall designed to resist the lateral pressure of water, earth or other materials.

Abutments – the three primary types of abutments are the “wing,” the “U” and the “T.” All types possess one characteristic feature, the body or face portion, commonly called the breast, which supports the bridge seat.

Piers – constitute the intermediate supports for multiple-span bridges. They should rest on stable, unyielding foundations with their bases well below frost line, and also below the elevation of any possible scouring action (AREMA, 2003).

II. Superstructure

The superstructure is the portion of a bridge supporting and conveying the live load to the substructure on which it rests. As a structure element, it is the portion of the bridge spanning the opening. The superstructure consists of arches, slabs, beams, girders, trusses or troughs, and such floor systems and bracing as may be required. Superstructures may be divided into two general classes: steel spans and concrete spans.

Bridge Deck – is that portion of a railway bridge that supplies a means of carrying the track rails. The choices are open deck and ballast deck bridge, shown in Figure 2.10 and 2.11 respectively.

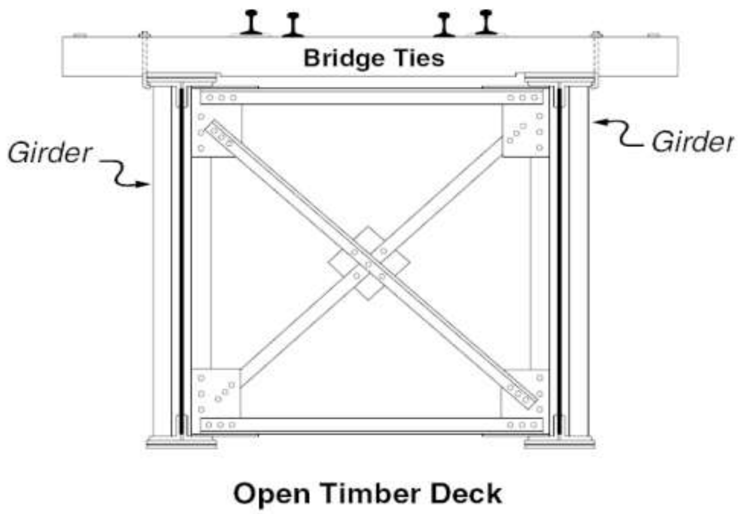

Figure 2.10: Open Timber Deck

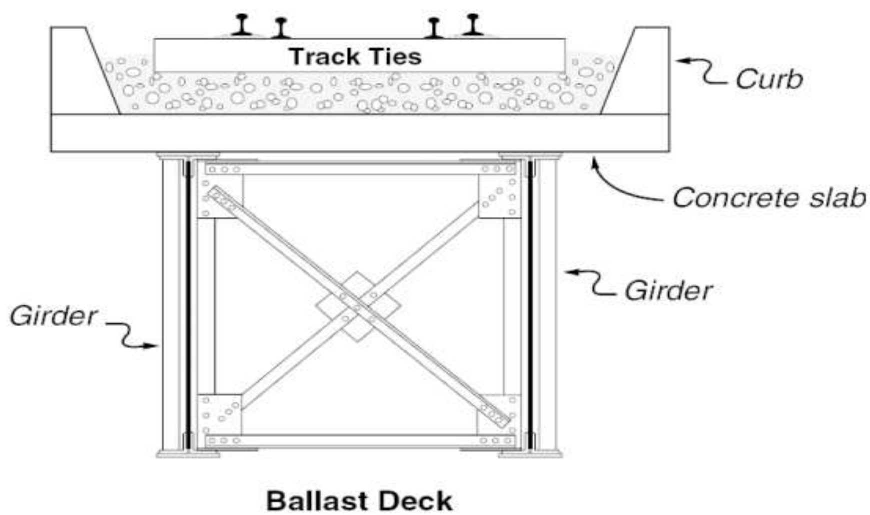

Figure 2.11: Ballast Deck (AREMA, 2003)

2.4.3 Construction

In particular to construction of concrete girder bridges, there is a close link between the designer's choice of bridge deck type and the most appropriate method of construction. In general, solid and voided slabs and twin rib decks are appropriate for the cast-in-situ construction of complete spans on falsework, while box sections are most easily cast in-situ in short sections, or precast.

The two principal components in the cost of building deck (apart from the material content of the deck) are labour and plant (Robert, 2008).

I. Cast-in-situ span-by-span construction of continuous beams

Span-by-span construction is applicable to decks with spans that lie generally between 20m and 45m. Due to the difficulties of casting boxes in-situ, decks are most commonly solid or voided slab or twin rib, and are usually continuous.

II. Precast segmental span-by-span erection

This method of construction is well adapted to long viaducts with spans that generally do not exceed 50m. The decks may be statically determinate or continuous. The segment joints may be glued with internal prestress or dry with external tendons.

III. Cast-in-situ balanced cantilever construction

Cast-in-situ balanced cantilever construction is ideally suited to box section bridges of medium or long span, where there is insufficient repetition to justify precasting. The method becomes economical for bridges with a main span of 60m and above, and remains viable up to the largest span that may be built, currently about 300m.

IV. Precast segmental balanced cantilever construction

The most widely used method of erection of precast segmental bridges is balanced cantilever. It is adaptable to spans from 25m up to about 150m, and can cope with virtually any succession of span lengths and deck alignments.

V. Progressive erection of precast segmental decks

In an extension of the method of balanced cantilevering, precast segmental decks may be erected by the method of progressive forward cantilevering. With the segments being handled either by crane or shear legs, the deck is cantilevered forwards on one front only, with each span being carried on a series of temporary props until the next pier is reached, and the installation of permanent prestress renders the span self-supporting. Several spans may be erected without any cast-in-situ stitches, offering the possibility of a fast construction schedule.

VI. Incremental launching

The deck is built in segments behind one of the abutments and pushed or pulled forwards out of the mould by hydraulic jacks. As successive segments are cast the lengthening bridge deck slides over the piers, cantilevering from one to the other. Usually, the deck is equipped with a steel launching nose to control the cantilever bending moments.

VII. Prefabrication of complete spans

The ultimate form of prefabrication for the construction of bridge decks is when a complete span is built in a casting yard and then transported to the construction head and launched into place (Robert, 2008).

2.5 Railway Tunnel

2.5.1 Introduction

Rail tunnels are enclosed railways with rail vehicle access that is restricted to portals regardless of type of the structure or method of construction. Rail tunnels are feasible alternatives to cross a water body or traverse through physical barriers such as mountains, existing roadways, railroads, or facilities: or to satisfy environmental or ecological requirements (TMDCRT, 2009).

2.5.2 Shape and Internal Elements

There are three main shapes of railway tunnels – circular, rectangular, and horseshoe or curvilinear (TMDCRT, 2009).

The shape of a tunnel cross section is also called profile. The most widespread ones, are circular and (mostly oblate) mouth profiles. The choice of the profile aims at accommodating the performance requirements of the tunnel (Dimitrios, 2005).

Considering the cross and longitudinal sections of tunnels shown in Figure 2.12 and 2.13, the various locations are denoted by the indicated names.

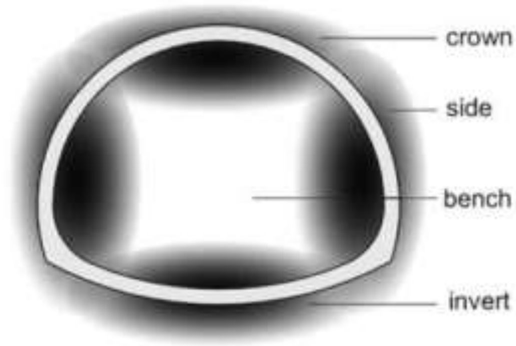

Figure 2.12: Parts of a Tunnel Cross Section

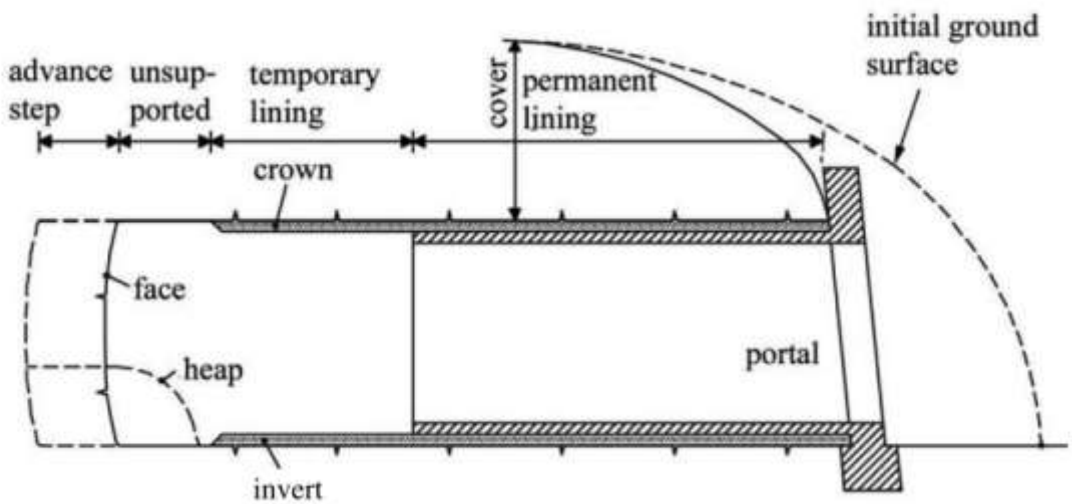

Figure 2.13: Longitudinal Sections of Heading (Dimitrios, 2005)

2.5.3 <u>Excavation and Support /Heading/</u>

The heading of a tunnel comprises the following actions: excavation, support of the cavity and removal of the excavated earth (mucking).

I. Excavation - Excavation is the process of detaching the rock using the following methods and tools:

- Hammer: Pneumatic and hydraulic hammers can be applied in weak rocks and achieve performances comparable with drill and blast.

- Excavators: Boomed backhoe buckets excavate weak rock, while thin rippers and hydraulic chisels are applied whenever hard rock inclusions are encountered.
- Road headers (boom cutters): These tools are used for moderate rock strengths and for laminated or joined rock.
- Cut and cover tunneling: The structure is built inside an excavation and covered over with backfill material when construction of the structure is complete.
- Tunnel boring machines (TBM): TBMs are applicable to rock of medium to high strength. TBMs excavate circular cross sections with a rotating cutter-head equipped with disc cutters. To press the cutter-head against the rock, the TBM is propped at the tunnel wall by means of extendable grippers. Therefore, the rock must have a sufficient strength. The support can be installed soon after the excavation.
- Drill & blast: It is suitable for hard rock (e.g. granite, gneis, basalt, quartz) as well as for soft rock (e.g. marl, loam, clay, chalk). Thus, it is applicable for rocks with varying properties. Moreover, drill & blast is advantageous for:
    - Relatively short tunnels, where a TBM does not pay
    - Very hard rock
    - Non-circular cross sections

  To keep drill & blast economical, the involved steps (drilling, charging, tamping, igniting, ventilating, support) must be coordinated in such a way that downtimes are avoided.

II. Mucking - The removal of the excavated rock/soil is known as mucking and consists of loading up, transport and unloading of the muck. For transport (haulage) the following variants are available:

- Trackless transport: Usual earthwork trucks are used.
- Rail-bound mucking (track transport): Is also applicable in crowded spaces, i.e. for spans < 6m.
- Continuous conveyors: Conveyors have a very large transport capacity (up to 200 t/h).

III. Support /Tunnel Lining/ – Tunnel support can be classified as Temporary and Permanent supports. (Technical Manual for Design and Construction of Road Tunnels – Civil Elements, 2009)

A. Temporary support

- Shotcrete: In tunneling, shotcrete is applied to seal freshly uncovered surfaces (in thickness of 3 to 5 cm) and for support of cavities.
- Steel meshes: Steel meshes (mesh size ≥ 100mm, ø < 10mm, concrete cover ≥ 2cm) are manually mounted and should, therefore, be not too heavy.
- Rock reinforcement: The mechanical properties of rock (be it hard rock or soft rock and soil) in terms of stiffness and strength can be improved by the installation of various types of reinforcement. Steel bars can be fixed at their ends and pre-tensioned against the rock. In this way, the surrounding rock is compressed and, as a consequence, its stiffness and its strength increase. Such reinforcing bars are called anchors or bolts.
- Timbering: In the early days of tunneling, timbering was the only means for temporary support. Nowadays it is mainly used for the support of small and/or irregular cavities (Dimitrios, 2005).

B. Permanent support

- Cast-in-place concrete lining: It is generally installed sometime after the initial ground support. Cast-in-place concrete linings are used in both soft ground and hard rock tunnels and can be constructed of either reinforced or plain concrete. Cast-in-place concrete linings can take on any geometric shape, with the shape being determined by the use, mining method and ground conditions.
- Precast concrete lining: It is used as both initial and final ground support. Segments in the shape of circular arcs are precast and assembled inside the shield of a tunnel boring machine to form a ring.
- Steel plate lining (liner plates): Are a type of segmental construction where steel plates are fabricated into arcs that typically are assembled inside the shield of a tunnel boring machine to form a ring. The steel plate lining may form the initial and final ground support (TMDCRT, 2009).

2.6 Summary of the Literature Review and Gap Identification

The main aspects of the literature review can be summarized with two points. First, an organization is a tool used by people to coordinate their actions to obtain something they desire or value; that is, to achieve their goals. Organizational chart is the visual representation of a whole set of underlying activities and processes in an organization. It also used to reflect organizational structure.

Second, there are three core project management processes which are planning, execution and controlling processes. Communication system, control mechanism, planning effort and developing an appropriate organization structure are project management factors which affect project success. Project management implementation is important for better project control in cost, time, quality and safety.

Construction projects and their success are closely related to contractors (Jaman and Margaret, 2012). Project management action is also a key for project success (Hubbard 1990). Jaselskis and Ashley (1991) suggested that by using the management tools, the project managers would be able to plan and execute their construction projects to maximize the project's chances of success. Then, the variables in project management include adequate communication, control mechanisms, feedback capabilities, troubleshooting, coordination effectiveness, decision making effectiveness, monitoring, project organization structure, plan and schedule followed, and related previous management experience (Belout 1998; Chua et al. 1999; Walker and Vines 2000).

Ethiopian Railway Corporation (ERC) is planning to establish a construction department with two main objectives; one to be able to construct small railway projects to link existing sugar factories. The second aim is to provide maintenance for the national railway network of the country. Min-Yuan, Cheng-Wei and Horng-Yuh (2007) report, the key element for smooth execution of a huge construction project is a suitable project organizational structure, which will improve the efficiency of communication between different groups of project members

Local contractors also have huge desire to participate in construction of modern railway projects; for example Tekleberhan Ambaye Construction P.L.C have highway and railway section since 2015, even if the company didn't have any projects related to railway. Jaman and Margaret (2012) report in post construction evaluation, about the CSFs of contractors that greatly impact on the success of a project. Based on the available literature, 35 CSFs were selected for this study. By employing a factor analysis approach, organizational structure and management and technical aspects of the contractor are the top two critical success factors.

In general, it is a fact that railway construction is a new side of infrastructure development for Ethiopian Railway Corporation (ERC) and local contractors. Therefore, a reliable project organizational structure for railway projects is not available to define and organize personnel for ERC and local contractors. A critical gap also exists in lack of key project management practices, where ERC and local contractors don't have construction procedures, task assignment method, reporting techniques and evaluating method of accomplished tasks in railway construction.

The title of the research includes the word "Adapting" to indicate that two railway contractors are taken as a case study and by compare their project organizational structures the one with higher quality will be adapted. It also tells the main intent of the research is only to take what is important to ERC and local contractors to be able to construct state of the art railway infrastructure with respect to railway track, bridge and tunnel. Therefore, this thesis tries to modify and adjust a case study results to Ethiopian railway construction industry.

Chapter Three – Research Design and Methodology

3.1 Study Area

Study area includes two projects namely; Awash – Weldia / Haragebaya Railway Project and Addis Ababa – Djibouti Railway Project with two international railway contractors.

I. Awash – Weldia / Haragebaya Railway Project by Yapi Merkezi

Awash – Weldia / Haragebaya railway line which connects northern Ethiopia with central region is shown in Figure 3.1. The total cost of the project amounts to 1.7 billion US dollar and it is under construction by a contractor Yapi Merkezi and with employer's representative SYSTRA-MD. The project starts at Awash Station diverting from the new Addis Ababa -Djibouti Railway Project traversing through the lowlands of Shewa towards Kombolcha and Weldia side. Most of the alignment passes through Amhara regional state and some part of it through Afar regional state of Ethiopia.

Figure 3.1: Awash – Weldiya / Haragebeya Railway Project Route

A. Description of Awash – Weldia / Haragebeya Railway Route

The area through which the project traverses can be classified as dominantly "semi-desert or kefil bereha" and "Warm or kola" near the end of the project route with mild effective temperature between 14^{o}c and 20^{o}c which is most of the time comfortable.

The mean monthly and annual rainfall of the project area is obtained from the Meteorological Maps of Ethiopia, 1979. Accordingly, the mean monthly rainfall of the project area is presented in the table below.

Table 3.1 Mean Monthly Rainfall (mm)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	50	50	100	50	50	50	150	150	50	50	25	10

The mean monthly minimum and maximum temperature of the project area is obtained from the Meteorological Maps of Ethiopia, 1979. Accordingly, the mean monthly maximum and minimum temperatures for the project area are presented in the table below.

Table 3.2 Mean Monthly Maximum and Minimum Temperature (^{0}C)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max.	30	30	30	35	35	30	25	30	30	30	30	30
Min.	15	15	15	15	15	20	15	20	15	15	10	10

The Project is characterized by a Rolling, Mountainous and Flat terrains both longitudinally and in the transverse directions. The terrain has been classified taking in to account the criteria indicated in the Ethiopian Roads Authority Geometric Design Manual - 2002 which is used in the country to classify terrain of any project. The terrain has been classified after collecting and analyzing the topography data.

Table 3.3 Summary of Terrain Classification

Terrain Type	Coverage (%)
Flat	48.7
Rolling	38.2
Mountainous	31.33
Escarpment	8.2
Total	126.43

According to geological map of Ethiopia (1996), the alignment soil varies along the alignment with the major portion of the alignment is covered with Black cotton soil, Light brown and dark brown silty/clayey sandy gravel material, basaltic and trachyte rock. There are frequent incursions of rock out crop of short stretches in the black cotton soil which shows that the thickness of the soil has no depth.

B. Yapi Merkezi

Yapi Merkezi is an international privately-owned contracting company, specializing in rail engineering, design, manufacture and construction. The company also has experience in electrification, signaling and telecommunication systems. It is founded in 1965, is located in Istanbul, Turkey, as well as branches in the United Arab Emirates, Qatar, Saudi Arabia, Algeria, Morocco, and Ethiopia.

Yapi Merkezi built 2600 km of railway and 300 stations in 39 projects. The projects able to provide safe transport for more than 2 million passengers daily in 3 continents. Yapi Merkezi received awards for its' projects; in 2004 UITP (International Association for Public Transport) "Light Rail Project of the Year" award is given to ESTRAM (Eskisehir LRTS), UITP "2010 Best Urban Integration Project of the Year" and British Light Rail Transit Association's "Worldwide Project of the Year" awards are given to Kayseray (Kayseri Light Rail System). Also in 2012, British

Light Rail Transit Association's "Best World Class Rail System of the Year" award is given to Casablanca Tramway.

C. Acclaim

Since 1998, Yapi Merkezi has been continuously listed in Engineering News Record's (ENR) annual Top 225 International Contractors List. In the mass transit / light rail category, Yapi Merkezi was ranked 4th largest in the world in 1998, 3rd in 1999 and 7th in 2000.

