Addis Ababa University
School of Commerce and Economics

Assessment of Project Procurement Practices: The Case of Ethiopian Electric Power, Electric Network Reinforcement, and expansion Project.

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DEDICATION

In blessed memory of my Mom & Dad: late Tsegewoyne Gebreyesus and late Hailu Gebregeorgis. May your souls continue to rest in perfect peace of the lord? I miss you…

LIST OF ABBREVIATIONS

ADB-Asian Development Bank

KPIs- Key Performance Indicators

EEP-Ethiopian Electric Power

ENREP-Electric Network Reinforcement and Expansion Project

EEU-Ethiopian Electric Utility

WBS- Work Breakdown structure

FAT-Factory Acceptance Test

ICB-International Competitive Bidding

FIDIC- Fédération Internationale des Ingéniurs Conseils(International Federation of Consulting Engineers)

O&M- Operation and Maintenance

IPPs-Independent Power Producers

LCC-Life Cycle Costing

GoE-Government of Ethiopia

DLP-Defect Liability Period

YESC-Yangon Electricity Supply Corporation

EDM- Electricidade de Mozambique

PGCB-Power Grid Company of Bangladesh Limited

CEB- Ceylon Electricity Board (Sirilanka Power Utility)

EPC- Engineering Procurement and Construction

MVA-Mega Volt Ampere

MW-Mega Watt

ABSTRACT

The objective of this study was to assess the influence of procurement practices on the occurrence of failures of power transformers in substation projects, particularly after warranty period is passed and the projects are closed. The study was made through case study of a substation project called Electric Network and Reinforcement (ENREP) of the Ethiopian Electric Power.

The study has utilized primary and secondary data sources. Primary data has been collected through questionnaire and interviews while secondary data was collected through a desk study of project documents. Accordingly, the procurement practices particularly the procurement planning, supplier selection and contract management found to influence the failures of power transformers, though the incidences happened several years after completion of the project.

In the planning stage, there was problem in applying sound risk planning, market assessment of qualified sellers, carrying out appropriate cost estimate for reliable products. In the supplier selection, the focus of the Ethiopian Electric Power was mainly on price and delivery schedule. With regard the contract management, the practice seems good enough, however, there was gap in applying lessons from failed cases which might have contributed to the continued failures of power transformers.

Therefore, to remedy the unprecedented failures of power transformers and other critical substation equipment in the Ethiopian Electric Power, using proper procurement planning practices to avoid potential risks, vetting manufacturers and their product in advance through prequalification process, applying complete cost of ownership during evaluation with good contract management including applying lessons learned to avoid similar mistakes in next project can help to improve the situation which essentially means revisiting and making improvement on the procurement practices of the Ethiopian Electric Power.

Key words: substations, Inherent, failures, warranty period, Power transformer, procurement

CHAPTER ONE

1.1. Background and Context

Project procurement process is an area of vital importance and interest to organizations responsible for delivering project outcomes (Alias et al., 2012). The influence that suppliers have on the success or failure of projects is significant since their performance affects the results of the entire business effort (Liu et al., 2014). Moreover, selecting an appropriately qualified supplier improves stakeholders' confidence since this is more likely to lead to project goals being achieved (Turskis, 2008). In this situation, quality in the procurement practices is essential in order to meet good outcomes in any kind of project. Therefore, planning the procurement, selecting the right supplier for an assignment, evaluating this supplier's performance while the contract is being implemented, as well as closely manage the relationship between the supplier and the client plays an important role in ensuring a good outcome. Thus, utilities should pay special attention to the procurement practices such as procurement planning, supplier selection and contract management. Cheng and Li (2004) affirm that suppliers selection is one of a company's primary activities hence it must select, appropriate suppliers to ensure that projects are completed successfully. Moreover, according to Zolghadri et al. (2011b), this choice is critical because it has a direct impact on the client's financial health and production capability.

Increasingly, cost is no longer the most important order qualifier, especially, for the technology oriented innovative products. Firms achieve cost efficiency and improve quality and order fulfilment through effective supplier selection. The purchasing activity, as part of the project procurement practice, determines the most important part of the final cost of the product, for this reason this selection is one of the decisions which determine the long-term viability of the company. Gencer & Gürpinar (2007), pointed out that over 50% of all quality defects can be traced back to purchased material. Consequently, a good purchasing and supply chain can make an important contribution to a company’s result and to be successful in nowadays competitive conditions.

On the other hand, the Ethiopian Electric Power is no exception to the challenge of defects in its project because of procurement practices (EEP, 2020). Critical Equipment purchased under one

of its projects, Electric Network Reinforcement and Expansion (ENREP) were failed within a couple of years after the warranty period was passed. The suppliers argued that they have delivered their obligation as per the specifications they have been given. This clearly pointed out that sub-optimal procurement practices such procurement planning, procurement procedures and contract management, among others have contributed to the poor delivery of the projects.