II. Addis Ababa - Djibouti Railway Project by China Railway Group Limited /CREC/

The Addis Ababa/Sebeta – Port of Djibouti railway line starts at the highlands of Ethiopia and traverses along the rift valley and terminates in the low lands of Djibouti. The Addis Ababa – Djibouti route alignment and surrounding area map is presented in Figures 3.2.

Figure 3.2: Addis Ababa - Djibouti Railway Project Route

The 320 km stretch from Sebeta to Mieso was awarded to the CREC, and the 339 km section from Mieso to the Djibouti border was awarded to the CRCC. In 2012, Djibouti selected the CRCC to complete the final 100 km to the port of Djibouti. The total costs of the railway amounted to 1.873 billion US dollar for the Sebeta-Mieso section, 1.12 billion US dollar for the Mieso-Dewele section and 525 million US dollar for the Dewele-Port of Doraleh section.

A. Description of Addis Ababa - Djibouti Railway Project Route

The railway line is located in East African Rift Valley, where crustal motion is active, geological structures mainly consisting of fault and volcano are under abnormal development and fault mainly belongs to feather fracturing, mostly secondary fault of Great Rift Valley of Ethiopia (generally the result of a compression-shear fault).

The land form and terrain condition varies from highland and plateau in Ethiopian to desert plain land in Djibouti. Except in a few undulating sections, most of the railway line can be considered flat terrain with acceptable altitude difference. The entire route can be grouped as follows:

- Plateaus, highlands and shadow hill area formed because of erosion and undercutting of seasonal flood for months and years, surface-deep dry gulch,
- Volcanic lakes at different sites
- Low mountain and shallow hill area
- Plain and low hill area mainly covered with dense spiky shrubbery
- Plain area with sparse vegetation and locally developed gulch.

The railway line is built in areas of highland terrace, shallow hill and plain, with wide terrain and small undulating in some sections. There is basically no natural disaster and major unfavorable geologies such as landslide, collapse, debris flow, coal bed and gob along the whole line. Main engineering geological problems are seismic faults, expansive soils, loose rock and bedrock soft interlayer, unstable slope and soft soil.

The underground water along the route mainly includes ditch-water, swamp water, and water from Awash River and Beseka Lake. There is no river with perennial water along the line except the Awash River. There are underground water resources at various sites along the route.

B. China Railway Group Limited /CREC/

China Railway Group Limited is an international leading comprehensive construction enterprise group. China Railway Group Limited enjoys a history of more than 120 years. By the end of 2015, China Railway Group Limited has a total assets of 108 billion US dollar, net assets of 20 billion US dollar, 43 super large subordinate enterprises and 300 thousand employees, with the business scope covering infrastructure construction of the whole industry chain. In 2015, the enterprise newly signed contracts amount to 144 billion US dollar, operating income of 94 billion US dollar.

China Railway Group Limited has successively built the railway lines of more than 90000 kilometers, among of which the high-speed railways were more than 10000 kilometers; designed and built a variety of bridges with a total length of more than 17000 kilometers and long tunnels of more than 16000 kilometers; built the subways and light rails of more than 2000 kilometers; built the high-class highway of more than 40 thousand kilometers, among of which the highways were more than 15000 kilometers; and built a large number of landmark buildings. China Railway Group Limited has a solid strength in the field of industrial manufacturing of survey and design, equipment manufacturing and steel beam, steel structure, railway switch and so on, has achieved fruitful results in the field of real estate development, resource development, financial investment and so on. At present, China Railway Group Limited is providing services to more than 90 countries and regions around the world.

C. Acclaim

It creates unprecedented outstanding achievements. Since 2006, CREC has entered the top 500 enterprises of the world for eleven consecutive years. In 2016, it ranks 57th among the top 500 enterprises of the world and ranks 7th among top 500 enterprises of China.

3.2 <u>Research Design</u>

The research employs a descriptive scientific study and interview will be a major means to collect essential data. In addition to this, desk study on actual organizational structures of the two contractors and contract documents gives valuable information to the research.

3.3 Data Collection

The following data was collected from construction of railway track, bridge and tunnel:

- Organizational structures of Yapi Merkezi and CREC
- Main duties and responsibilities of construction workers
- Gather data on sequence of construction activities
- At the construction site, gather data on construction process of railway track, bridge and tunnel
- Interview to document how construction tasks are assigned and communicated
- Document line of command during execution of construction work
- Controlling and evaluating method for construction of railway track, bridge and tunnel

3.4 Interview Design

Seven interview questions are prepared based on research questions from section 1.4 and are directly related to research objectives.

Question 1: Can you explain work flow of your division or department?

Question 2: What are your main duties and responsibilities?

Question 3: Do you have any working procedures (method statements) to accomplish your task?

Question 4: Who give you the tasks that you have to undertake?

Question 5: How do you communicate with your team to achieve the tasks given by team leader or chief?

Question 6: How do you report and for whom you report the work done?

Question 7: How do you evaluate yourself or your team performance?

3.5 Population Definition

Respondents to the top of organizational hierarchy includes Project Manager and Deputy Project Manager. In addition to this, to construction division level; Division Manager, Division Chief Engineer, Site Engineer and Forman are selected for an interview.

3.6 Method of Analysis

The analysis of the data gathered will be executed by four stages:

- First Stage: Compare organizational structure of Yapi Merkezi and CREC.
- Second Stage: Select a higher quality organizational structure and detail it for construction of railway track, bridge and tunnel.
- Third Stage: Assess key project management practices for construction of railway track, bridge and tunnel.
- Fourth Stage: Analyze the data and adapt a project organization structure and key project management practices for construction of railway track, bridge and tunnel.

Chapter Four – Comparison of Organizational Structures /Yapi Merkezi and China Railway Group Limited/

4.1 Introduction

In this chapter factors affecting organizational structures selectin and dimensions of organizational design are presented. In addition to this, organizational chart of Awash – Weldia Railway Project contractor Yapi Merkezi and Addis Ababa – Djibouti Railway Project contractor China Railway Group Limited are presented below. Finally, it discuss comparison of the two organizational structures.

4.2 Dimensions of Organization Design

The first step for understanding and evaluating organizations is to look at dimensions that describe specific organizational design traits. These dimensions describe organizations in much the same way that personality and physical traits describe people. Organizational dimensions fall into two types: structural and contextual. (Richard, 2010)

A. Structural dimensions

Provide labels to describe the internal characteristics of an organization. They create a basis for measuring and comparing organizations.

1. Formalization – pertains to the amount of written documentation in the organization. Documentation includes procedures, job descriptions, regulations, and policy manuals. These written documents describe behavior and activities. Formalization is often measured by simply counting the number of pages of documentation within the organization.
2. Specialization – is the degree to which organization tasks are subdivided into separate jobs. If specialization is extensive, each employee performs only a narrow range of tasks. If specialization is low, employees perform a wide range of tasks in their jobs. Specialization is sometimes referred to as the division of labor.
3. Hierarchy of Authority – describes who reports to whom and the span of control for each manager. The hierarchy is depicted by the vertical lines on an organization chart. It is also related to span of control (the number of employees reporting to a supervisor). When

spans of control are narrow, the hierarchy tends to be tall. When spans of control are wide, the hierarchy of authority will be shorter.

4. Centralization – refers to the hierarchical level that has authority to make a decision. When decision making is kept at the top level, the organization is centralized. When decisions are delegated to lower organizational levels, it is decentralized.
5. Professionalism – is the level of formal education and training of employees. Professionalism is considered high when employees require long periods of training to hold jobs in the organization. Professionalism is generally measured as the average number of years of education of employees, which could be as high as twenty in a medical practice and less than ten in a construction company.
6. Personnel ratios – refer to the deployment of people to various functions and departments. Personnel rations include the administrative ratio, the clerical ratio, the professional staff ratio, and the ratio of indirect to direct labor employees. A personnel ratio is measured by dividing the number of employees in a classification by the total number of organizational employees.

B. Contextual dimensions

It characterize the whole organization, including its size, technology, environment, and goals. They describe the organizational setting that influences and shapes the structural dimensions. Contextual dimensions can be confusing because they represent both the organization and the environment. They can be envisioned as a set of overlapping elements that underlie an organization's structure and work processes.

1. Size – can be measured for the organization as a whole or for specific components, such as a plant or division. Because organizations are social systems, size is typically measured by the number of employees.
2. Organizational technology – refers to the tools, techniques, and actions used to transform inputs into outputs. It concerns how the organization actually produces the products and services it provides for customers and includes such things as flexible manufacturing, advanced information systems, and the Internet.

3. The environment – includes all elements outside the boundary of the organization. Key elements include the industry, government, customers, suppliers, and the financial community. The environmental elements that affect an organization the most are often other organizations.
4. The organization's goals and strategy – define the purpose and competitive techniques that set it apart from other organizations. Goals are often written down as an enduring statement of company intent. A strategy is the plan of action that describes resources allocation and activities for dealing with the environment and for reaching the organization's goals. Goals and strategies define the scope of operations and the relationship with employees, customers, and competitors.
5. An organization's culture – is the underlying set of key values, beliefs, understandings, and norms shared by employees. These underlying values and norms may pertain to ethical behavior, commitment to employees, efficiency, or customer service, and they provide the glue to hold organization members together. An organization's culture is unwritten but can be observed in its stories, slogans, ceremonies, dress, and office layout.

4.3 Yapi Merkezi /Awash – Weldia Railway Project Contractor/ Organizational Structure

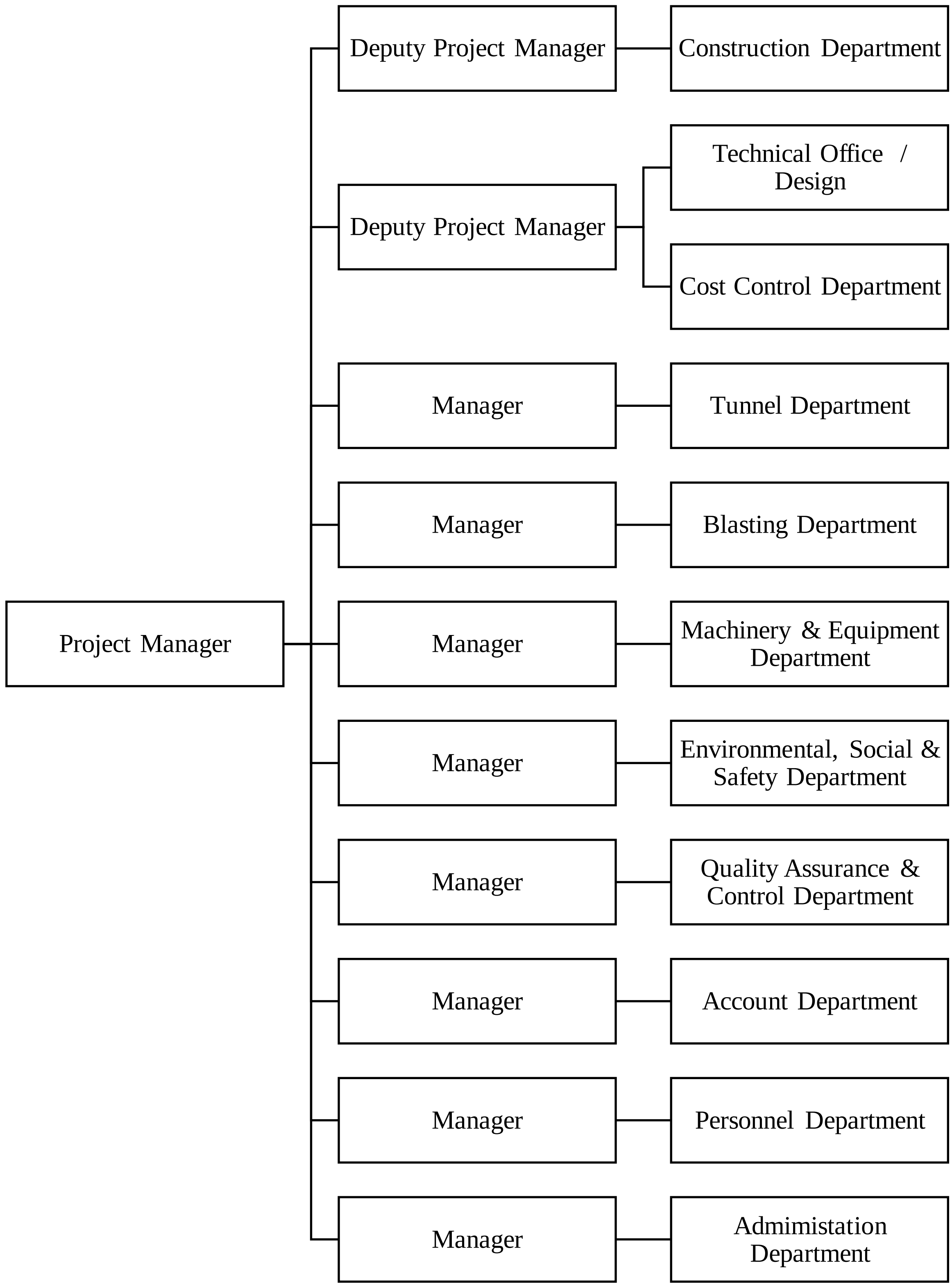

Figure 4.1: Yapi Merkezi Organizational Chart

4.4 China Railway Group Limited /Addis Ababa – Djibouti Railway Project Contractor/ Organizational Structure

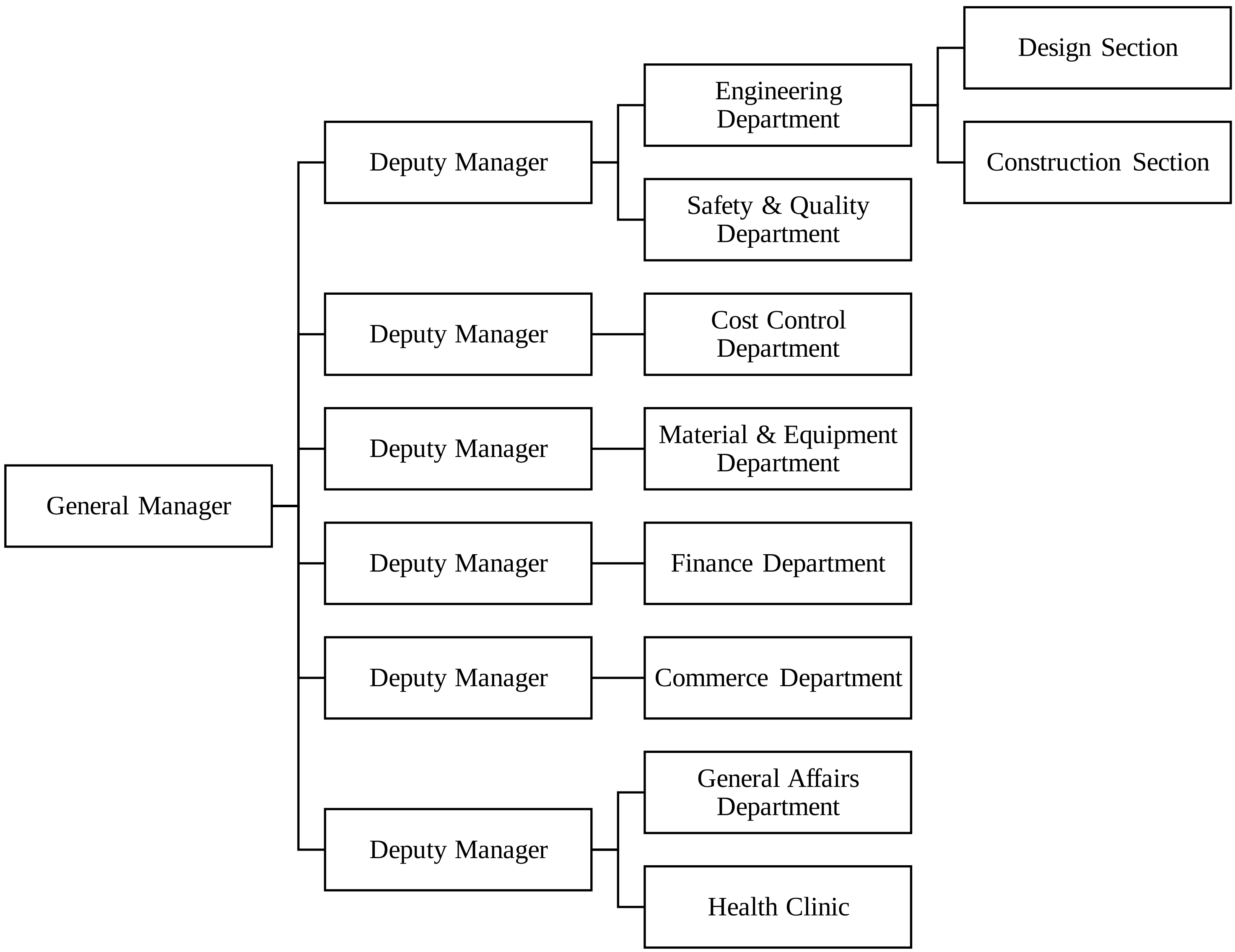

Figure 4.2: China Railway Group Limited (CREC) Organizational Chart

4.5 Comparison

The two organizational structures; Yapi Merkezi Organizational Structure and China Railway Group Limited (CREC) organizational structure are compared in Table 4.1 using dimensions of organizational design and factors affecting organizational structure selection as follows:

Table 4.1: Comparison of Yapi Merkezi and CREC Organizational Structure

	Dimensions & Factors	**Yapi Merkezi**	**CREC**
1	Specialization – Number of separate departments with separate tasks	Ten	Six
2	Hierarchy of Authority – Spans of control (a number of employees reporting to Manager and Deputy Project Manager)	Narrow	Wide
3	Centralization – Decision making is kept at the top level	Decentralized	Decentralized
4	Professionalism – Level of formal education and training of employees	High	Medium
5	Size – Number of employees (Permanent)	High	Low
6	Organizational technology – Advanced information systems and internet	High	Medium
7	The Environment – Government requests for Environment, Social & Safety concerns	Fully Developed /Environment, Social & Safety Department/	Partially Developed /Safety & Quality Department/
8	An organization’s culture – Values and norms may pertain to ethical behavior, commitment to employees, efficiency or customer service	High	Medium
9	Complexity of the project – Number and types of railway track, bridge and tunnel	High	Medium

In general, the comparison table shows; Yapi Merkezi organizational structure is better than CREC organizational structure. Therefore, Yapi Merkezi organizational structure and its' key project management practices for construction of railway track, bridge and tunnel are adapted and elaborated in great detail in chapter five.

Chapter Five – Adapted Project Organization Structure and Key Project Management Practices of the Case Study Analysis

5.1 Introduction

A total of forty interviews were undertaken and extensive amount of data is collected on Yapi Merkezi handling of the project. Gathered data analyzed systematically to give a proper understanding of how Yapi Merkezi organize the project and integrate the construction of railway track, bridge and tunnel.

This chapter reports and discuss adapted project organizational structure and key project management practices of Yapi Merkezi. For ERC and local contractors, adapting is an alternative as it is faster and cheaper means to bring advanced project organization structure and key project management practices to immediate practice. Apart from this, adapting provides a means to modify the process in every possible way and enable to create a system that can upgrade the current construction process without a major disruption.

5.2 Awash – Weldia Railway Project

Awash – Weldia railway project has a total length of 389 km. The project designed for a Single Track, to accommodate 20 freight locomotives and 6 passenger trains.

ERC (Ethiopia Railway Corporation) signed EPC / Turnkey Contract for execution of the project with Turkish company Yapi Merkezi Construction and Industry Inc. In a turnkey basis the contractor shall undertake the survey, design, procurement, manufacture, construction, installation and testing for execution of the project. In addition to this, SYSTRA and MULTI-D Engineering Consultancy PLC jointly represent ERC.

5.3 Major Divisions for Construction of Railway Track, Bridge and Tunnel

A case study analysis shows, there are six construction divisions and five construction departments used by Yapi Merkezi. All construction divisions and departments are vital for realization of railway track, bridge and tunnel. Therefore, the following divisions and departments are adapted for construction of railway infrastructure.