1.2. Problem Statement

The structure of electricity delivery can be categorized into three functions: generation, transmission, and distribution, all of which are linked through key assets known as substations. The loss of transformers at substations represents a significant concern for energy security in the electricity supply chain due to shortages in inventory and manufacturing materials, increased global demand in grid developing countries, and limited manufacturing capabilities. Substations are highly specific (customized) to the systems they serve, which also limits the interchangeability of transformers. Replacing a transformer is associated with a long delivery lead time as they are generally difficult to transport due to their size and weight. Failure of even a single unit could result in service interruption (Office of Electricity Delivery and Energy Reliability U.S. Department of Energy, 2015).

The Ethiopian Electric Power (EEP), responsible to generate, transmit and distribute bulk power, had faced several failure cases of large power transformers in the last five years (failure investigation reports of EEP, 2014-2019). Defects can be classified as two types, named: 'Patent Defects' and 'Latent Defects'. Patent Defects can be detected by the normal inspection or testing and apparent to naked eye such as foundation crack. However, Latent Defects are hidden and cannot be discoverable by normal examination or testing which will appear itself after certain period (Anon, 2007).

The Ethiopian Electric uses the International Federation of consulting Engineers'(FIDIC) silver book for turnkey EPC implementation of substation Projects. According to FIDIC silver book, any patent defects shall be cleared by the Contractor within the defect liability period. As per the observation of the writer, patent defects are relatively less severe as the supplier has contractual obligation to remedy it, though there is no contractual provision to claim for loss of income

during the replacement or remedial period. However, the issue of latent defects is very serious because these failures usually occur after the contractor supplied, installed and the defect liability period is passed.

As residents of the Country we have been witnessing frequent interruption of power supply (including for home lighting purposes) for long time. Furthermore, as a professional and practitioner in the industry, the writer has also witnessed that sizable part of the problem is related to poor quality of equipment in substations, particularly Large Power transformers, though the interruption due to shortage of power from generations, failures of the transmission lines, distribution lines and other faults played their own part.

EEP's 2019 customer satisfaction survey concluded that more than 60% of customers who were interviewed expressed dis-satisfaction with the quality of service they are provided by the utility (EEP's SWOT Analysis, 2019). Better service quality increases perceived service value and satisfaction; improves the service provider's customer retention and financial performance; and enhances a firm's corporate image (Nguyen and Leblanc, 1998).

Recognizing these severe problems, the operation department has been trying to inform the procurement and project offices not to consider the manufacturers who manufactured the failed transformers for new projects (EEP's internal memo, 2019). Besides, there were efforts such as inserting special clause to extend the defect liability period on the standard bidding document of the Ethiopian Electric Power, particularly for large power transformers from the standard 1(one) year changed to five (5) years etc. (EEP's Contract documents, 2020). However, no structured study has been made to address the root causes of the premature failures of power transformer because of latent defects.

Hence, the failures of large power transformer have continued to happen at unprecedented rate. Due to the nature of their design and construction, substations have a typical service life of more than 40years (Substation Asset Methodology, 2018). Unlike the industry practice, in the last 5 years alone, more than ten (10) large power transformers were failed in the Ethiopian Electric Power, once the project is done and transferred to operation department within life time of less

than 6years, which is much less than the 40years of the industry practice (EEP's Transformer Investigation Report, 2018).

Considering the price of each power transformer, is minimum of a couple off millions of dollars. This has resulted in not only to loss of public money (in millions of US dollars), it also resulted in revenue loss, customers dissatisfaction and other socio-economic crisis.

Therefore, this study is intended to investigate the process of acquiring these big assets, by studying the influence of project procurement practices on the occurrence of premature failures of power transformers as a result of latent defects, thereby recommend possible remedial actions based on the finding of the study.

1.3. Research Questions

Specific Questions to be answered by the study are;

1) What is the influence of procurement planning on performance of power transformers in substation projects of EEP, beyond defect liability period?
2) What is the influence of supplier selection on performance of power transformers in substation projects of EEP, beyond warranty period?
3) What is the influence of Contract management on performance of power transformers in EEP's substation projects once it finished its warranty period?

1.4. Objective of the study

General objective is to study influence of project procurement practices on occurrence of latent defects that result in failures of Power transformer of the Electric Network Reinforcement and Expansion Project (ENREP) of the Ethiopian Electric Power (EEP).

The specific objectives include the following;

1) To assess the influence of procurement planning on performance of power transformers in EEP's substation projects, after defect liability period.
2) To examine the influence of supplier selection on the performance of power transformers in EEP's substation projects, after defect liability period.

3) To investigate the role of contract management on the performance of power transformers in EEP's substation projects, after defect liability period.

1.5. Scope of the Study

This study is limited to study of the influence of project procurement practices on the sources of failures of power transformers in substations once the project is done and warranty period is finished. The study focused only on the Electric Network Reinforcement and Expansion Project (ENREP). The study was made using Four (4) cases of failures of power transformers in fours substations included in this report which are located two in Addis Ababa, one in Debremarkos and the other in Alamata. The study period includes failures occurred from 2016 to 2020. Conceptually, causes of the defects after completion of the defect liability period with respect to project procurement practices will be assessed and recommendation for possible remedial action will be given based on the result of the study and assessment of the literature on industry best practices.

1.6. Importance of the Research

There were considerable cases of quality performance problems exhibited in substations and transmission lines investments of the Ethiopian Electric Power (EEP's strategic document, 2020). Various sources, including power equipment manufacturers, estimated that the average age of LPTs (large power transformers) installed in the United States is 38 to 40 years, with approximately 70 percent of Large power transformers being 25 years or older. According to an industry source, there are some units well over 40 years old and some as old as over 70+ years that are still operating in the grid (U.S Infrastructure Security and Energy Restoration Office of Electricity, 2014) on the other hand large power transformers purchased by the Ethiopian Electric Power were failed within few years after start operation which resulted in serious problem of power interruptions. (EEP's Investigation Reports, 2016/17/18)

The implication of this poor power quality is not only resulting in financial losses to the EEP, it has also resulted in bad public image (Draft EEP Strategy Document, 2020). Furthermore, it negatively affects the economy by causing interruptions of processes, equipment failure,

equipment downtime, lower energy efficiency, lower product quality, lower labor productivity, and other indirect costs. (EEP's Draft Strategic Document, 2020)

Considering the quality performance problem exhibited in the Ethiopian Electric Power and further implication to the country, this research will attempt to assess the influence of procurement practices on the sources of latent defects that resurfaced after the defect liability period and resulted in failures of power transformers. It will further develop recommendations based on the result of the study and the industry good practices to be used by the Ethiopian Electric Power, procurement office, and Engineering design office in minimizing potential problems in the future. Furthermore, as the failure is anticipated to continue, it will the operation and maintenance Department of the Ethiopian Electric Power as an input to minimize the impact of the failures, by preparing contingency plan in advance. It will also be expected to give insight to the top management to consider power transformer as a national security issue and take necessary backup plans in place and exercise utmost caution during the process of procuring these strategic assets.

Apart from this, the findings from this study can provide inputs for further research works of similar natured industry. The study also contributes to the project management discipline by adding to the literature and findings, ultimately contributing to the improvement of other similar projects.

1.7. Limitation of the study

In the case project different stakeholder were involved. Some of the major ones include the manufacturer of the power transformers, the main supplier/Contractor and other installation service providers, the consultant, and the client/project office, the end user/operation & maintenance department.

The equipment manufacturers are sub-suppliers of the main contractor who have not direct contractual relationship with the Client. However, considering their key role, their response could have enriched the study. However, being a foreign company, which does not have representative locally, effort to contact them through the contractor was unsuccessful, hence their response is not included in this study.

1.8. Organization of the Research Report

The study is organized into five chapters. Chapter one provides a brief background to the study, discusses statement of the problem, the research question, objective of the study, scope and limitation and significance of the study. Chapter two presents review of related literature followed by Chapter three which presents the research methodology in which the research methods, data collection, the sources of data and the methods of data analysis. The fourth chapter focuses on the presentation, analysis, and interpretation of the research findings. Finally, chapter five provides recommendations of the study.

1.9. Definition of important terms used in the study

- **Substation** – A substation is a part of an electrical generation, transmission, and distribution system that transform voltage from high to low, or the reverse, or perform any of several other important functions.
- **Defects –** In general terms, defects or defective work is where the standard and quality of workmanship and materials as specified in the contract is deficient
- **Latent Defects** – Latent defects are hidden and cannot be discoverable by normal examination or testing which will appear itself after a period of time
- **Patent Defects –** Defects that can be detected by the normal inspection or testing and apparent to naked eye
- **Power transformer –** A transformer is a four-terminal device that transforms an AC input voltage into a higher or lower AC output voltage. It transforms power from a circuit to another with no frequency changes regardless of the voltage levels.
- **Defect Liability Period (DLP) –** A defects liability period is period during which the Contractor is responsible for repairing or rectifying defects that appear in the works. The period usually commences upon practical completion of the works and runs for a specified time frame (sometimes also known as the maintenance period).

Figure 1: Typical three phase power transformer

(Source-internet)

CHAPTER TWO-LITRATURE REVIEW

2.1 Theoretical Review

Defee *et al.*, (2010) stated that, good research should be grounded in theory. This study will be guided by institutional theory, socio-economic theory, and Resource based Theory. The institutional theory is the traditional approach that is used to examine elements of public procurement (Obanda, 2010).