Specific to Trackworks, due to a need for specialization and to provide regular maintenance it must be organized independently as a sister company.

A. Infrastructure Division
   - A-1. Survey Department
   - A-2. Alignment Works Department
   - A-3. Precast Production & Building Department
   - A-4. Electromechanical Department
   - A-5. Trackworks Subcontractor /Sister Company/
B. Tunnel Division
C. Machinery & Equipment Division
D. Environmental, Social & Safety Division
E. Blasting Division
F. Quality Assurance / Quality Control Division

5.4 Adapted Project Organizational Structure of the Case Study Analysis

Yapi Merkezi organizational chart have been changed a number of times; two organizational chart versions are available, version 11 with last modified date of 14/12/2015 and version 15 with last modified date of 28/12/2016. The main reasons for change are as follows:

- To speed up construction and meet the planned schedule
- To increase productivity
- To accommodate additional working force due a need for increasing productivity

The current Yapi Merkezi project organization chart which is version 15 is discussed in three major points. From Roman number “I” to “II” explain about construction and Roman number “III” is about technical office.

This section adapts most of the organizational structure. However, to come up with simple and flexible hierarchy there are minor modifications. Contents of adapted organizational structure are presented from Figure 5.1 to Figure 5.15.

I. Project Manager

Awash - Weldia / Haragebeya railway project is assigned to a single Project Manager and manage the project by dividing it into two major activities that are directly accountable to the Project Manager.

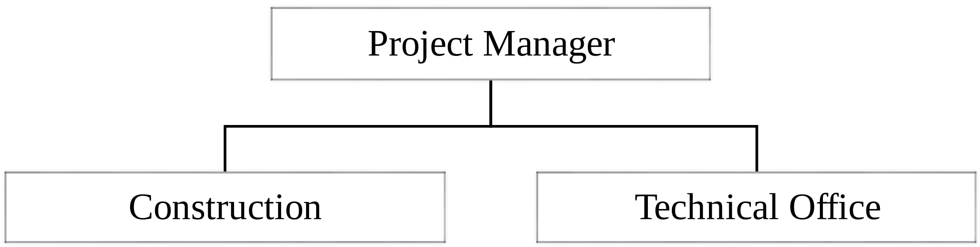

Figure 5.1: Project Manager

Job Title: Project Manager

Job Description: - To provide leadership and to establish and maintain effective and harmonious working relationships with all those involved in the project

- To organize, supervise and coordinate the project and on-site staff

- To have adequate knowledge and understanding of Contract Documents, General Contract and Subcontracts

- To make sure that all drawings and specifications are examined for design deficiencies, impractical details and possible code violation, prior to beginning of construction

- To make sure project work completed on schedule, within the budget and to the quality of workmanship specified

- To see that the prescribed quality control measure are implemented and maintained throughout the life of the project

- To utilize skills to run multiple projects as efficiently as possible

Job Qualification: B.Sc. Degree in Civil Engineering and above twenty years of experience.

II. Construction

There are six divisions under the construction part of the project. Besides, six division managers are responsible to lead their respective teams.

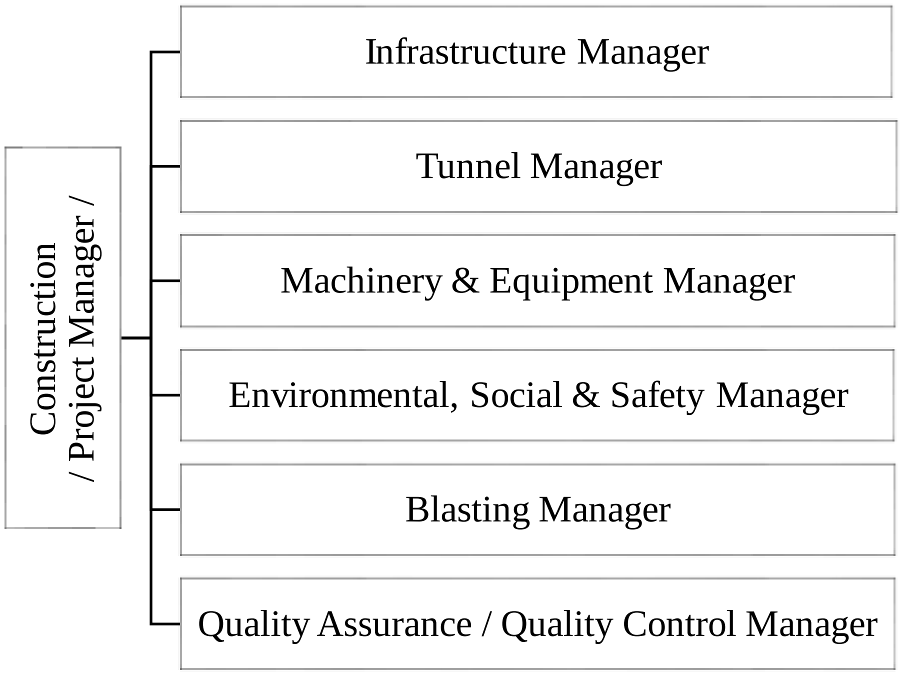

Figure 5.2: Construction

A. Infrastructure Division

The infrastructure part of the project is divided into two and managed by two different teams with their own respective Deputy Project Manager.