2.1.1 Institutional Theory

According to Scott (2004), institutions are composed of cultural-cognitive and regulative elements that, together with associated activities and resources give meaning to life. He further explains the three pillars of institutions as regulatory, normative and cultural cognitive. The regulatory pillar emphasizes the use of rules, laws and sanctions as enforcement mechanism, with expedience as basis for compliance. The normative pillar refers to norms (how things should be done) and values (preferred or desirable), social obligation being the basis of compliance. The cultural-cognitive pillar rests on shared understanding (common beliefs, symbols, shared understanding).

This theory is very important when it comes to the implementation of sustainable procurement policy and practice in organizations that serve the public. This is a matter of organizational culture and the degree to which the prevailing climate in an organization is supportive of sustainability and/or of change in general (Brammer& Walker, 2012). From this theory, one can understand the laws and regulations governing procurement practices in effective project implementation for instance from the Evaluation period, Award, Substantial Completion and End of Defects Liability period of project justifying its implementation. This is gained by considering the procurement practices like procurement planning, supplier selection, contract review and monitoring and evaluation towards project implementation.

2.1.2 Socio-Economic Theory

Sutinen and Kuperan (2012) propounded the socio-economic theory of compliance by integrating economic theory with theories from psychology and sociology to account for moral obligation and social influence as determinants of individuals' decisions on compliance.

According to Lisa (2010), psychological perspectives provide a basis for the success or failure of organizational compliance. Wilmshurst and Frost (2000) also add that the legitimacy theory postulates that the organization is responsible to disclose its practices to the stakeholders, especially to the public and justify its existence within the boundaries of society. This theory, which focuses on the relationship and interaction between an organization and the society, provides a sufficient and superior lens for understanding government procurement system (Hui et al., 2011). From this theory, we can understand the procurement policy, planning, supplier selection, contract reviews and sustainable procurement practices in public institutions and their influence on service delivery to the society as well as project implementations. This theory is very important when it comes to the implementation of sustainable procurement policy and practice in organizations that serve the public. This is a matter of organizational culture and the degree to which the prevailing climate in an organization is supportive of sustainability and/or of change in general (Brammer& Walker, 2012). From this theory, one can understand the laws and regulations governing procurement practices in effective project implementation for instance from the Evaluation period, Award, Substantial Completion and End of Defects Liability period of project justifying its implementation. This is gained by considering the procurement practices like procurement planning, supplier selection, contract review and monitoring and evaluation towards project implementation.

2.1.3 Resource Based Theory

Resources are inputs into a firm's production process, such as capital, equipment, skills of individual employees, patents, finance, and talented managers. Resources are either tangible or intangible in nature. With increasing effectiveness, the set of resources available to the firm tends to become larger. Individual resources may not yield to a competitive advantage. It is through the synergistic combination and integration of sets of resources that competitive advantages are formed. The Resource-based Theory (RBT) is a strategic management theory that is widely used in project management. It examines how resources can drive competitive advantage (Killen *et al*., 2012). The RBT has become one of the most influential strategic management theories cited in strategic management literature due to its immediate face validity, appealing core message, and ease to grasp and teach (Kraaijenbrink *et al*, 2010). However, these advantages do not come without criticism. Those who are against the application of the RBT are criticizing areas that are

mainly related to the state of the definitions that RBT is based on, the conceptual and empirical methodology, and so-called deficiencies of the concept (Truijens, 2013).With the help of this theory one can understand how to utilize the available resources, select our suppliers, do contract reviews to accomplish and implement a given project effectively by prioritizing the project needs.

2.2 Empirical Review

2.2.1 Defects in Project Works

In general terms, defects or defective work is where the standard and quality of workmanship and materials as specified in the contract is deficient (S. Ojo, 2006). It is generally believed that there are two major types of defects in construction projects. According to Cama (2004), defects are often referred to as patent defects and the latent defects. Where the latent defects are the opposite of patent defects. Patent defects can be found out upon examination or shortcoming in a structure that is apparent to reasonable inspection for example a roof leak or a foundation crack. Normally, defects are readily apparent to the naked eye and are therefore capable of being assessed and measured relatively easily and then, if necessary, rectified. Latent defects, on the other hand, are those hidden or concealed defects that would not be discovered during a reasonable inspection. A latent defect is something that is not easily discoverable. Normally, defects only become apparent at some later date or upon an investigation of some consequential effects caused by the defect. Patent defects are plain to see, or at least, that is the theory. Whether the engineer could or should have seen defects on site during site visits has exercised more than one judicial mind (Nigel, 1996).