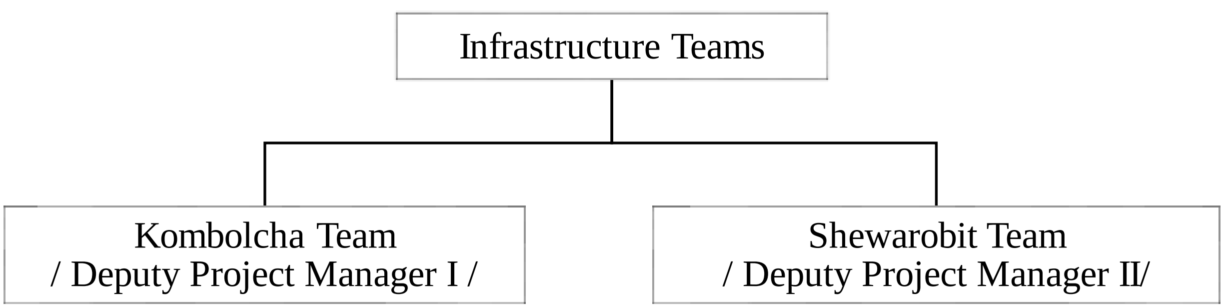

Figure 5.3: Infrastructure Team

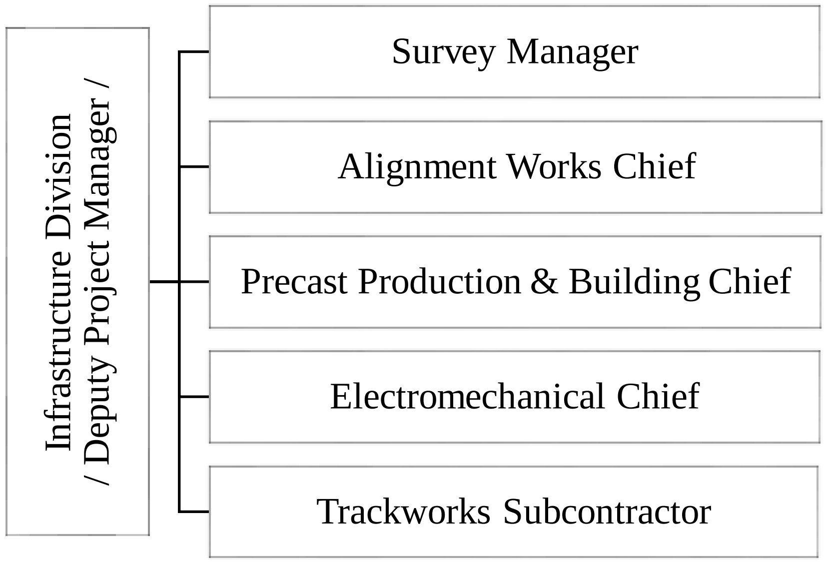

Figure 5.4: Infrastructure Division

A – 1. Survey Department

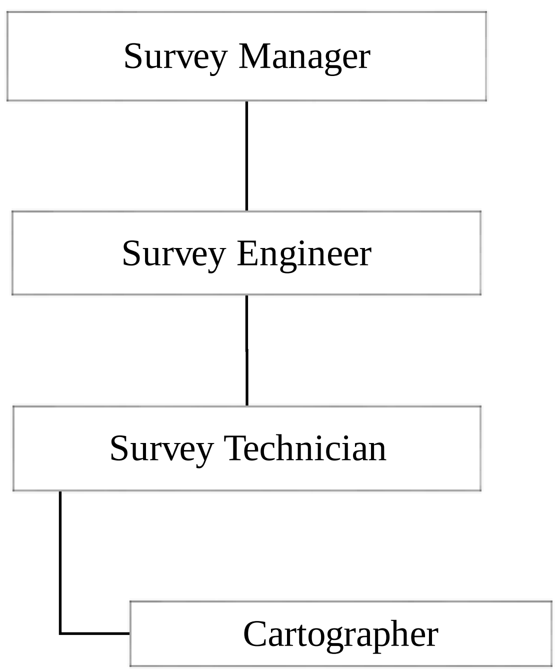

Figure 5.5: Survey Department

A – 2. Alignment Works Department

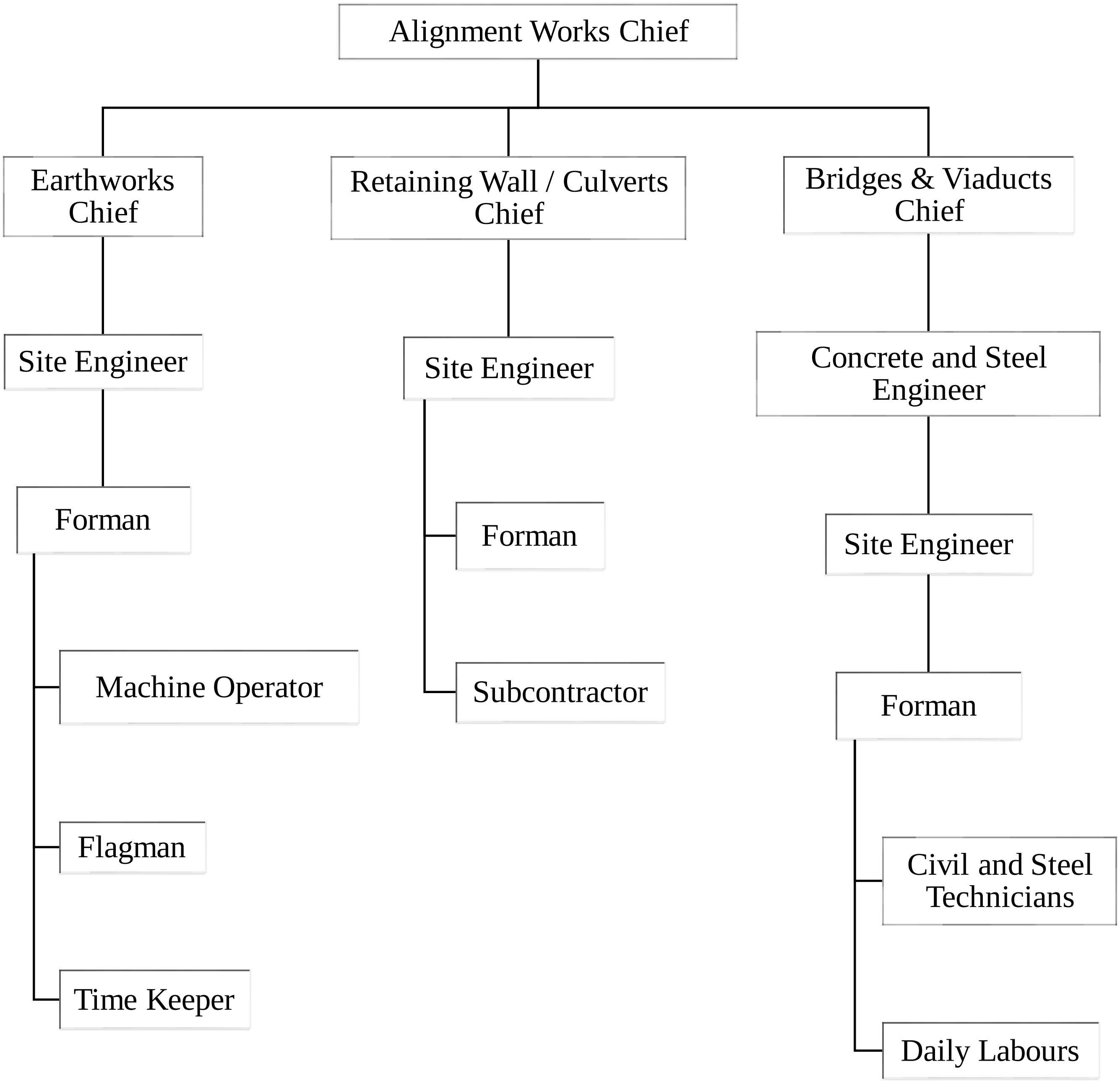

Figure 5.6: Alignment Works Department

A – 3. Precast Production / Building Department

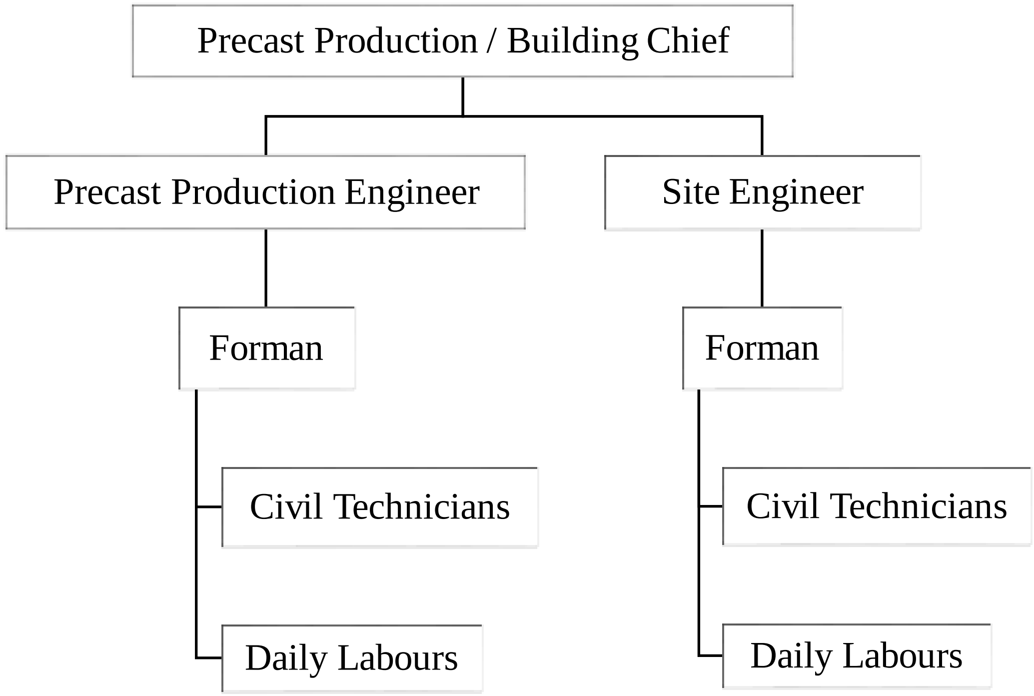

Figure 5.7: Precast Production / Building Department

A – 4. Electromechanical Department

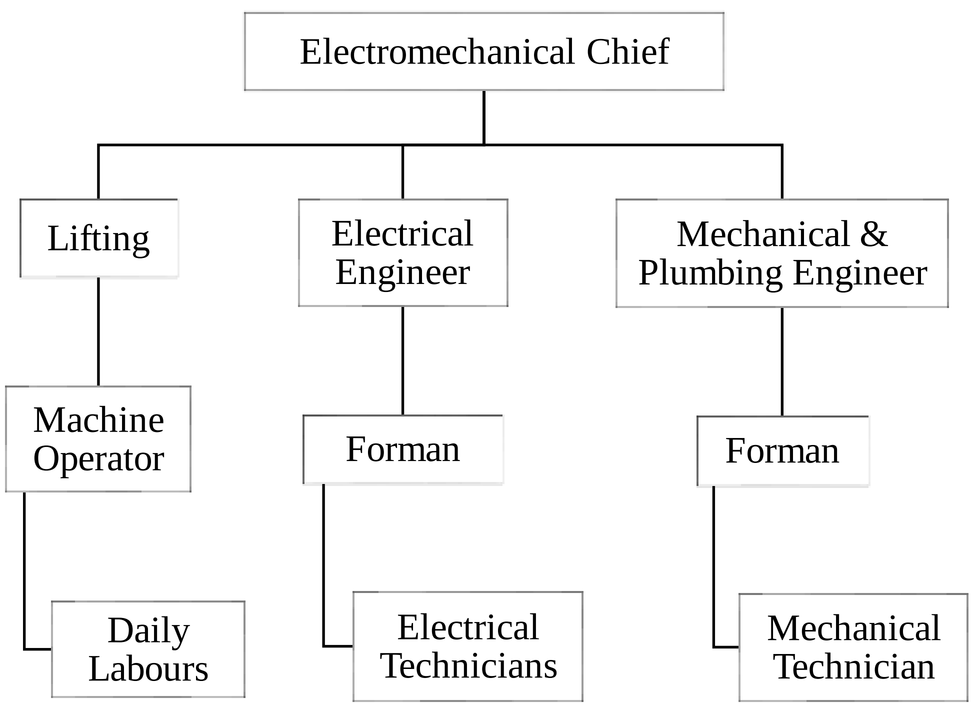

Figure 5.8: Electromechanical Department

A – 5. Trackworks Subcontractor /Sister Company/

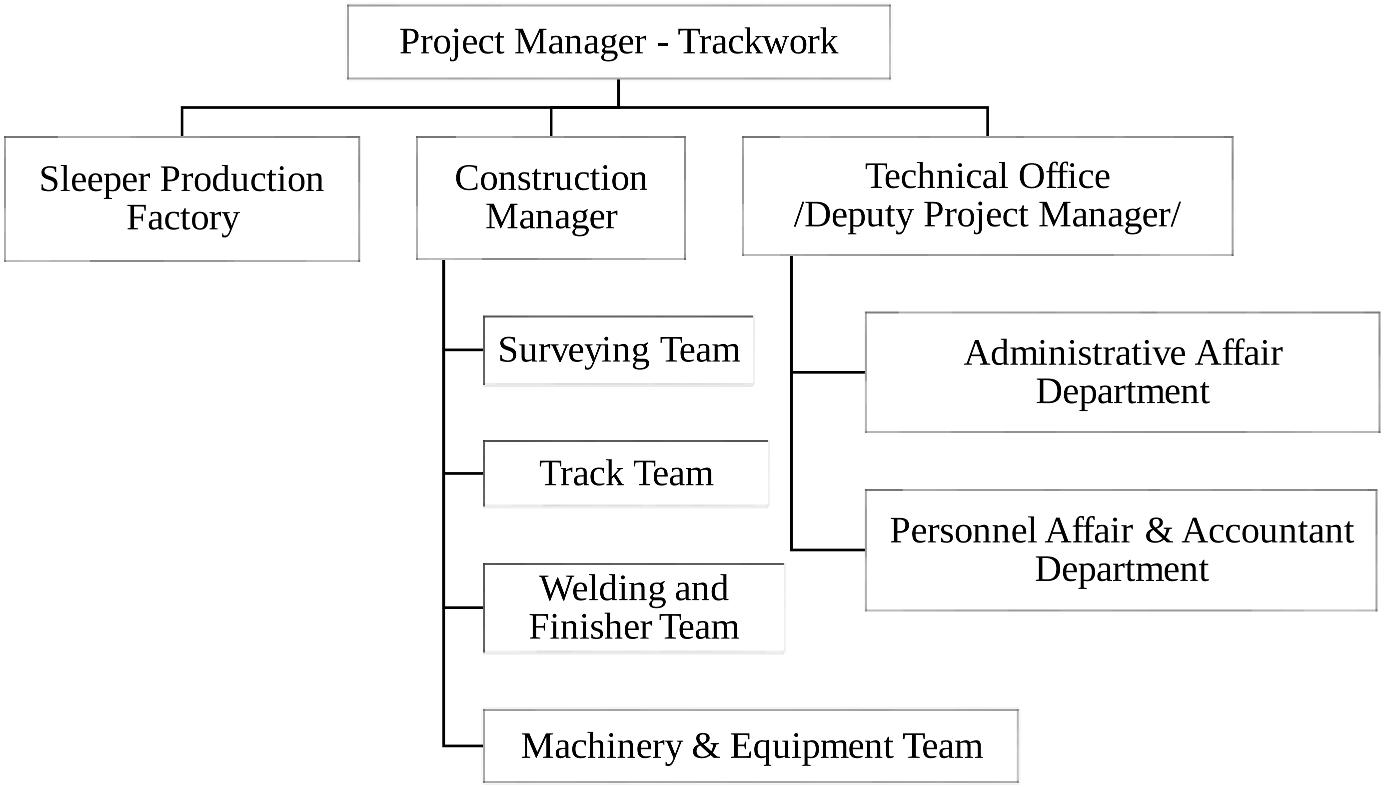

Figure 5.9: Trackworks Subcontractor

B. Tunnel Division

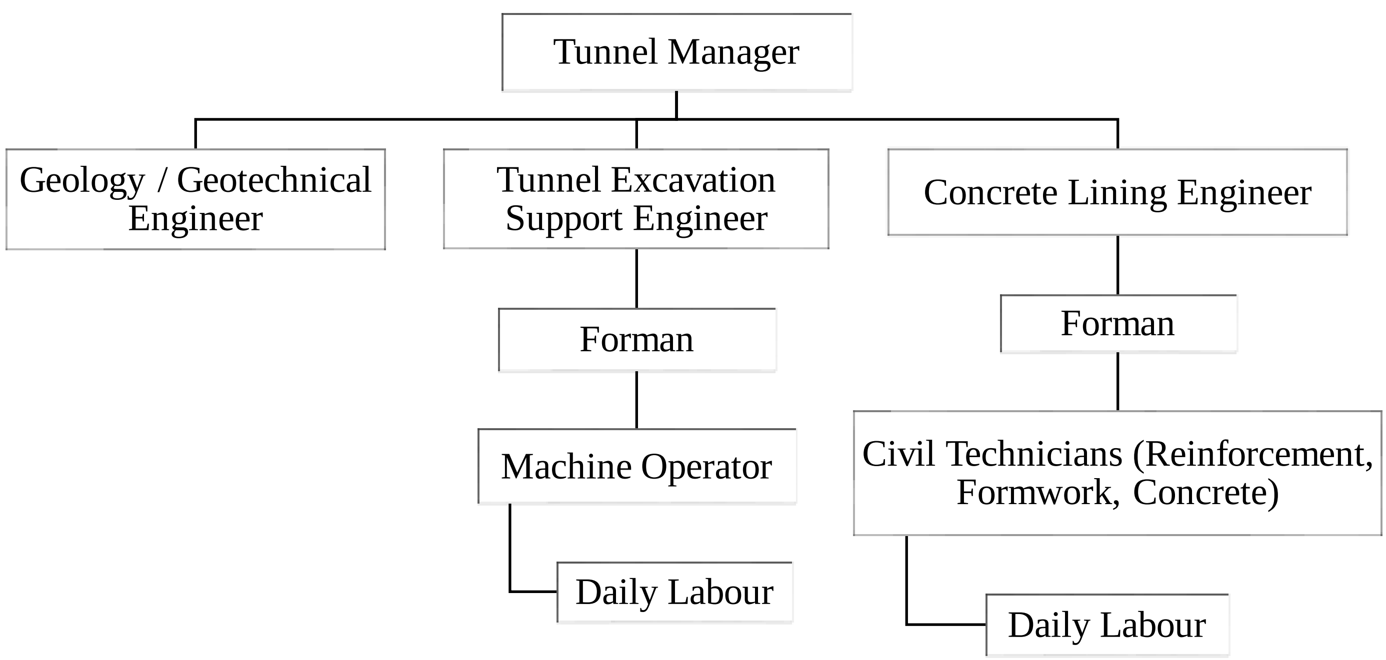

Figure 5.10: Tunnel Division

C. Machinery & Equipment Division

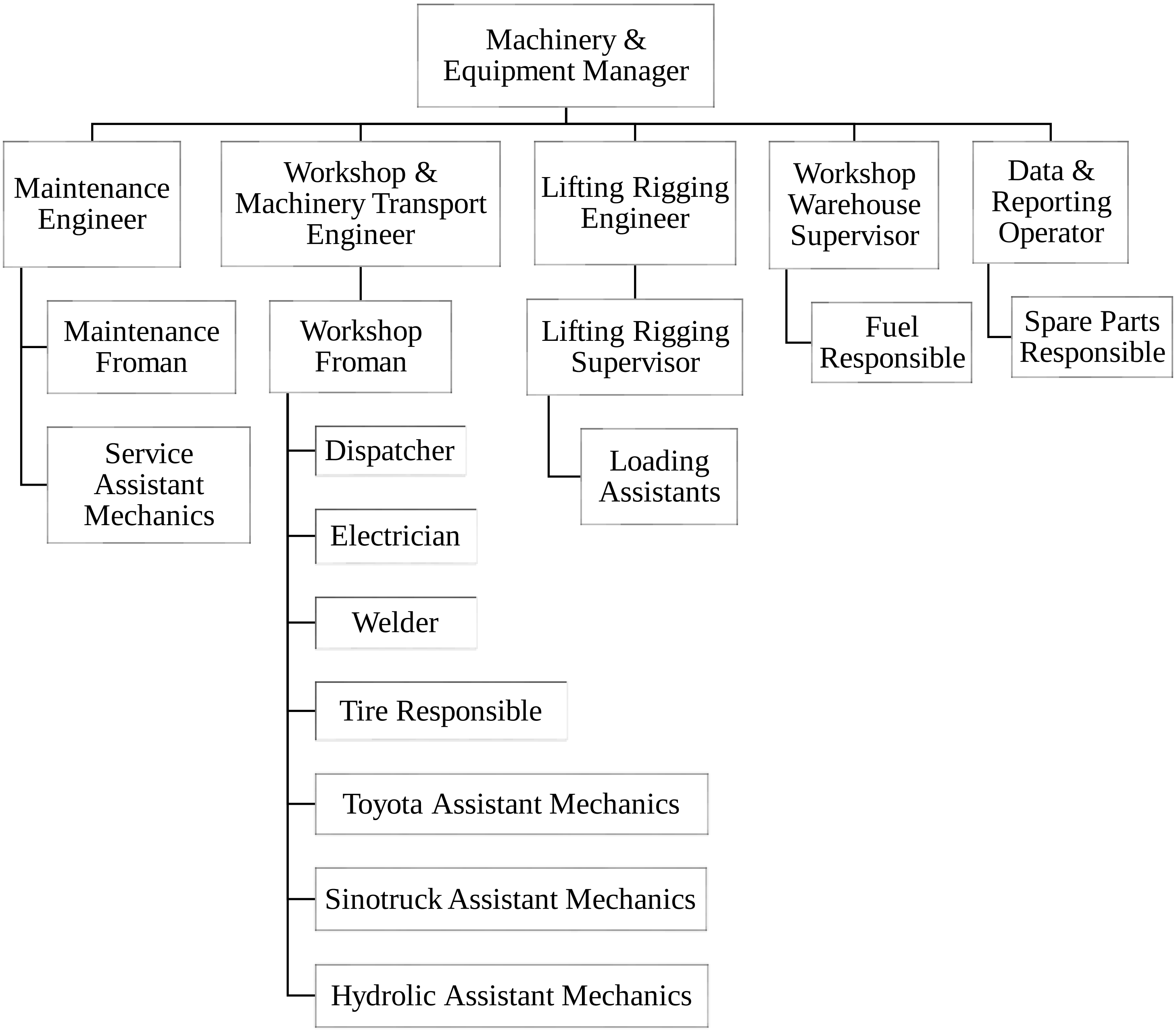

Figure 5.11: Machinery & Equipment Division

D. Environmental, Social & Safety Division

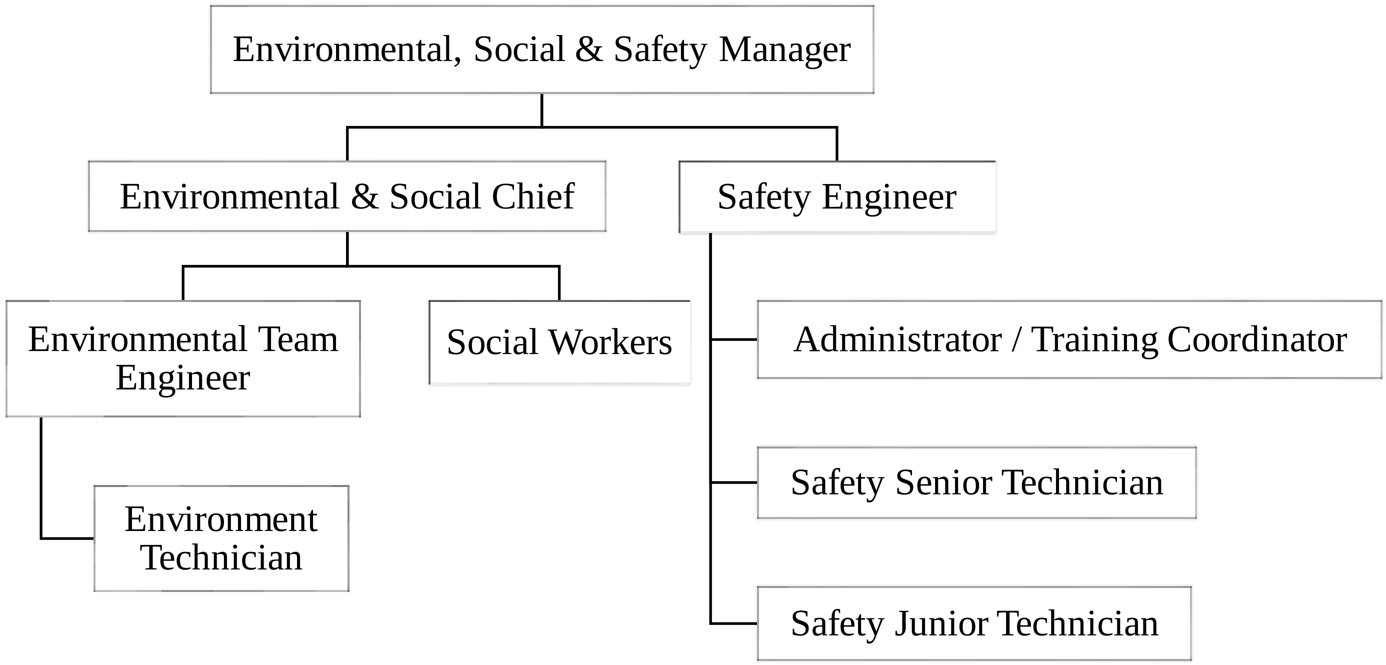

Figure 5.12: Environmental, Social & Safety Division

E. Blasting Division

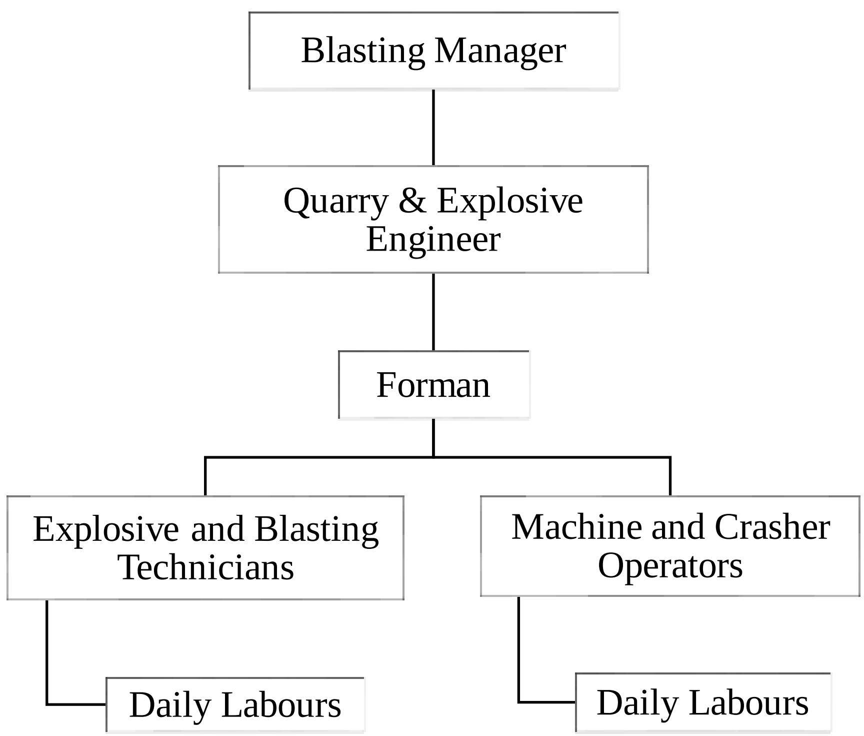

Figure 5.13: Blasting Division

F. Quality Assurance / Quality Control Division

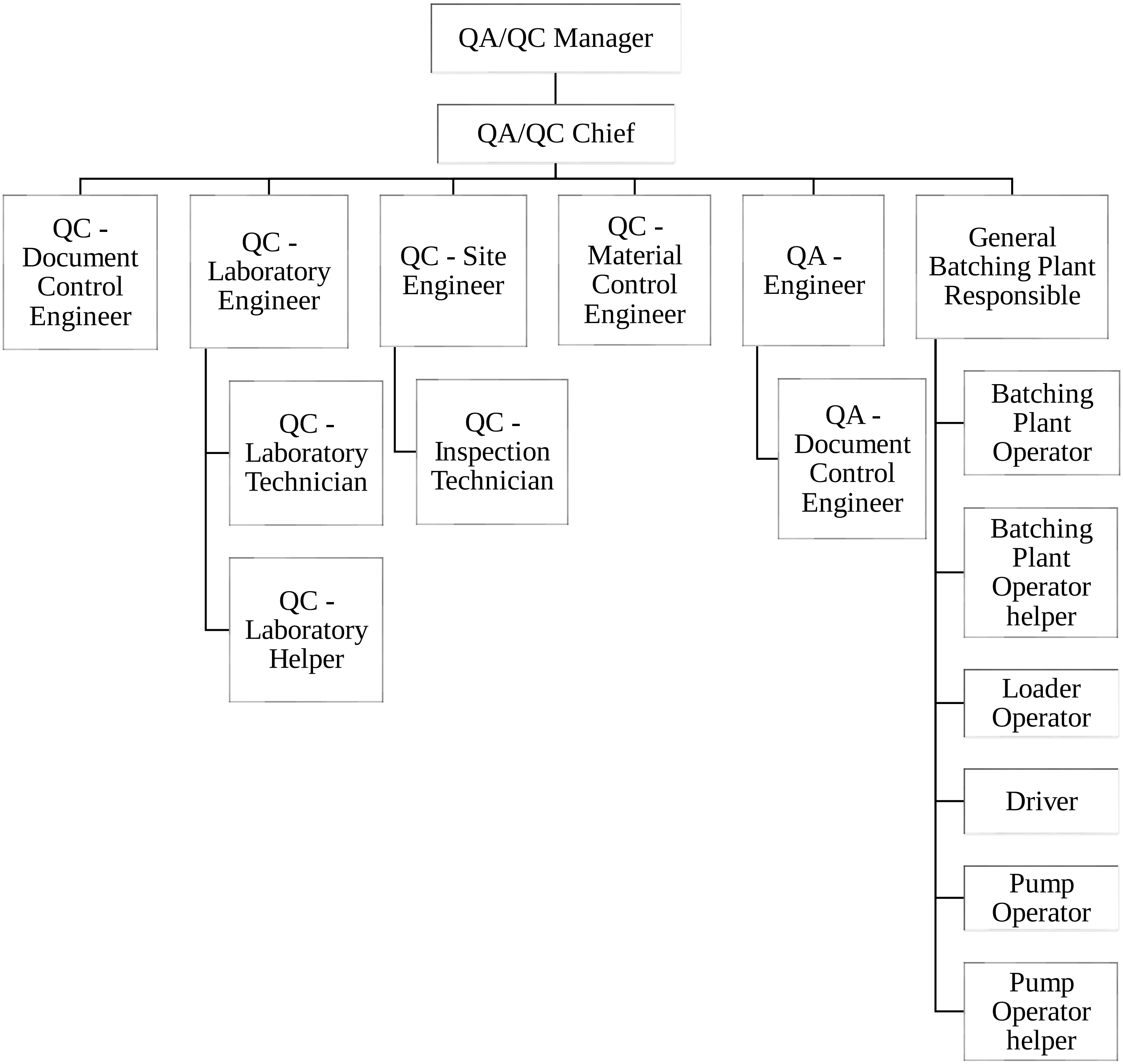

Figure 5.14: Quality Assurance / Quality Control Division

III. Technical Office

There are four division managers under technical office manager to undertake the necessary office work, to manage human resource and closely follow the contract document.

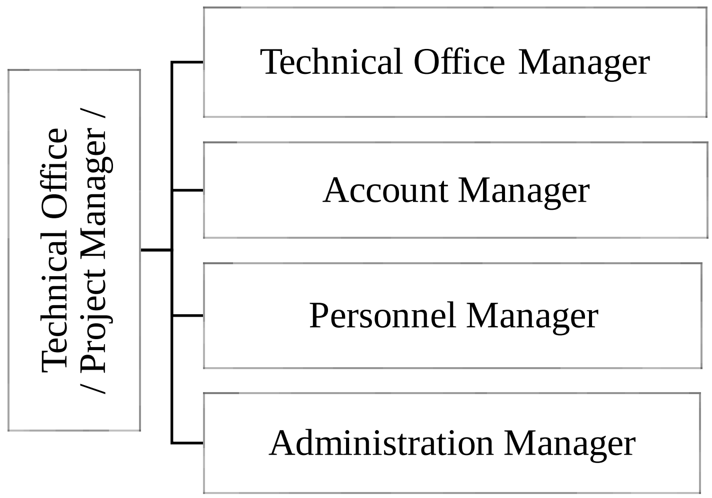

Figure 5.15: Technical Office

5.5 Adapted Key Project Management Practices of the Case Study Analysis

This portion includes how Yapi Merkezi identify, define, combine, unify and coordinate the various construction processes and project management activities. Each construction division will be discussed in four sections. For executing process group, working procedures /construction method/ applied and task assignments will be discussed. For monitoring and controlling process group, reporting /to track, review and regulate the progress/ and evaluating performance will be discussed. Apart from this, a critical aspect of project management depends on preparation of Method Statements. Quality Assurance (QA) Engineers compile a total of fifty five Method Statements specific to track, bridge and tunnel construction.

Construction divisions' and departments' key project management practices are discussed with respect to four points listed above. However, Trackworks will not be part of this discussion; it is because it requires specialization in sleeper production, upper track layer construction, welding and finishing. Therefore, Trackworks must be independent and managed as a sister company.

All method statements, Inspection and Test Plan Forms, Test Result Registration Forms, Excel Formats, Request for Inspection Form, Environmental, Social & Safety Procedures and Toolbox are adapted and available with DVD as part of the thesis.