Glover (2008) has provided a practical approach by grouping causes under four headings, human error being a thread linking each of the four categories.

a) Design deficiencies
b) Material deficiencies
c) Specification problems
d) Workmanship deficiencies

a) Design deficiencies – Design is fundamental function in the construction process and affects every event downstream. It is considered that some, though not all of the critical process which are dependent on design decisions are: material selection, how, or if, specifications can

be complied with, and how plant and equipment is installed (Aris, 2006). It is believed that design problems can be initiated at the very outset of the project (Houghton, 2005). Design considerations associated with the occupier and facilities management team are essential during all design stages. The sooner key consultants and maintenance teams are engaged during the construction period is the better. When designs are rushed to meet immovable deadlines, the quality of work can suffer. Far better to match resources with job needs. Of course, the client has a key role. Late design requirement changes may add to already pressurized design programmes.

b) **Material deficiencies –** Materials defects commonly occur because designers do not consider how materials will behave during construction and during the life of the building/plant (Houghton, 2005). It is also believed that material defects are commonly caused by the effects of material incompatibility (Rushton, 2009). Specifications should be based on knowledge, not only of material performance, but they should also aim to prevent poor manufacturing techniques and poor installation methods during construction period. When the designer selects or approves materials for any given construction project it is important, he establishes that the material or item of equipment is fit for purpose i.e. will it do the job it is required to do. Training and experience play very important, though material science is a discipline which may require input from experts.

c) Specification problems – A sound specification shall start to be prepared at the start of the preliminary design stages of any project. All contracts are commercial in nature and therefore money and economics must be duly considered during the process of preparing specifications. Bidding and types that squeeze contractors and suppliers can lead to specification adjustments perhaps dictated more by financial pressures than by good engineering practice, especially where project expectations differ from party to party. It is believed that design and build projects which do not have tight specifications can prove to suffer from post – tender differences in design interpretation with a consequence of increased defects (Aris, 2006). Works which do not have or have not been developed as part of a holistic project design may result in incomplete information, late changes or an inaccurate assessment of the quantity of work.

d) **Workmanship deficiencies –** Poor workmanship can occur resulting in defective systems or latent defects that exhibited later. Design nowadays commonly over specifying systems in a

fail-safe manner to allow specific redundancy due to these failings. Common causes for poor installation techniques are inadequate training, programme constraints, cost constraints and design ambiguities (Aris, 2006). The construction industry best functions on skills, knowledge, and experience. Capacity building at all levels is very important. Additionally, innovative products and systems are constantly being brought into the industry that can help in remedying the poor workmanship. A successful project relies on competent designers, managers, and skilled tradesmen.

Looking at the power sector, Katsutoshi-Toda (2018) has also identified the following types and sources of defects in power transformers,

i. **External Conditions**- Vandalism, external short circuit, lightning strikes
ii. **Network operators**- Improper installation, improper terminations, faulty earth connections, by passing of protection system, inadequate maintenance and prolonged overloading and unbalancing
iii. **Manufacturer**- Faulty design, quality of materials, poor workmanship, improper manufacturing process, improper transportation
iv. **Procurement stage**- Improper technical specifications, improper inspection process

Accordng to Dr. Katsutoshi-Toda, the solution proposed to minimize the defects due to manufactures is selecting reliable manufacturer and ensure transformers are manufactured as per specifications. Furthermore, technical evaluation of manufacturing facilities and process by a competent team, prototype testing in 3rd party independent lab, adapting stringent FAT and conduct post landing inspection are some of measure proposed. Regarding avoiding the failures of transformers during procurement stage, the counter measure proposed by Katsutoshi-Toda, are Vendor pre-qualification process, product qualifications process, Factory acceptance testing, post landing inspection and training for field engineers and staff.

Yet the question, can defects be completely eradicated? remains unsolved. For complex projects, it is unlikely that all the technical and sequential risk areas can be eliminated. However, it is possible to suggest that a defect management policy can ensure that defects are minimized, resolved, and learned from. As per the Rethinking Construction Report (2018), it was suggested that for the construction industry to move forward and become fully competitive, lowest cost

tendering needs to be re-thought. This approach shall also be applied to design consultants. Lowest cost tendering forces all parties involved in the supply chain to compromise on quality to make some profit.

The other mechanism is design engineers need to work more closely with clients at the start of a project. The client also must give emphasis and be convinced on the importance of early engagement. This process should identify and consider all critical aspects of the project. The client involvement and early engagement can produce a solid structure upon which to develop project and eliminate errors long before a shovel hits the ground (Kier Western, 2004). Western also suggests that involving key subcontractors early within the design stage to provide technical input can help the design flourish and creates a "good working relationship" which he believes is "fundamental to the coordination of the design and permits the efficient use of design resources and skills.

2.2.2 Project Procurement Practices

2.2.2.1 Procurement Planning

(Chandra, 2010) asserts that unlike small projects that involve few activities, complex projects that go beyond a certain threshold level of magnitude should proceed on the basis of a sound formal planning platform without which there may be chaos.

Therefore, necessity of procurement planning is undisputable. Procurement planning stage involves decisions that impact on quality throughout the procurement process and over the life of a contract. It is critical that procurement planning is done well, and that quality is considered, since the impacts on quality can be high and can carry through the entire project or contract life cycle (Asian Development Bank, 2008).