1. **Survey Department**

   A. Working Procedures / Construction Method / Applied

   For Track, Bridge and Tunnel surveying there are two Method Statements, which are listed below:

   1. Method Statement for Superstructure Surveying
   2. Method Statement for Infrastructure Surveying

   Survey division uses the following software that are listed in Table 5.1 below:

   Table 5.1: Software Types and Main Functions

Software	Main Function
AutoCAD Civil 3D	To calculate area, volume…
Net Cad	Turkish cad
Global Mapper	File type changer
Homeport	Used as hand GPS
Geo-office	To adjust GPS
Road line	To create alignment data
Crimson Editor	For text array
Google Earth	To identify location

   Surveying devices and communication equipment used are as follows:

   - Global Positioning System /GPS/
   - Total Station
   - Levelling Device
   - Radio Communication Device
   - Radio Communication Antenna

   B. Task Assignment

   Survey manager is responsible to determine and allocate extent of daily, weekly and monthly tasks of survey engineers. Document Control Center (DCC) sends Request for

Inspection (RIF) Form to survey manager before 24hours. Besides, DCC sort-out requests for timely and effective response.

Survey division have daily meetings at 7:00AM headed by survey manager. Main points of the discussion are:

- To evaluate executed requests
- Number of requests received
- Progress of works at hand

Based on RFI form, survey engineers start to prepare essential data for topographers and are responsible to deliver accurate survey data within the given time frame. Finalized survey data handed to different survey groups. For main camp of the project, survey personnel can be organized as shown in the Table 5.2, Table 5.3 and Table 5.4. Work classification and device used are fully adapted but working area is included to show extent of location difference they are working on.

Table 5.2: Personnel at Main Camp – Part One

Camp	**Main Camp**				
Topographer	1	1	1	1	1
Device Operator	1	2	1	1	1
Chainman	2	2	3	2	2
Drivers	1	-	-	1	1
Cars	1	1	1	1	1
Radio Communication Device	1	2	2	2	-
Work Area	Km 0 - Km 90	Km 0 - Km 40	Km 30 - Km 87	Km 40 - Km 80	Km 40 - Km 50
Survey Device	GPS	Total Station	Total Station	Total Station	GPS
Main Work	Earthworks and Benchmark	Culverts, Irrigation and Boxes	Bridges	Culverts and Level Crossings	Earthworks

Table 5.3: Personnel at Main Camp – Part Two

Camp	Main Camp					
Topographer	1	1	1	1	1	1
Device Operator	1	1	-	1	-	1
Chainman	2	2	3	3	3	2
Drivers	-	1	-	1	1	1
Cars	1	1	-	1	1	1
Radio Communication Device	2	2	2	2	-	2
Work Area	Km 86 - Km 94	Km 120	Main Camp	Km 114 - Km 157	Km 0 - Km 200	Km 120
Survey Device	Total Station	Total Station	Total Station	Total Station	Leveling Device	Total Station
Main Work	Electrical Excavations & Earthworks	Electrical Excavations & Drainage	Station Buildings	Bridge	Benchmark Installation & Leveling Measurement	Catenary Anchorage

Table 5.4: Personnel at Main Camp – Part Three

Camp	Main Camp			
Topographer	1	1	1	1
Device Operator	1	2	1	1
Chainman	1	2	3	2
Drivers	-	1	-	1
Cars	-	1	1	1
Radio Communication Device	-	3	2	-
Work Area	Main Camp	At Km 179, Km 185	Km 160 - Km 200	Km 159 - Km 200
Survey Device	Total Station	Total Station	Total Station	GPS
Main Work	Station & Deformation Measurements	Tunnels & Retaining Walls	Culvert Inlet - Outlet Excavations & Gabion Walls	Earthworks, Drainage & Electrical

C. Reporting / To Track, Review and Regulate the Progress /

Topographers prepare daily work report and give to survey engineers. In combination with what survey engineers accomplish; engineers prepare daily, weekly and monthly report of the division. Finally, survey manager check, sign and send it to DCC.

D. Evaluating Performance

Survey division evaluates division performance with respect to request made by construction division. The cumulative work of survey engineers, topographers, device operators and chainman is a means to evaluate survey division.

- Survey Manager – evaluated for RFI made to RFI executed with respect to time.
- Survey Engineer – evaluated for RFI received to survey data prepared with respect to time.
- Topographer – evaluated for survey data received to located survey points with respect to time.

2. Alignment Works Department

A. Working Procedures / Construction Method / Applied

I. Earthworks

For Track, Bridge and Tunnel earthwork activity there is one Method Statement, which is listed below:

1. Method Statement for Earthworks

Material and Equipment required are listed below:

- Dump Trucks, Excavators, Dozers, Loaders, Graders
- For normal fill (Dynapac, Bomag)
- For structural fill (Roller & Compactor, Double Drum Hand Roller, Hand Compactor)
- Drill Machines, Light Towers, Water Pump, Water Tanker
- Mobile Crane, Crane or HI-UP

Earthwork division uses three excel formats, which are listed below:

1. Itinerary Excel Sheet – shows a path where an earthwork activity if required.

2. Site Tracking and Daily Progress Excel Sheet – shows type of activity (excavation or fill), design quantity, actual quantity and balanced quantity.
3. Cut and Fill Balance Excel Sheet – shows a location, amount of cut and fill and borrow requirement.

II. Retaining Wall / Culverts

For Track, Bridge and Tunnel structures which require construction of retaining wall or culverts there are four Method Statements, which are listed below:

1. Method Statement for Corrugated Steel Pipe Culvert
2. Method Statement for Reinforced Earth Structure
3. Method Statement of Reno Mattresses Systems
4. Method Statement for Stone Pitching

Culvert inlet and outlet masonry work and ditch masonry work handed to sub-contractors. For controlling purpose earthwork site engineers use simple excel sheet to register name of subcontractor, date, culvert inlet and outlet progress, and ditch progress.

III. Bridges & Viaducts

For Bridge & Viaducts construction there are thirteen Method Statements, which are listed below:

1. Method Statement for Steel Bridges Piers Erection Works.
2. Method Statement for Steel Bridge Piers and Capping Beam Erection Works (20m-45m)
3. The Method Statement of Steel Piers Bridges.
4. Method Statement for Steel Bridges Girders Erection Works.
5. Method Statement for Incremental Launching.
6. Method Statement for Incremental Launching for Bridges
7. The Bored Pile Construction Method Statement
8. Method Statement of the Precast Fabrication Process
9. Method Statement of Mobile Flash Butt Pre-Welding on Work Bases (18+18=36m)
10. The Method Statement of Concrete Piers Bridges
11. Method Statement for Tightening of Preloaded Bolts

12. Method Statement for Bridge Foundation Without Piles
13. Method Statement for Freyssibar Stressing

Concrete site engineers use simple excel sheet with the following content:

- Bridge identification number and type.
- Number of piles excavated.
- Tone of reinforcement used.
- Volume of concrete used.
- Quantity of black paint, water proofing and geotextile used.

Steel site engineers use simple excel sheet with the following content:

- Bridge identification number and type.
- Number and type of steel girders and bridge deck used.

B. Task Assignment

I. Earthworks

Awash – Kombolcha / Haragebay railway project have a master construction schedule presented in project Gantt chart and planning department prepares a three week construction plan for all divisions. Based on this, Alignment Works Chief identifies earthwork task required for a specific duration and orders earthwork engineers to accomplish it. Earthwork chief set up department meetings at 7:00AM in the morning and discusses the following points:

- According to the plan, arrange departments shift work (day and night).
- According to the plan, arrange personnel requirement.
- According to the plan, arrange machinery requirement.

Site engineers are responsible to achieve the goal of the department where work executed equal or surpass planned. In addition to this, at different stages of construction site engineers send request for inspection (RFI) for two divisions through Document Control Center (DCC); to QA/QC Division for a test and to survey division to locate points of fill or cut.

II. Retaining Wall / Culverts

Planning department prepares a three week construction plan for retaining wall / culverts construction. Based on this, Alignment works chief identifies the tasks required for a specific duration and orders retaining wall / culverts engineers to accomplish it. Retaining wall / culverts chief set up department meetings at 7:00AM in the morning and discusses the following points:

- Identify the number and location where excavation is required.
- Sort-out the number of retaining walls, culverts and ditch locations which require survey points.
- Identify the number of retaining walls, culverts and ditch locations which require concrete.
- Sort-out the number of retaining walls, culverts and ditch locations which require subcontractor assignment.
- Identify culvert location which require corrugated steel pipe installation.
- For installation, arrange Forman and steel technicians.
- Discuss progress of corrugated steel pipe assembly.
- Discuss progress of inlet and outlet masonry work.
- Discuss progress of ditch masonry work.
- Discuss progress of retaining wall construction.

Retaining wall / culverts chief tasks site engineers to prepare the following request for inspection (RFI) forms:

1. RFI forms to earthwork department for excavation.
2. RFI forms to survey division for survey points.
3. RFI forms to QA/QC division – concrete batching plant responsible for concrete.
4. RFI forms to corrugated steel pipe store for number of corrugated steel pipe pieces required.

In addition to this, site engineers assign subcontractors for a new task.

III. Bridges & Viaducts

Bridges & Viaducts Department receive a three week construction plan from Planning Department. According to the plan, Bridges & Viaducts Chief assigns concrete and steel site engineers for a task with a specific duration. The departments' chief set up a meeting at 7:00AM and discuss the following points:

- Drilling of piles required

- Total tone of reinforcement and area of formwork required
- Total volume of concrete required
- Total quantity of black paint, water proofing and geotextile needed
- Type and total number of steel girders and bridge decks needed
- Progress of drilling activities, reinforcement assembly and formwork construction
- Progress of steel girders assembly and bridge deck positioning

Bridges & Viaducts chief assigns concrete site engineers to prepare the following request for inspection (RFI) forms:

1. RFI forms to survey division for survey points.
2. RFI forms to QA/QC Division – concrete batching plant responsible for concrete.
3. RFI forms to Electromechanical Division for lifting machines.
4. RFI forms to QA/QC Division for a test

Bridges & Viaducts chief assigns steel site engineers to prepare the following request for inspection (RFI) forms:

1. RFI forms to Electromechanical Division for lifting machines.
2. RFI forms to Precast Production & Building Division for Bridge Decks.
3. RFI forms to stock for a number of steel girder required.

C. Reporting /To Track, Review and Regulate the progress/

I. Earthworks

Site engineers report the daily progress to earthwork chief and compile weekly and monthly report. Finally, earthwork chief check, sign and send it to DCC.

II. Retaining Wall / Culverts

Site engineers compile daily report of the department. The report includes;

- Total volume of excavation performed by earthwork department
- Total number of surveying executed by survey division
- Total volume of concrete provided by QA/QC - concrete batching plant responsible
- Total length of corrugated steel pipe assembled
- Total number of subcontractors who start the work
- Progress of inlet and outlet masonry work

- Progress of retaining masonry work

Compiled report handed to retaining wall / culverts chief; chief check, sign and send it to Document Control Center (DCC).

III. Bridges & Viaducts

Concrete Site Engineers compile daily report and send it to departments' chief on the following points:

- Progress of drilling activities and number of excavated piles.
- Total tone of reinforcement and area of formwork done.
- Progress of reinforcement assembly and formwork construction for newly started bridge structures.
- Total volume of concrete used.
- Progress of reinforcement assembly and formwork construction for newly started bridge structures.

Steel site engineers compile daily report and send it to departments' chief on the following points:

- Applied quantity of black paint, water proofing and geotextile material.
- Type and total number of steel girders and bridge decks assembled.

D. Evaluating Performance

I. Earthworks

Earthwork chief evaluated for a total earthwork volume executed by the department to the planned quantity. Site engineers also evaluated for executed earthwork volume to assigned earthwork volume by earthwork chief.

II. Retaining Wall / Culverts

Retaining wall / culverts chief evaluated for executed work of the department to planned one. Besides, site engineers evaluated for progress of inlet and outlet masonry work, progress of retaining masonry work and length of ditch constructed to volume of the work expected to be accomplished.

Apart from this, subcontractors will also be evaluated for volume of the work awarded with respect to time of completion and quality of the final work.

III. Bridges & Viaducts

Bridges & Viaducts chief, evaluated for accomplished work of the department to estimated execution prepared by Planning Division. Apart from this, concrete and steel site engineers evaluated for volume of task received to task performed.

3. Precast Production & Building Department

A. Working Procedures / Construction Method / Applied

For precast production & building construction there are six Method Statements, which are listed below:

1. Method Statement for Concrete Masonry Units
2. Method Statement of the Precast Fabrication Process
3. Method Statement for Shotcrete
4. Method Statement of General Concrete Work
5. Method Statement for Reinforcement Steel Works
6. Method Statement for Structural Steel Erection Works of Maintenance Workshop Building

Precast production engineer uses a format to register total number of precast pieces produced. Building (Station) construction engineer uses one excel sheet with a title Building and Mobilization Works Daily Report and it has the following content; activity work location, unit, actual quantity, labour quantity, spent hours, man-hour and activity work information. Besides, separate part of the sheet allocated to photos captured during construction.

B. Task Assignment

A three week construction schedule handed to Precast Production / Building Chief from planning department. According to the plan, chief identifies the work extent and set a daily meeting at 6:45AM to discuss the following points:

- Identifying new camp mobilization
- Dismantling established camp
- Sort-out precast type and number to be produced
- Precast stock capacity
- Total area of formwork planned to be assembled

- Total tone of reinforcement required
- Total volume of concrete needed
- Identify number of RFI to be sent to other divisions
- Progress of precast production and station construction
- Total number of construction professionals required

Chief tasks precast production engineer to prepare the following RIF:

1. RFI forms to QA/QC Division – concrete batching plant responsible for concrete
2. RFI forms to QA/QC Division for concrete test

In addition to this, chief tasks building site engineer to prepare the following RIF:

1. RFI forms to QA/QC Division – concrete batching plant responsible for concrete
2. RFI forms to QA/QC Division for inspection and concrete test
3. RFI forms to survey division for survey points
4. RFI forms to earthwork department for excavation

C. Reporting /To Track, Review and Regulate the Progress/

Precast production engineers compile daily report, then divisions' chief check, sign and send it to Planning Department through DCC. The report have the following points:

- Progress of precast elements under construction
- Type and total number of precast pieces on the stock

Station site engineers compile daily report and send it to divisions' chief on the following points:

- Progress of new camp mobilization
- Status of dismantling established camp
- Total area of formwork construction
- Total tone of reinforcement prepared and assembled
- Total volume of concrete utilized
- Total number of RFI send to other divisions
- Total number of construction professionals utilized

D. Evaluating Performance

Precast Production / Building Chief evaluated for executed work of the department to planned one. Apart from this, precast production engineer is evaluated for produced precast elements to planned one. Site engineers also evaluated for camp mobilized, formwork constructed and reinforcement assembled to departments' construction goal.

4. Electromechanical Department

A. Working Procedures / Construction Method / Applied

For electromechanical construction there are three Method Statements, which are listed below:

1. Method Statement for Plumbing and Drainage Piping Installation
2. Method Statement for Incremental Launching for Bridges
3. Method Statement for Structural Steel Erection Works of Maintenance Workshop Building

Lifting equipments are machineries used for lifting or lowering loads or people, including accessories and attachments used for anchoring, fixing or supporting the equipment. Crane, fork lift and telescopic handler are mostly used lifting equipment and accessories include chains, ropes and lifting beams.

B. Task Assignment

Electromechanical chief determine extent of the work for each engineer based on a three week schedule from planning department. The chief sets a meeting at 6:45AM with divisions' engineers and discuss the following points:

- Identifying number and location of temporary electric and underground conduit
- At what locations circuit wiring is required
- Which electrical systems are at testing stage
- Number of new escalators, heating ventilation and air conditioning system, lightning protection system, refrigerator, plumbing and drainage system required
- Sort-out working and available lifting equipment
- Number of RFI received

Lifting engineers based on received RFI from different construction divisions and prepare a plan to accommodate their request. Electrical engineers clarify the electrical specifications and lead their technicians to achieve the departments' performance goal. Mechanical & Plumbing engineer work on drawings and prepare a plan & lead installation of escalators, heating ventilation and air conditioning system, lightning protection system, refrigerator, plumbing and drainage system.

C. Reporting /To Track, Review and Regulate the Progress/

Lifting, electrical and mechanical engineers compile a daily report and send it to electromechanical chief. Departments chief check, sign and e-mail it to DCC.

D. Evaluating Performance

Electromechanical chief evaluated for actual lifting, electrical, mechanical and plumbing works to departments' goal.

- Lifting Engineer – evaluated for RFI made to RFI executed
- Electrical Engineer – evaluated for planned electrical work and RFI received to RFI executed
- Mechanical & Plumbing Engineer – evaluated for executed mechanical and plumbing activities to the departments goal

5. Tunnel Division

A. Working Procedures / Construction Method / Applied

For Tunnel construction there are four Method Statements, which are listed below:

1. Method Statement for Tunnel Lining Works
2. Drilling and Blasting Excavation Method Statement for Tunnel Blasting Applications
3. Method Statement of Waterproofing for Tunnels
4. Method Statement of Waterproofing PVC Membrane for Tunnels
5. Method Statement for Tunnel Excavation and Initial Lining Construction

Tunnel construction uses different machines based on excavation procedures applied to that specific tunnel.

- ❖ Road Header Tunneling Method – Day and night working shift are applied.
- ❖ Drill & Blast Tunneling Method – Works for 24hour
  - Drilling holes– between 5AM to 12AM
  - Installing explosives and blasting – between 12AM to 2PM
  - Supervision – between 2PM to 3PM

- Disposal – between 3PM to 11PM
- Providing temporary tunnel support – 11PM to 5AM

B. Task Assignment

Tunnel Manager is assigned to determine and give working plan for all engineers in the department. Manager sets a meeting at 6:45 AM and discuss the following points:

- Types of tunnel excavation method to be applied
- Sample test of disposed excavated material
- Progress of tunnel excavation
- Area of formwork, tone of reinforcement and volume of concrete required

Geology Engineers take material sample after tunnel excavation or blast. Their frequency depends on the excavation method. For Drill & Blast Method they take samples at every blast and for Road Header Method they take sample at the designed excavation length. Apart from this, geology engineers test the samples and compare actual results with previously determined value. If the test results deviated from designed data, it will be forwarded to design team and updated immediately.

Tunnel Excavation Support Engineer tasks Excavation Forman to work on tunnel excavation by mobilizing the team. Besides, controls applied excavation method, drilling length, explosive types and disposal area.

Concrete Lining Engineer works to make sure primary support reinforcement, application of shotcrete, formwork and final concrete lining are according to the design.

C. Reporting /To Track, Review and Regulate the Progress/

Geology, Tunnel Excavation Support and Concrete Lining Engineers put together their daily work and at 6:00PM forward it to Tunnel Manager. Finally, tunnel manager checks daily report, authorize and send it to DCC.

D. Evaluating Performance

Tunnel manager evaluated for the aggregate work of Geology, Tunnel Excavation Support and Concrete Lining Engineers; with respect to the plan compose by planning department.

- Geology Engineer – evaluated for a number of test samples to be carried out to the planned one.
- Tunnel Excavation Support Engineer – evaluated for actual excavated tunnel length to expected tunnel excavation

- Concrete Lining Engineer – evaluated for area of formwork, tone of reinforcement and volume of concrete executed to departments schedule

6. Machinery & Equipment Division

A. Working Procedures / Construction Method / Applied

For machineries and equipment maintenance the division uses repair manuals, which are listed below:

1. SANY Repair Manual
2. TOYOTA Repair Manual
3. SINOTRUCK Repair Manual
4. CATRPILLAR Repair Manual
5. HITACHI Repair Manual
6. KOMATSU Repair Manual

Maintenance section uses the following format shown in Table 5.5 to control types of service provided. The mechanic who is providing the service mark on the type of service given to the vehicle.

Table 5.5: Maintenance Check List Format

Company Logo	**Date:**
Maintenance Done KM-HOUR:	Future Maintenance KM-HOUR:
Fuel Filter	Engine Oil
Oil Filter	Transmission Oil
Air Filter	Differential Oil
Explanation:	
Maintain By:	

B. Task Assignment

Machinery & Equipment Manager direct departments' engineers to be ready for departments' main duties and sets a meeting at 6:45 AM to discuss the following points:

- Type and amount of oil and grease utilized and required
- Accessories needed for electric, welding and tire sections of the division
- Progress of vehicles under maintenance inside and outside workshop
- Total number of received and processed vehicles with load
- Warehouse updated stock list and list of utilized spare-parts
- Received, consumed and available fuel.

Maintenance Engineer clarify repair manuals and direct sections' labour force to provide service for engine, transmission and differential oil. Apart from this, organize the team to change fuel, oil and air filter.

Workshop & Machinery Transport Engineer manages workshop which is a vital part of the division. In addition to this, identifies the work and assign departments mechanics to work on electricity, welding or tire. With respect to significance of the work, task prioritizing is a mandate to the engineer.

Lift Rigging Engineer works in collaboration with Lifting Chief from electromechanical department. Engineer receives loaded vehicles and dispatch it to the right location. Besides, controls lifting rigging supervisor to apply correct procedure and provide maximum safety during operation.

Data & Reporting Operator controls spare parts received and give essential spare part to maintenance and workshop section. Apart from this, register the spare parts to companies' server.

C. Reporting /To Track, Review and Regulate the Progress/

Maintenance, Workshop & Machinery Transport and Lifting Engineer compile daily report and send it to Machinery & Equipment Manager. Manager checks, sign and send it to DCC. In addition to this, the manager controls available and required spare parts through network.

D. Evaluating Performance

This division doesn't have predefined work schedule rather its' work determined by request for maintenance and workshop service. Based on this, Machinery & Equipment Manager evaluated for the total work of the division.

- Maintenance Engineer – evaluated for a number of maintenance requests received to provide services with respect to duration.
- Workshop & Machinery Transport Engineer - evaluated for a number of workshop requests made to provided services with respect to duration.

7. Environmental, Social & Safety Division

A. Working Procedures / Construction Method / Applied

Environmental, Social & Safety Division use seventeen working procedures to achieve its goal. The procedures are listed below:

1. Water Quality Management Procedure
2. Air Quality and Emissions Procedure
3. Waste Management Procedure
4. Noise and Nuisance Reduction Procedure
5. Environmental Consents Procedure
6. Code of Conduct Procedure
7. Environmental and Social Inspection Monitoring Auditing Procedure
8. Stakeholder Engagement and Grievance Mechanism Procedure
9. Biodiversity and Ecological Protection Procedure
10. Environmental and Social Design Change Management Procedure
11. Off Site Working Procedure
12. Environmental Incident Response and Reporting Procedure
13. Chance Finds Procedure
14. Integrated Pest Management Procedure
15. Evaluating of Compliance with Environmental Legal and Other Conditions Procedure
16. Environmental Impact Assessment Procedure
17. Community Safety Procedure

A training materials with Amharic, English and Turkish version are compiled in toolbox talks. A total of nineteen toolbox talks are listed below:

1. Archaeology
2. Be A Good Neighbor
3. Bentonite

4. Cement and Concrete
5. Dust and Odor
6. Energy and Fuel Efficiency
7. Fuel and Oil
8. Material Handling and Housekeeping
9. Noise and Vibration
10. Pumping and Over-pumping
11. Segregation of Waste
12. Silt
13. Spill Prevention and Response
14. Storage of Waste
15. Washing Down Plant and Machinery
16. Waste Hierarchy
17. Working Around Trees and Hedgerows
18. Working on Previously Developed Land
19. Grievance Mechanism

B. Task Assignment

Environmental, Social & Safety Manager controls Environmental & Social Chief and Safety Engineer based on the working procedures of the division. Manager sets a meeting at 6:45 AM and discusses the following points:

- Total number of sensitive receptors to be checked for noise and dust
- Number of surface and ground water test to be made
- Progress of daily inspection
- Locations of high risk construction activities
- Written warnings to departments, which trans-pass safety procedure
- Response of the departments to written warnings
- Total number of grievance cases and their progress
- Progress of safety training activities of the division
- Progress of rehabilitation works of construction sites
- Number of RFI received regarding explosions

Environmental, Social & Safety Manager according to a three week schedule, checks some of sensitive receptors among 200 sensitive receptors the project installed. Apart from this, measures the depth of the 20 water wells; and test quality of surface and ground water. The engineer have also a responsibility to manage waste water treatment plant and recycling of waste materials.

Safety Engineer receive RFI before 24hour for explosion activity, based on this the engineer plans safety visit. Besides, sends two safety technicians to construction sites to check if all activities follow safety procedures and work discipline of the company. In collaboration with training coordinator give safety training for all who plan to work in construction.

C. Reporting /To Track, Review and Regulate the Progress/

Environmental & Social Chief and Safety Engineer compile daily work activities and report at 6:00PM to Divisions' Manager. Divisions' manager check, sign and send it to DCC.

D. Evaluating Performance

Environmental, Social & Safety Manager evaluated for the cumulative work of the division. Managers' success determined with respect to request made to accomplished tasks.

- Environmental & Social Chief – evaluated for planned checkup for sensitive receptors to actual performed and quality test planned to actual performed
- Safety Engineer – evaluated for planned safety training to provided training and degree of understanding and implementation of safety in every construction activity of the project

8. Blasting Division

A. Working Procedures / Construction Method / Applied

For Track Construction specific to earthwork activities and production of construction materials there are two Method Statements, which are listed below:

1. Drilling and Blasting Excavation Method Statement for Surface Blasting Applications
2. Method Statement for the Production and Supplying of Ballast

B. Task Assignment

Blasting Manager according to a three week construction plan, identifies and details extent of divisions' work. After this, orders Quarry & Explosive Engineer to accomplish the tasks. Manager sets a meeting at 6:45 AM and discuss the following points:

- Progress of surface blasting works
- Received RFI for surface blasting works
- Type and volume of ballast produced
- Received RFI for production of ballast materials
- Number of RFI to be prepared for Environmental, Social and Safety Division

Quarry & Explosive Engineer based on surface blasting request; identifies the location and sends the technicians to the site. Besides, controls the technicians to follow the correct procedure. Explosive and Blasting Technicians communicate planned detonation time and based on this the engineer prepares RFI to Environmental, Social and Safety Division for safety supervision.

Quarry & Explosive Engineer tasks divisions' Forman to produce the type and volume of ballast materials required for that specific duration.

C. Reporting /To Track, Review and Regulate the Progress/

Quarry & Explosive Engineer report progress of surface blasting and production of ballast material to Blasting Manager at 6:00PM. Manager check, sign and send it to DCC.

D. Evaluating Performance

Blasting Manager evaluated for the total work of the division to planned surface blasting and ballast production.

- Quarry & Explosive Engineer – evaluated for RFI received to RFI executed and planned surface blasting to accomplished work.

9. Quality Assurance / Quality Control Division

A. Working Procedures / Construction Method / Applied

Quality Assurance (QA) Engineers prepare construction management system according to ISO 9001. In addition to this, they prepare construction procedures in order to set out uniform construction quality throughout the project. QA Engineers send construction procedures to the consultant for approval. If it is approved it will be adopted; if it is commented, it will be corrected; if it is rejected, it will be changed.

QA/QC Division uses controlling and monitoring forms called Inspection and Test Plan Forms. Inspection and Test Plan Forms contains Activity No, Activity, Frequency, Responsible Person, QC Category, Related Standards & Documents, Compliance Criteria and Verification Document /Quality Control Report/. Example is shown in Figure 5.16 and Figure 5.17.

ERC SYSTRA MD — AKH Railway Project — yapı merkezi

INSPECTION AND TEST PLAN FOR EARTHWORKS

Activity. N°	ACTIVITY	FREQUENCY	Responbible Person (*)	QC CATEGORY			RELATED STANDARDS & DOCUMENTS	Compliance Criteria	VERIF DOC./QCR
				YMI	ERC	ER			
1	TRACK LINE FILLING MATERIAL								
1.1	Classification of Material								
1.1.1	Sieve Analysis	1/ For each different material and gradation	QI , QE	H	R	R/S	EN 933-1, EN 933-2	Passed from 0,075 mm sieve (No. 200) ≤ % 12	YMI Laboratory Test Report
1.1.2	Consistency Limits - Atterberg Limits	1 / Once test for each 25000 m³ fill	QI , QE	H	R	R/S	AASHTO T 90, ASTM D4318	PI ≤ % 12 , LL ≤ %35	YMI Laboratory Test Report
1.1.3	Proctor Test	1/ Each different gradation and/or each 25000 m³ fill	QI , QE	H	R	R/S	AASHTO T T99, T180 ASTM D1557, ASTM D698	Maksimum dry unit weight > 1,7 gr/cm³ Standard Proctor test or Modified Proctor test depending on the type of line, high of the embankment and country)	YMI Laboratory Test Report
1.1.4	CBR (California Bearing Ratio)	Each different gradation and/or each 25000 m³ fill	QI , QE	H	R	R/S	AASHTO T-193 ASTM D 1883	CBR Ratio > %6	YMI Laboratory Test Report
1.2	Compaction of soil								
1.2.1	Sand Cone Test	For each layer (optional, if there is no nuclear test) 1/ Test at 250 m.,	QI , QE, S/E	H	R	W	AASHTO T 191 ASTM D 1556-00	Compaction Ratio ≥ % 95	Test Report
1.2.2	Nuclear Compaction	1/ For each layer, once test at 25 m	QI , QE, S/E	H	R	W	ASTM D2922, ASSHTO T-310	Compaction Ratio ≥ % 95	YMI Laboratory Test Report

Figure 5.16: Inspection and Test Plan for Earthwork – First Half Part

1.2	**Compaction of soil**								
1.2.1	Sand Cone Test	For each layer (optional, if there is no nuclear test) 1/ Test at 250 m.,	QI , QE, S/E	H	R	W	AASHTO T 191 ASTM D 1556-00	Compaction Ratio ≥ % 95	Test Report
1.2.2	Nuclear Compaction	1/ For each layer, once test at 25 m	QI , QE, S/E	H	R	W	ASTM D2922, ASSHTO T-310	Compaction Ratio ≥ % 95	YMI Laboratory Test Report
1.2.3	Non-Nuclear Compaction (SDG), Standard Test Method for In-Place Density (Unit Weight) and Water Content of Soil Using an Electromagnetic Soil Density Gauge	1/ For each layer, once test at 25 m	QI , QE, S/E	H	R	W	ASTM D7830 / D7830M	Compaction Ratio ≥ % 95	YMI Laboratory Test Report
1.3	**Loading Capacity of Soil**								
1.3.1	Dynamic Plate Load Test	For each layer, once test at 25 m	QI , QE, S/E	H	R	W	UIC 719	EV2 ≥ 45 MN/m^2 for fine soils, or EV2 ≥ 60 MN/m^2 for sandy and gravelly soils	YMI Laboratory Test Report EV2/EVd ≤ 2,2 for EVd less than the minimum value prescribed for EV2

(*) KEY TO QC RESPONSIBILITIES :		KEY TO QC CATEGORY :		
SS = SITE SUPERVISOR **QI** = QUALITY INSPECTOR **QE** = QUALITY ENGINEER **ERC** = ETHIOPIAN RAIL WAY COMPANY	**S / E** = SUPERVISOR OR SITE ENGINEER **LT** = LABORATORY TECHNICIAN **S** = SURVEYOR **SUP** : SUPPLIER **ER**= EMPLOYER'S REPRESANTATIVE	**W** = Witness Point **I** = Inspection Point **R** = Review Point	**T** = Test Point **S** = Surveillance Point **SP** = Sampling Point	**C** = Certification Point **V** = Verification Point **H** = Hold Point
Notes :	Prepared by:	Checked By:		Authorized by:
Inspection and Test Plan For Earthworks	**AKH – YMI – AL – GL00X – G– QC – ITP – 0007 – 8**			20.06.2016

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Figure 5.17: Inspection and Test Plan for Earthwork – Second Half Part

For Track Construction there are nine Inspection and Test Plan /ITP/ Forms, which are listed below:

1. ITP For Earthworks
2. ITP For Sub-Ballast Application
3. ITP For Ballast Works
4. ITP For Track Laying
5. ITP For Stone Pitching
6. ITP For Ballasting – Tamping – Stabilizing
7. ITP For Aluminothermic Welding
8. ITP For Mobile Flash Butt Welding Into LWR
9. ITP For Ballast Production

For Bridge Construction there are seven Inspection and Test Plan /ITP/ Forms, which are listed below:

1. Lifting Plan
2. ITP For Pilling Works
3. ITP For Flash Butt Pre-Welding On Work Bases (18+18=36m)
4. ITP Checklist For – Weekly Bend Test of Flash Butt Welds
5. ITP Checklist For – Checking Rail Ends And Step Across
6. ITP For Mobile Flash Butt Welding Into LWR
7. ITP For Reinforcement Bars

For Tunnel Construction there are two Inspection and Test Plan /ITP/ Forms, which are listed below:

1. Waterproofing Membrane Welding Inspection Form
2. Summary Of Construction Inspection And Test Plan

For Common Construction there are nineteen Inspection and Test Plan /ITP/ Forms, which are listed below:

1. ITP For Shotcrete Works
2. ITP For Bentonite Suspension
3. ITP For Prefabricated Vertical Drain (PVD)
4. ITP For Concrete Works
5. ITP For Plumbing Pipes Installation

6. ITP For Drainage & Indoor Sewage Pipe Installation (Gravity Pipes – Hydrostatic Test)
7. ITP For Reinforcement Bars
8. Tensile Testing Steel Reinforcement Bar (Rebar) Form
9. The Unit Weight Result Of Reinforcement Steel Bars For Concrete Form
10. Bend Testing Steel Reinforcement Bar (Rebar) Form
11. ITP For Nonloadbearing Concrete Masonry Units
12. Briquette Control Form (EN 771-3)
13. Temperature Monitoring Form
14. Water Cure Control Form For Precast Element Production
15. ITP For Destressing
16. Checklist – Destressing Recording Sheet
17. Checklist For Destressing
18. ITP For Concrete Masonry Units
19. Curing Process Control Form For Concrete Masonry Units

To do laboratory test according to Inspection and Test Plan there are seventeen forms to help register results of the test. In addition to this, there are seven points that are common to all forms which are; Laboratory Code No., Standards, Date, Sample Information, Results, Test Performed by and Employer's Representative. The forms are listed below:

1. Determination Of Water (Moisture) Content, Sieve Analysis, Atterberg Limits
2. Unit Weight And Voids In Aggregates / Gravity Method
3. Determination Of Resistance To Fragmentation (Los Angeles)
4. Laboratory Compaction Characteristics Of Soil Using Modified Effort (2700 kN-m/m^3)
5. Coarse Aggregate, Specific Gravity And Water Absorption
6. Determination Of CBR (California Bearing Ratio)
7. Sub – Ballast Sieve Analysis (ASTM C 136)
8. Ballast Sieve Analysis (ASTM C 136)
9. Sand Equivalent Value Of Fine Aggregate And Methylene Blue Test
10. Coarse Aggregate Sieve Analysis (ASTM C 136) - Classification 5-15 mm

11. Site Record Of Taken Fresh Concrete Sample And Concrete Slump / Temperature Control Form
12. Micro-Deval Test Results
13. Aggregate Sieve Analysis (ASTM C 136)
14. Concrete Impermeability Test Report
15. Coarse Aggregate Sieve Analysis (ASTM C 136) - Classification 22-31.5 mm
16. Fine Aggregate, 0-5 Mm. (Sand), Specific Gravity And Water Absorption
17. Fine Aggregate (Sand) Sieve Analysis (ASTM C 136) – Classification 0-5 mm

B. Task Assignment

The main functions of QA/QC Division is determined by Divisions' Manager and assigned to QA/QC Chief. QA/QC Chief will have two meetings; every morning at 7:00AM with day shift and every evening at 6:00PM with night shift. The main discussion points are: to determine available volume of cement, aggregate and sand. Besides, they plan transportation means and required personnel.

Every evening at 6:00PM Document Control Center (DCC) send Request for Inspection (RFI) Form to QA/QC Chief that has been sent to DCC from construction divisions. In addition to this DCC sorted out the concrete requirement in tabulate form and provide QA/QC Chief with daily concrete program. The RFI and Daily Concrete Program must be notified before 24hour.

QA/QC Chief printout RFI form sent by DCC and handed to QC Laboratory Engineers to undertake laboratory test and to QC Site Engineer to undertake inspection according to the request.

QC Laboratory Engineers test all materials except reinforcement. One material engineer is responsible to test all reinforcement imported from Turkey and the consultant is always present during reinforcement test.

QC/QA Chief manages concrete batching plant with day and night shift. The required personnel for a day or night shift tabulated in Table 5.6:

Table 5.6: Personnel for Batching Plant

Personnel	**Number**
Batching plant operator	1

Batching plant operator helper	1
Loader operator	1
Loader operator helper	1
Drivers	7
Pump operator	1
Pump operator helper	1

C. Reporting / To Track, Review and Regulate the Progress /

QC Laboratory Engineers perform laboratory test and QC Site Engineers inspect according to the request. When QC Laboratory Engineers and QC Site Engineers finish their work, they give laboratory test results and completed RFI form to QA/QC Chief, then the chief check, sign and send it to QA/QC Manager.

QA/QC Manager check the documents, sign and send documents to DCC. In DCC Document Control Engineers compile materials for a report. According to this procedure weekly and monthly report send to the consultant.

D. Evaluating Performance

QA/QC Division mainly evaluates the department performance with respect to request made by construction divisions. Generally, QA/QC Chief evaluated for cumulative work of QA/QC Division engineers.

- QC – Site Engineer evaluated for the number of inspection request to inspection performed
- QC – Laboratory Engineer evaluated for the number of laboratory tests requested to actually performed laboratory tests
- General Batching Plant Responsible – evaluated for requested daily concrete program to actually produced and delivered concrete volume

5.6 <u>Contractors' /Yapi Merkezi/ Vital Aspects of Construction</u>

There are a number of very important techniques to be learn from Yapi Merkezi. From those points, two systems are identified as valuable to Ethiopian contractors. This are; Project Construction Plan and Main Camp I /Kombolcha Camp/ Layout and Content.

A. Project Construction Plan

The construction is divided into two phases as it is presented in Figure 5.18.

- Phase I Construction – 150km starts from chainage Km 120+000 to Km 270+500.
- Phase II Construction – 239km where it is a summation of chainage from Km 0+000 to Km 120+000 and Km 270+500 to Km 389+000

To accomplish the plan two major camps are constructed at Kombolcha (Main Camp I) and Shewarobit (Main Camp II). In addition to this, two construction teams are also located at the above mentioned camps.

For phase I construction, Kombolcha team constructs from Km 270+500 to Km 190+000. Shewarobit team constructs from Km 120+000 to Km 190+000.

For phase II construction, Kombolcha team constructs from Km 270+500 to Km 389+000. Shewarobit team constructs from Km 190+000 to Km 0+000.