The selection of procurement arrangements is an important contributor to the achievement of project objectives. It is critical that end user's needs, and minimum requirements and project objectives, are clearly identified at the outset of the procurement process or, preferably, beforehand during the project conceptualization stage of the procurement cycle (Asian Development Bank, 2008).

Procurement planning and development of sound procurement strategies lead to consistently better value for money; higher quality project and service delivery; improved opportunities for sustainable procurement; and reduced risks to the agency (Joseph Ansah & Stephen Normanyo, 2017). According to Deme and Andrea (2009), procurement planning is seen to be important, and even more so in large and complex, multi-year and/or multi-million dollar requirements, where people will change over time or requirements will evolve and where risk and scrutiny increases.

Though it is key project activity, the need for planning seems lacks the attention it deserves. It is at the initial stages of procurement projects but the absence of it is highlighted at projects' end. Procurement Planning is highly supported by project management practitioners. Therefore, procurement practice is necessary to clarify the technical, cost, and schedule objectives of the procurement furthermore to define the plan for delivering the project objectives and finally to decide a way for evaluating performance against defined objectives during the time that the project is being executed. Procurement planning if done properly, it is essential to optimize the contribution of the procurement function towards achieving the overall goals of the organization. It helps to exhibit transparency, to define success criteria and to select the right quality and product quality in advance.

Table 1: Issues Affecting Quality in the Procurement Planning Stage

Activity	Potential Issues Affecting Quality
Project concept	• Borrower or end user requirements incorrectly defined or there is a lack of alignment on requirements among project owners and stakeholders • Project delivery methodology not defined
Market analysis	• Suitably qualified contractors do not exist in the geographical market or market sector • The power of contractors is high, and the risk of substitutes and new entrants is low • Incorrect supply positioning
Risk management	• Risk assessment fails to identify integrity-related risks and key risks to quality, or fails to cover key stages of the contract life cycle • Excessive allocation of risk to contractor reduces motivation of private sector to participate, potentially leading to lower quality outcomes
Options analysis and procurement strategy development	Procurement strategy options generated or selected are not the most appropriate to ensure quality and do not adequately avoid or manage potential integrity-related risks.

Source: Asian Development Bank, 2008

2.2.2.2 Supplier Selection

Supplier selection is the process by which firms identify, evaluate, and contract with suppliers of products needed to meet their objectives. The supplier selection process uses a tremendous amount of firms financial resources. In response, firms expect significant benefits from contracting with supplier' offering high value. Suppliers have been acknowledged as the best intangible assets of any business organization. As a result, supplier selection problem has become one of the most important issues for establishing an effective supply chain system. In fact, supplier selection and evaluation represent one of the significant roles of purchasing and supply management functions.

Arguably purchasing and supply chain plays an important part in supply chain management through proper selection of competent suppliers. According to Weber, Current & Benton (1991), firms cannot successfully produce low cost, high quality products without judicious selection and maintenance of a competent group of suppliers. Lee and et al (2013), emphasize that selection of the best supplier is an essential strategic issue imperative for supply chain effectiveness and efficiency. For Lee and other, strategic partnership with the right suppliers must be integrated within the supply chain to contain costs, improve quality and flexibility to meet end-customers" value and reduce lead time at different stages of the supply chain. Purchasing and supply management support the management of supplier network with respect to identification of supplier selection criteria, supplier selection decisions, and monitoring of supplier performance (Jose Gerardo & Martinez Martinez, 2007).

The quality of the supplier evaluation and selection process highly depends on the effective selection of the criteria. In recent years, researchers and practitioners started to integrate new dimensions such as sustainability, green practices and risk into the supplier evaluation process (Wetzstein, 2016 & Guo, 2017). Especially, the use of intangible and qualitative factors has increased. For example, supplier relationships, reputation of the company, risk, level of trust, communication, and corporate social responsibility (Er Kara, 2016).

The major factors in supplier selection are highlighted as in the following:-

i. Quality

Quality of raw material are very important in any organization and firms need to select suppliers with supplier's certification, proven track record of world-class service and quality raw materials. Lin et al. (2005) noted that quality management practices are imperative in supplier selection strategies. Gonzales et al. (2011) also found that quality is the most significant attribute in supplier selection.

ii. Cost

Cost has traditionally been considered as one of the most important aspects of supplier selection criteria in the purchasing and supply management literature. The lowest price is not always the best value for money. If one wants reliability and quality from suppliers, one has to have to decide how much is willing to pay for the supplies and the balance one wants to strike between cost, reliability, quality and service (Meredith & Mantel, 2012).

iii. After sales Services & strategic Partnership

Supplies' after sales services are very important for any organization. They are expected to provide high-quality services that include on-time delivery, value added services, and ease of communication. One needs suppliers to deliver on time, or to be honest and give plenty of warning if they can't. The best suppliers will want to work closely with their clients even after the project/product is delivered. The ability of suppliers to help buyers reduce risk can positively affect cost containment, quality improvement operational efficiency, process improvement and consistency, and supply chain visibility (Lysons & Farrignton, 2010).

iv. Risk Management

Suppliers must be able to proactively mitigate and manage supply risks. The ability of suppliers to help buyers reduce risk can positively affect cost containment, quality improvement operational efficiency, process improvement and consistency, and supply chain visibility (Lysons & Farrignton, 2010).