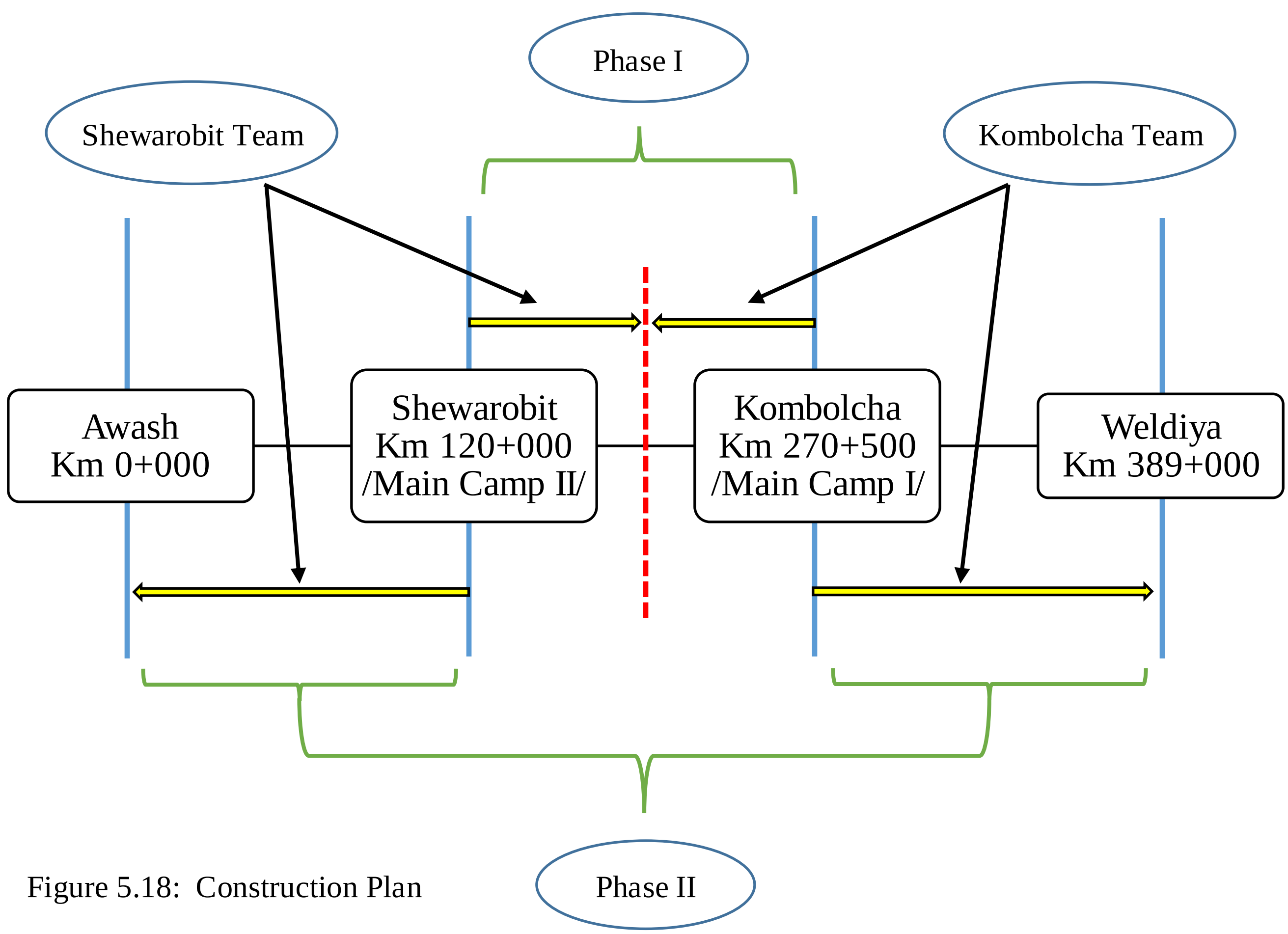


Figure 5.18: Construction Plan

B. Main Camp I /Kombolcha Camp/ Layout and Content

Camp layout and its' content are one of the best practices that can be turned into immediate implementation. In this section, kombolcha camp will be discussed. Kombolcha camp is the main camp of the project where, project manager, two deputy project managers, head of consultant and head of employer representative are located. In addition to this, it holds sleeper production factory which belongs to Trackworks subcontractor.

The camp has a total area of 434,000m^2, it also constructed at the side of the main route. Being near to the main route will facilitate cost effective transportation of sleepers and ballast materials.

For easy understanding of content of the camp, the camp is divided into eight sections and presented from Figure 5.19 to Figure 5.27.

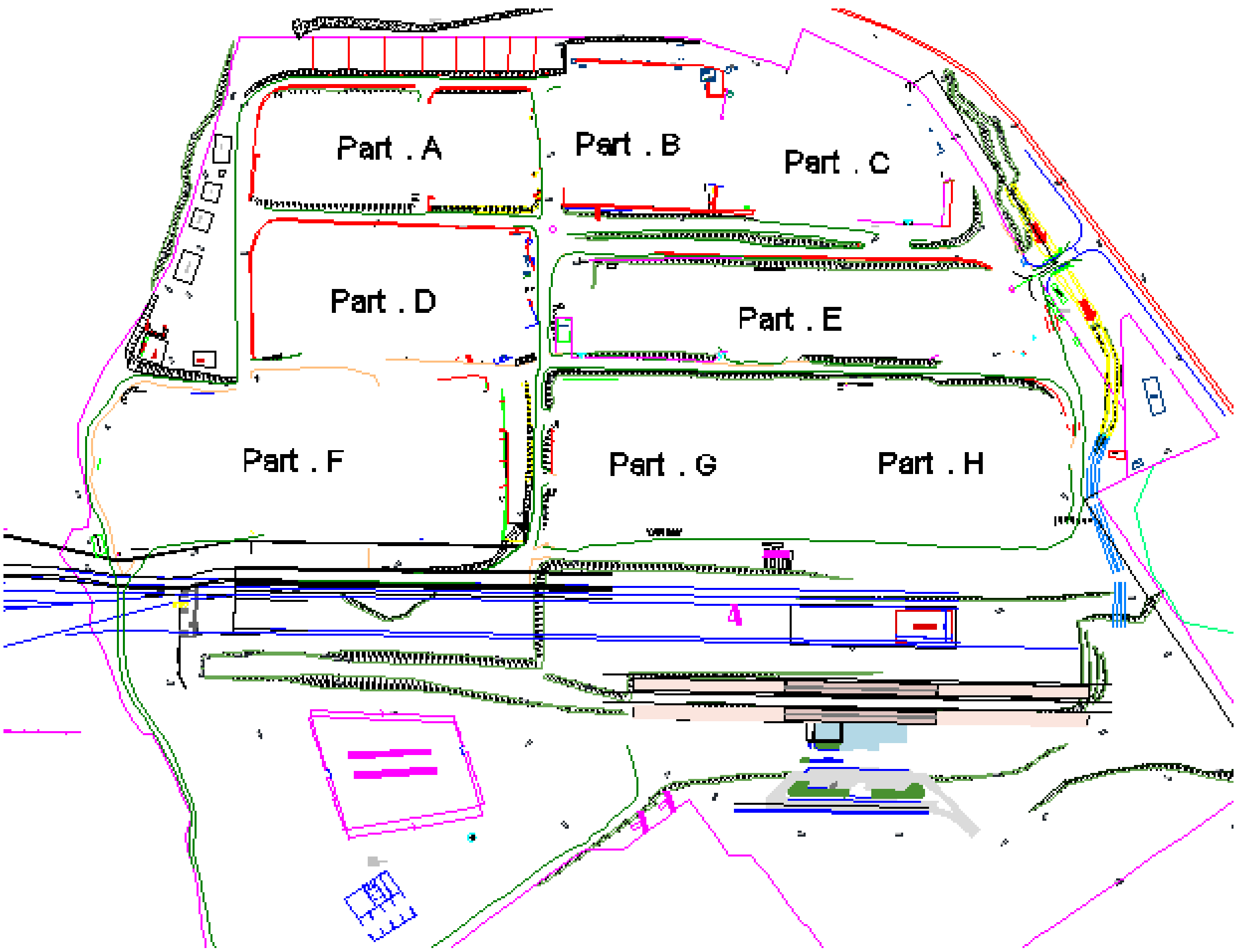
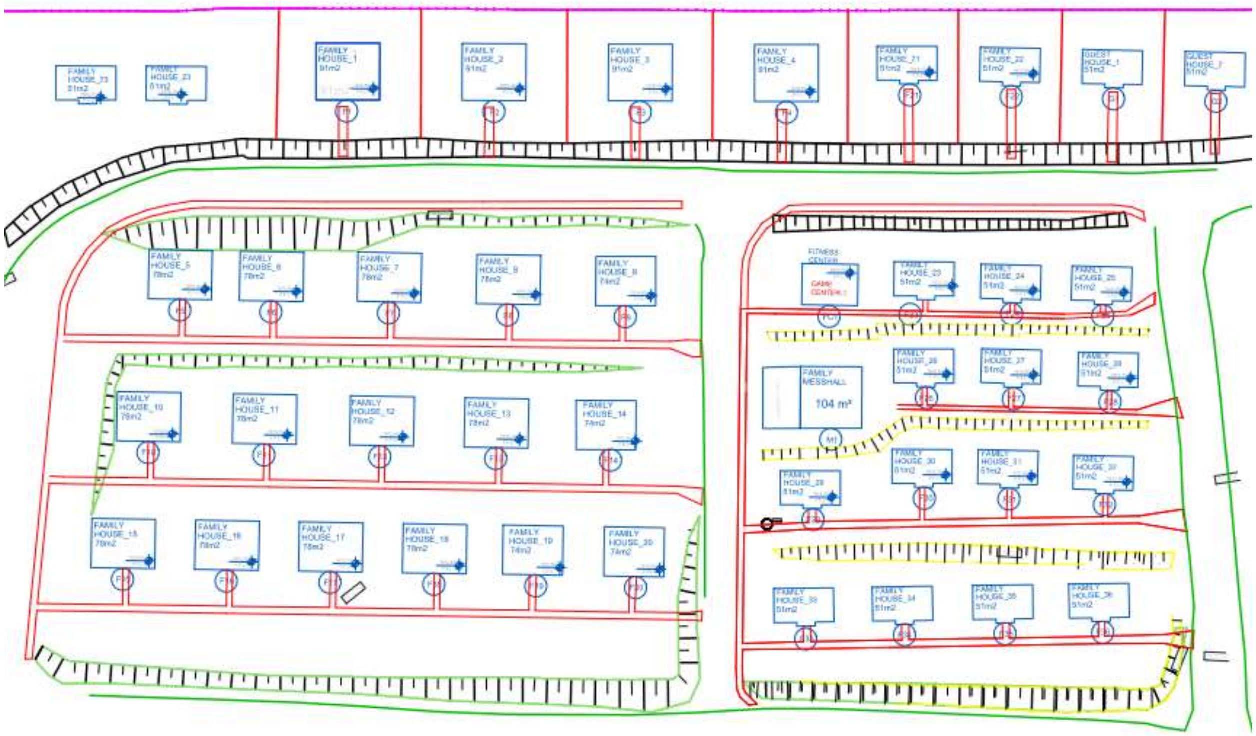
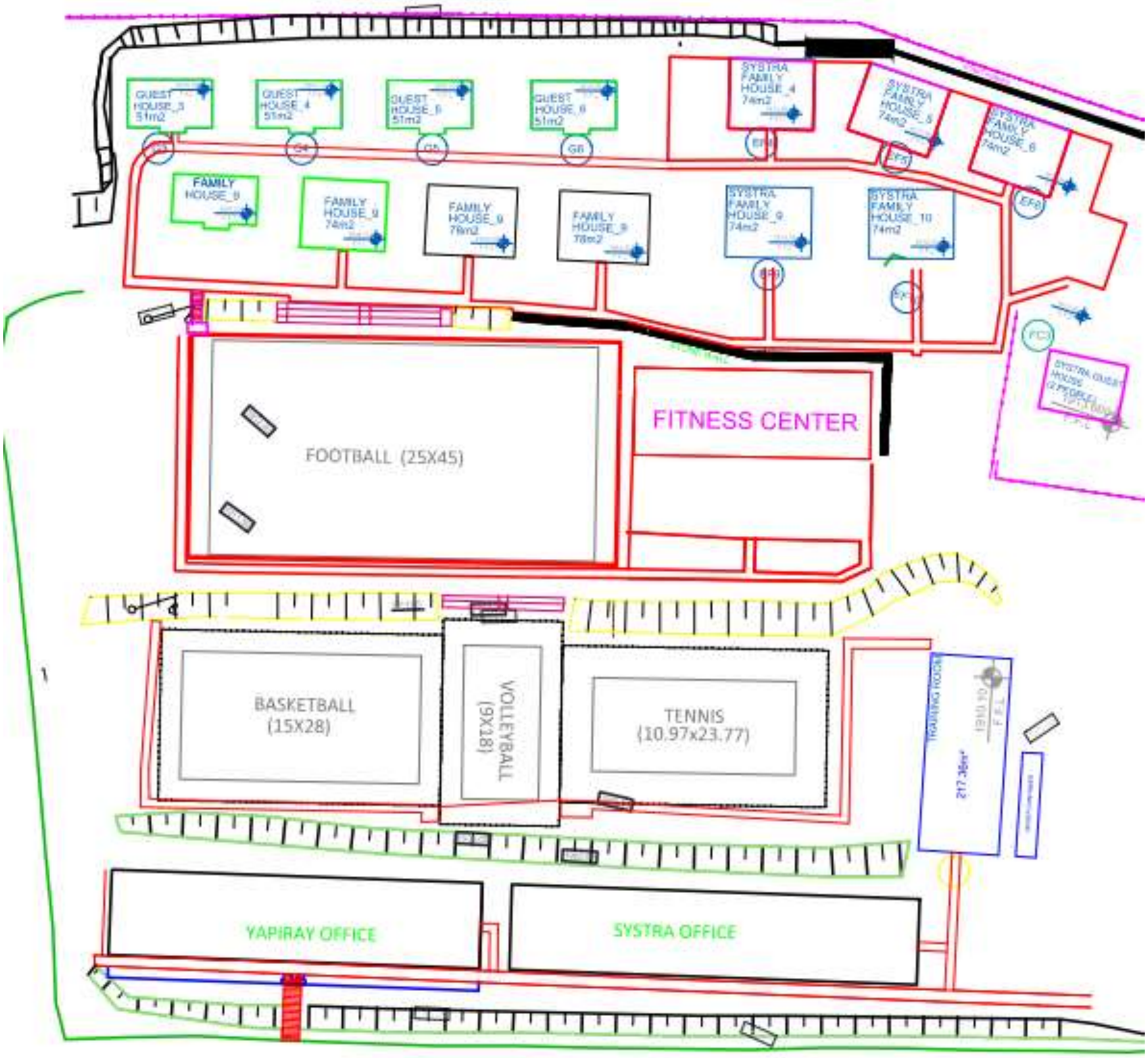


Figure 5.19: Kombolcha Camp Layout



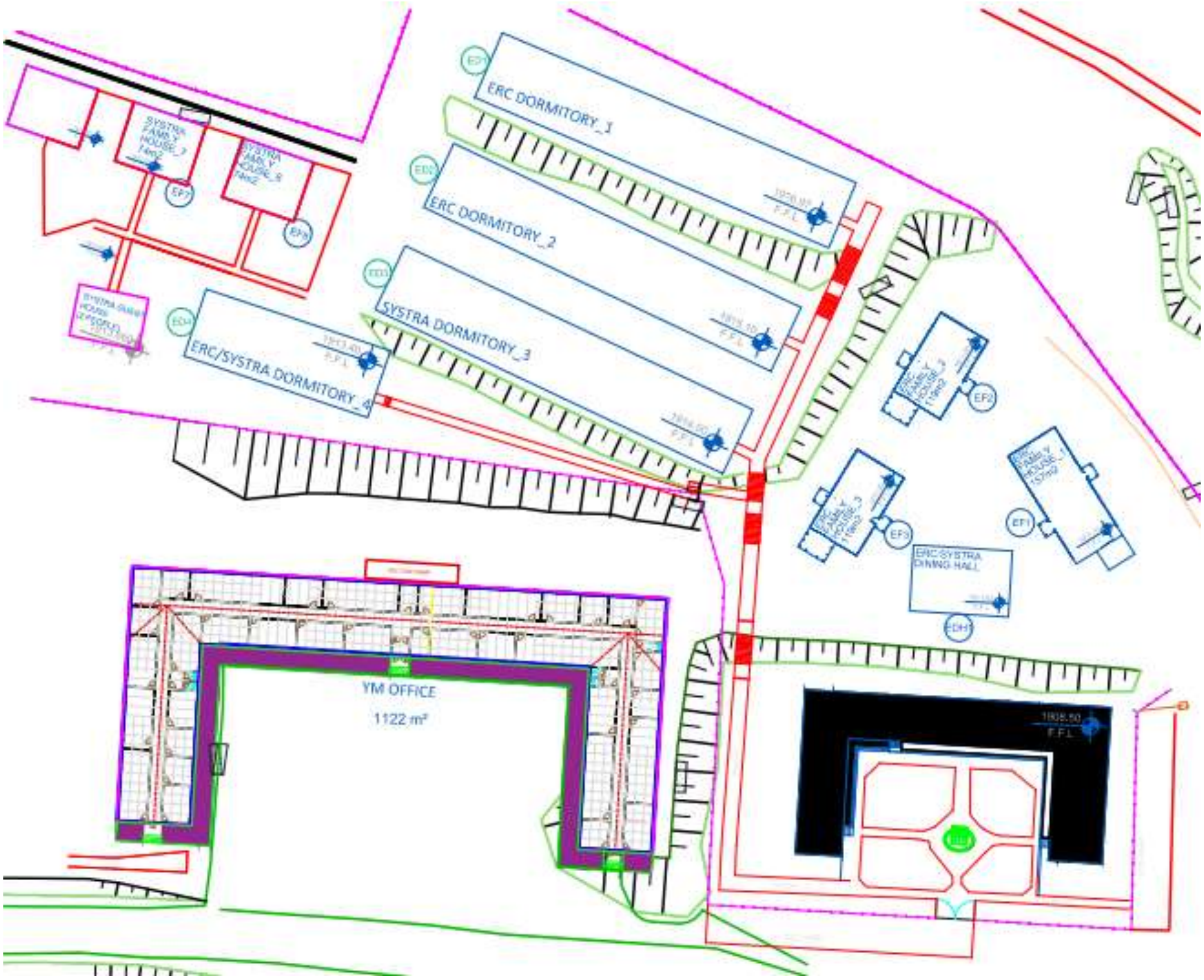
Item	Number	Area
Family House	16	78m^2
Family House	20	51m^2
Family House	4	91m^2
Fitness Center	1	51m^2
Family Messhall	1	104m^2