As per (Er Kara & Fırat, 2018) the risk criteria that are used to evaluate suppliers are explained in the following.

- **Previous supplier assessments:** It is an important indicator that represents the historical performance and reliability of the suppliers.
- **Purchase (commodity) price variance**: It represents the competitiveness of the price and Sustainability
- **Financial condition of the supplier**: This indicator represents the risk rating of the supplier's financial condition by considering its economic status, debt structure, market share, annual revenue and growth, and financial stability.
- **Percentage of supplier's work commonly subcontracted**: It is the ratio of the supplier's work that is subcontracted. Suppliers are dependent on their subcontractors for this part of their job. Hence, a high level of subcontracting leads to a high level of uncertainty and risk exposure.
- **Manufacturing capability:** This indicator refers to the rating of the supplier's manufacturing capability in terms of the conditions, qualification, adequacy and capacity of the production facility, machines, equipment and employee of the supplier.
- **Flexibility**: Supplier flexibility can be defined as the ability of the supplier to respond to changing demands and requirements of customers.
- **Technological capability** : It is a measure of the capability and robustness of supplier's technological systems, and used to measure technology risk
- **Average defect rate of the supplier**: Defect rate is the proportion of the number of products that do not meet quality specifications to the total number of units supplied from the supplier
- **Quality management effort**: It refers to the rating of the supplier based on its quality efforts (commitment to quality).
- **Late delivery rate of the supplier**: It is the ratio of the number of late deliveries to the total number of orders.
- **Supplier lead time variability**: This indicator is measured by dividing the difference between quoted and actual supplier lead time by the quoted lead time (in days). It is an indicator of the variation from promised delivery lead time.
- **Packaging and shipping quality**: This indicator refers to the risk rating of the supplier's packaging and shipping functions both in terms of quality of this function and compliance to standards.
- **Ease of communication**: This indicator refers to the overall communication rating of the supplier. It considers problems and difficulties in communicating with suppliers such as unstable and inefficient communication networks, difficulty to reach contact persons/sales representatives
- **Reliability**: It represents the reliability level of the supplier based on compliance to contract terms and conditions in previous businesses, accuracy and reliability of documentation and

information provided by suppliers, reputation in the sector, and references. Level of trust in the buyer-supplier relationship is a very important factor that affects the strength of business relationships and information sharing.

- **Problem solving performance:** This indicator represents the risk level arising from ineffective and poor sales and technical support. Problem solving performance includes the response time of suppliers to a complaint, quality concern or emergency problem, problem solving capability, handling of complaints, technical support level, and remedy to correct a quality problem.
- **Warranty policy and after sales service**: This indicator refers to the rating of the supplier's after sales service, and warranty and claim policy (in terms of coverage of warranty and service agreements, warranty period, and satisfaction about claims).
- **Disaster recovery plans to deal with major disruptions**: This indicator refers to the score of a supplier based on its disaster recovery plans.

v. Financial Stability

It's always worth making sure that supplier has sufficiently strong cash flow to deliver what one want, when you need it (Lysons & Farrignton, 2010). This can be checked through line of credit or other means of financial sources.

2.2.2.3 Contract Management

Contract management plays a vital role in contributing to quality outcomes. Active measurement and monitoring of process measures and outputs informs the contractor and borrower on whether the contract objectives are on track or are at risk of not being achieved (ADB, 2008). This allows rectification when certain milestones are not being met, thus improving the likelihood that desired outcomes are obtained.

According to ADB (2008), potential issues in the contract management stage of the procurement cycle that affect quality can be categorized into the activities of:-

- Performance measurement,
- Relationship management,
- Contract change management, and
- Contract closure.

These activities are further elaborated under table 2.