Figure 5.20: Part A of Kombolcha Camp Layout



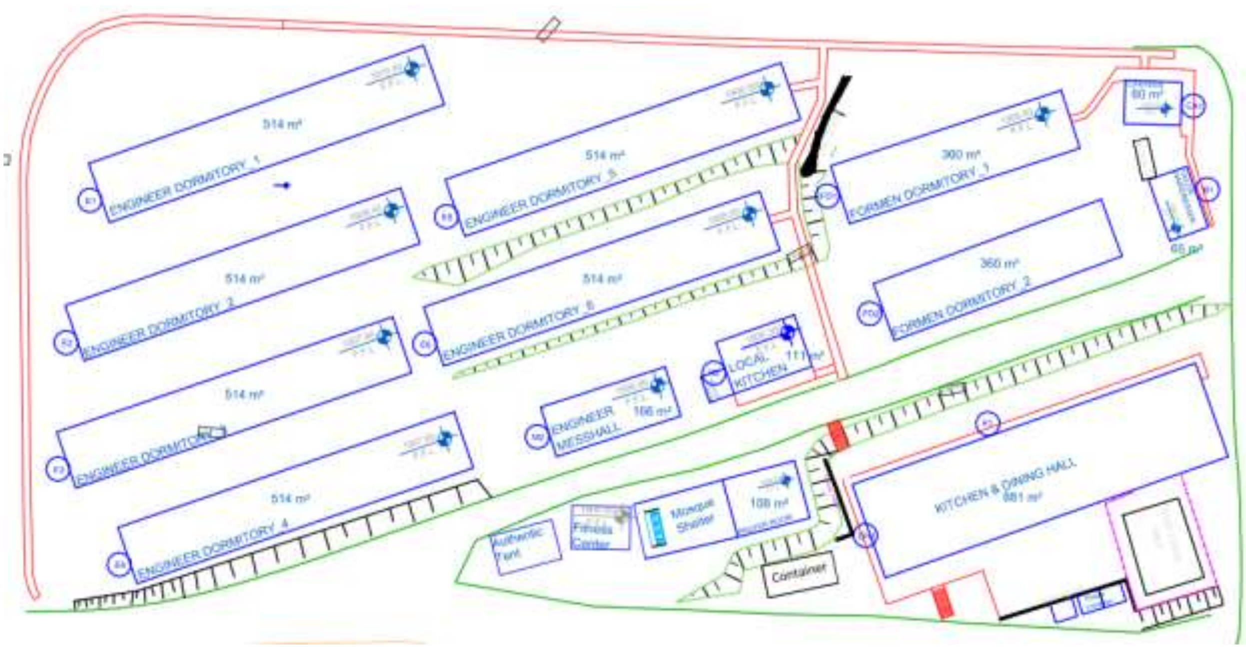
Item	Number	Area
Guest House	4	$51m^2$
Family House	6	$78m^2$
Consultant Family House	6	$74m^2$
Football Area	1	$1,125m^2$
Volleyball Area	1	$162m^2$
Basketball Area	1	$260m^2$
Training Room	1	$217m^2$

Figure 5.21: Part B of Kombolcha Camp Layout



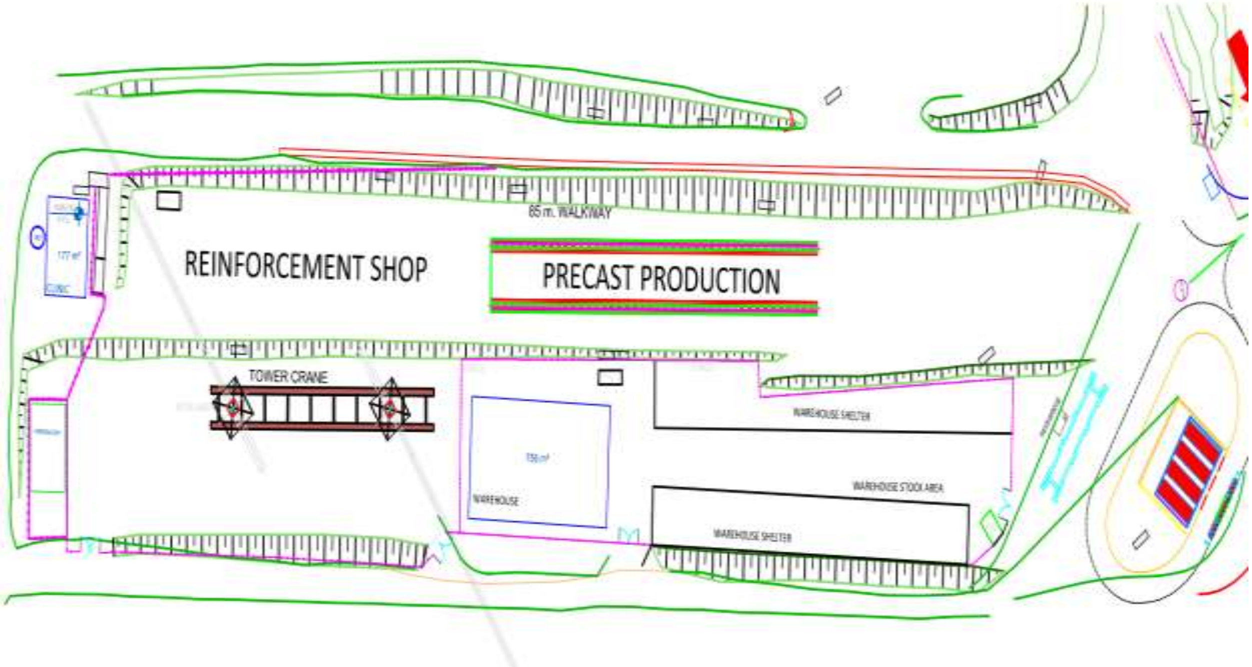
Item	Number	Area
Employer Dormitory	4	340m^2
Employer Family House	3	119m^2
Employer & Consultant Dining Hall	1	160m^2
Employer Office	1	640m^2
Contractor Office	1	1,122m^2

Figure 5.22: Part C of Kombolcha Camp Layout



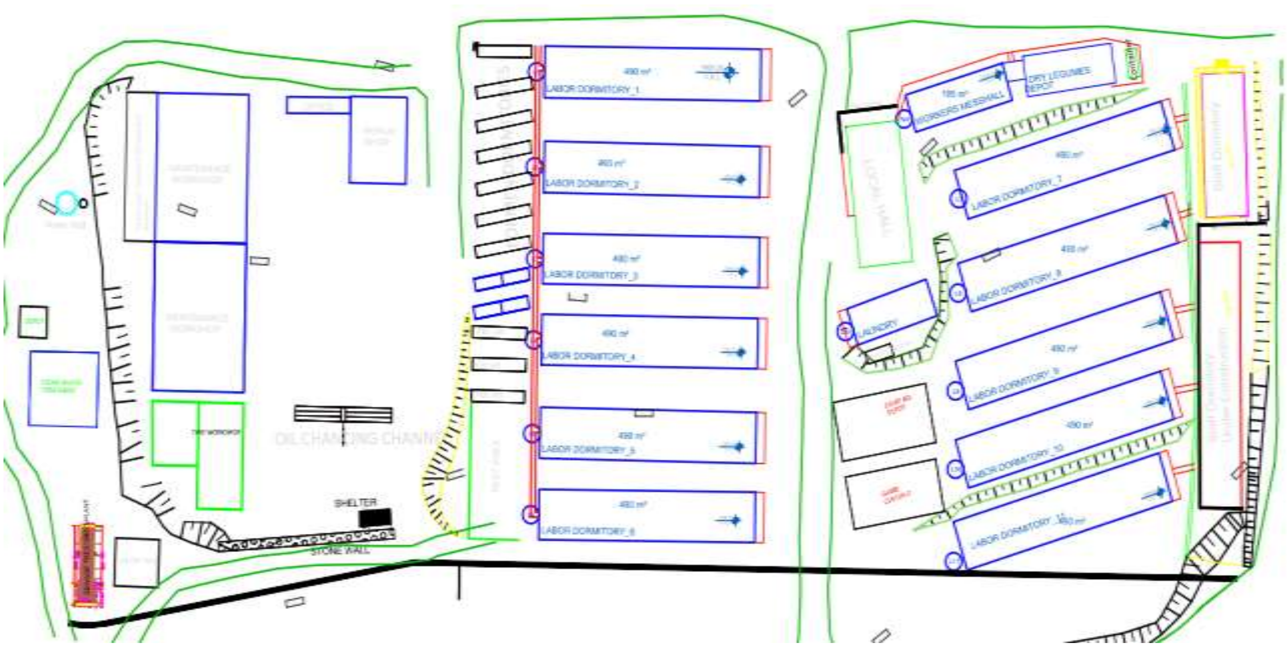
Item	Number	Area
Engineer Dormitory	6	514m^2
Engineer Messhall	1	166m^2
Local Kitchen	1	111m^2
Formen Dormitory	2	360m^2
Kitchen & Dining Hall	1	881m^2
Tailor Hairdresser	1	65m^2
Canteen	1	60m^2
Waste Location	1	50m^2
Fitness Center	1	90m^2
Prayer Room	1	108m^2

Figure 5.23: Part D of Kombolcha Camp Layout



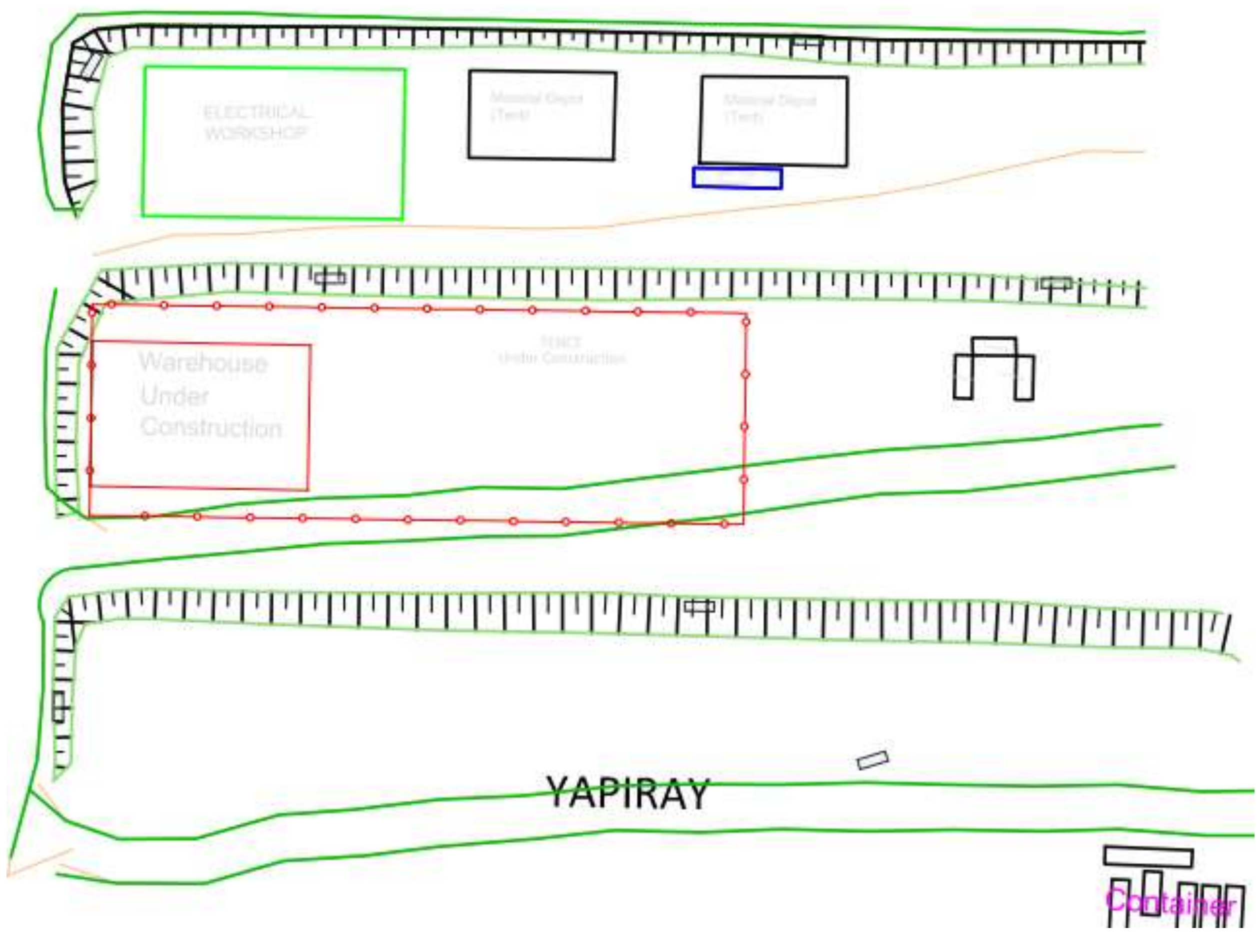
Item	Number	Area
Clinic	1	$117m^2$
Reinforcement Shop	1	$1,500m^2$
Precast Production	1	$1,500m^2$
Generator	1	$150m^2$
Tower Crane	2	$50m^2$
Warehouse	1	$756m^2$
Warehouse Shelter	2	$1,000m^2$
Warehouse Stock Area	1	$1,000m^2$
Weight Bridge	1	-

Figure 5.24: Part E of Kombolcha Camp Layout



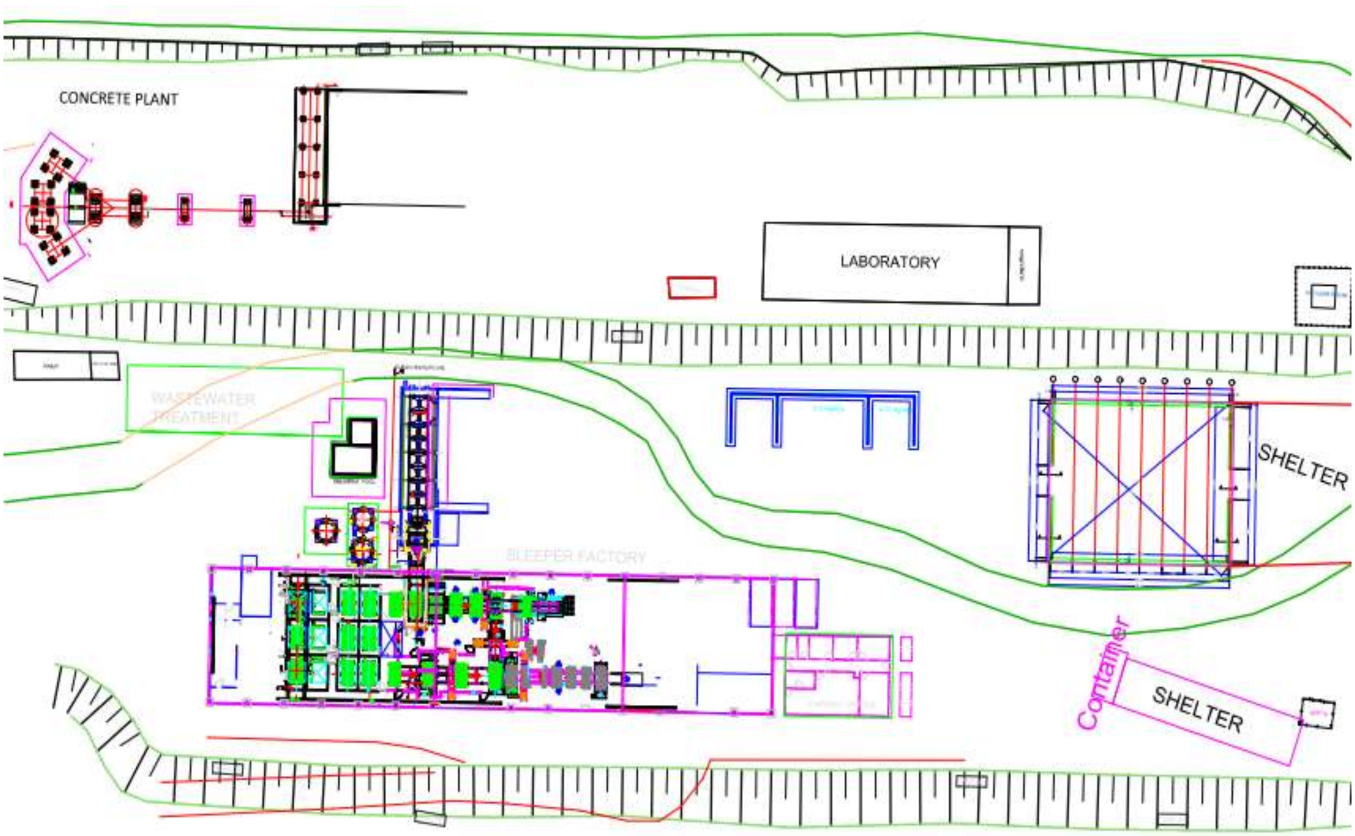
Item	Number	Area
Depot	1	$50m^2$
Clean Water Treatment	1	$275m^2$
Maintenance Workshop	2	$720m^2$
Sewage Treatment Plant	1	$150m^2$
Tyre Workshop	1	$300m^2$
Repair Shop	1	$245m^2$
Oil Changing Channel	1	$150m^2$
Formen Dormitory	12	$35m^2$
Labor Dormitory	11	$490m^2$
Workers Messhall	1	$185m^2$
Dry Legumes Depot	1	$160m^2$
Laundry	1	$160m^2$
Game Center	1	$200m^2$

Figure 5.25: Part F of Kombolcha Camp Layout



Item	Number	Area
Electrical Workshop	1	500m^2
Material Depot	2	250m^2
Warehouse Under Construction	1	475m^2
Container	1	120m^2
Sleeper Stock Area	1	1500m^2

Figure 5.26: Part G of Kombolcha Camp Layout



Item	Number	Area
Concrete Plant	1	1,000m^2
Laboratory	1	400m^2
Sleeper Factory	1	2,000m^2
Sediment Pool	1	270m^2
Wastewater Treatment	1	400m^2
Shelter	1	800m^2

Figure 5.27: Part H of Kombolcha Camp Layout

Chapter Six – Conclusions and Recommendations

6.1 Introduction

This chapter presents conclusion and recommendation part of the investigation.

6.2 Conclusions

From results of data analysis the following points can be concluded:

I. Yapi Merkezi has higher quality organizational structure than China Railway Group Limited in terms of specialization, hierarchy of authority, professionalism, size, organizational technology, the environment and an organization's culture.

II. Project manager leads railway project with two sections; construction and office sections. Furthermore, all construction division managers are directly accountable to project manager.

III. For construction of railway track, bridge and tunnel; there are six construction divisions and under infrastructure division there are five construction departments.

IV. Method statements are the core working procedures. Each construction division and department has its' own method statement specific to the work.

V. Quality Assurance / Quality Control division is responsible to prepare all Method Statements required for a project

VI. Construction Division work, strictly follow a three week construction plan prepared by Planning Department which bases a master construction schedule of the project

VII. Request for Inspection (RFI) form is a basic means to send work requests' to construction divisions and it has to be delivered before 24hours

VIII. All construction divisions use simple excel formats to register work accomplished.

IX. Earthwork department uses Itinerary Excel Sheet, Site Tracking and Daily Progress Excel Sheet, and Cut and Fill Balance Excel Sheets with their own specific purpose.

X. Quality Assurance / Quality Control Division use a total of thirty seven Inspection and Test Plan forms.

XI. Environmental, Social & Safety Division use seventeen working procedures to achieve its goal.

XII. All construction divisions prepare daily, weekly and monthly report

XIII. Construction divisions evaluate divisions' performance to the extent of the work assigned by planning department.

6.3 Recommendations

Recommendation for three independent entities will be given below:

I. Government (Ethiopian Railway Corporation)

I recommend ERC to adapt project organization structure and key project management practices and establish its' own construction and maintenance department.

II. Local Contractors

Local contractors are recommended to use results of the research to organize overall management system and take part in railway construction.

III. Local Consultants

Local consultants are recommended to apply thesis findings to support and guide railway projects.

6.4 Recommendation for Future Studies

Further studies have to undertake on the following points:

I. Document Control Center /DCC/ uses advanced network and software technology which requires through investigation
II. To conduct similar studies into electrical and mechanical works of railway project
III. Local consultants have to investigate working procedures for design of railway infrastructure
IV. Technical Office requires similar type of research to clarify its' organization and integration management

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Supplemental Materials

The following supplemental materials are attached to this thesis in DVD.

1. Method Statement
   A. Track – Method Statement
   B. Bridge – Method Statement
   C. Tunnel – Method Statement
   D. Common – Method Statement
2. Inspection and Test Plan
   A. Track – Inspection and Test Plan
   B. Bridge – Inspection and Test Plan
   C. Tunnel – Inspection and Test Plan
   D. Common – Inspection and Test Plan
3. Quality Assurance / Quality Control Laboratory Results Registration Forms
4. Request for Inspection Form
5. Kombolcha Camp Layout
6. Organizational Chart
7. Earthwork Excel Formats
   A. Itinerary Excel Sheet
   B. Site Tracking and Daily Progress Excel Sheet
   C. Cut and Fill Balance Excel Sheet
8. Environmental, Social and Safety Procedures & Toolbox Talks
9. Precast Production & Building Division Report Excel Format