Table 2: Issues Affecting Quality in the Implementation and Contract Management Stage

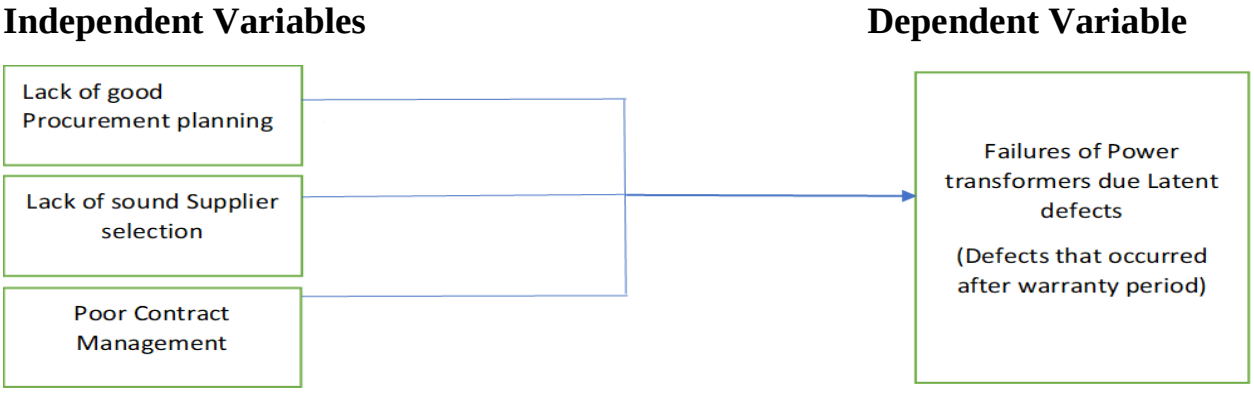
Activity	Potential Issues Affecting Quality
Performance measurement	• Performance measures not aligned with contract objectives • Incorrectly designed performance measures • Inattention to performance measurement and monitoring
Relationship management	• Adversarial relationship affects capacity to jointly address quality issues • Relationship structure not clearly defined • Inadequate contract administration corrodes relationship
Contract change management	• Contract objectives or scope change over the course of contract
Contract closure	• Mishandling of contract expiry or termination •Lesson learned not properly captured

Source: Asian Development Bank, 2008.

2.3 Conceptual Framework

According to Mugenda & Mugenda (2013), a conceptual framework refers to conceptualization of the relationship between variables in the study. The conceptual framework of this study is shown diagrammatically as in the following.

Figure 2: Conceptual Framework



CHAPTER THREE – METHODOLOGY

3.1 Research Approach and Design

This research used a qualitative research approach which is suitable to study complex research problems that cannot be explored in isolation from their human and social context (Creswell, 2013). It is the preferred method for an in-depth exploration of a complex phenomenon such as project procurement practices where the boundaries between the phenomenon and its context are not always clear (Yin, 2014).

According to (Stake,1995), case study is a commonly used research method in qualitative research approaches because it facilitates the investigation of a contemporary phenomenon (e.g. a programme, an event, individuals, actions) within its social context, in its natural setting (Eisenhardt, 1989; Yin, 2014). It also deploys various methods of data collection to gather information from one or a few entities like people, group, or organizations (Benbasat et al, 1987, p.370). Single or multiple case studies can be used depending on the requirements of the research problem (Stake, 1995; Yin, 2014).

Eisenhardt & Graebner (2007) and Yin (2014) argued that a single case study fits for a revelatory/extreme/unique case. Dyer & Wilkins (1991) also argued that it is appropriate in the situation where very little theoretical insight is available into the phenomenon under study. In contrast, Eisenhardt (1989) explained that a multiple case study approach supports the comparison between different cases for theory building, testing and generalization.

Accordingly, this study used the single case study approach and collected survey data from a project administered by the Ethiopian Electric Power called the Electric Network Reinforcement Expansion project (ENREP). Thus, the findings may also be applicable to other projects currently administered by the enterprise or other public institutions in Ethiopia which manage construction projects of similar nature.

3.2 Target Population

The target population in this research to which findings were generalized were key players and stakeholders at the Electric Network Reinforcement Expansion Project (ENREP). ENREP had 85 personnel which participated in procurement, consulting services, project management,

installation, operation & maintenance, and equipment supply. Out of the total staff size, 71% of the staffs are in the position of technical expert and above, having direct involvement in the procurement, project management, supply chain, consulting/engineering, supervision and operation and maintenance functions of the project. The remaining 29% are support staffs largely involved in works not directly related to the basic functions of the project i.e. janitorial services, and other non-clerical works. Accordingly, the study considered the whole staff of the case project including staffs participated during operation and maintenance period as a target population for the study.

3.3 Sample Size and Sampling Procedure

A sample is a representative portion of a population (Creswell, 2014). According to Kothari (2004), in a circumstance where the target population is small, the entire population can be considered as the sample. He further asserted that the complete enumeration of all items in the target population is known as a census inquiry. Thus, this study considers the target population as the sample i.e. all of ENREP's key staff (71%) representing all staff in the position of technical expertise and above were considered for the survey for which the structured questionnaire was designed, distributed and filled by these respondents to collect the primary data.

The study adopted purposive sampling method as the research has a pre-determined purpose. Besides, the sample population was pre-determined and known to only include people with knowledge in the study and those with no knowledge to the study were excluded (Oso & Onen, 2005).

3.4 Source of Data and Research Instruments

Research instruments were used for the collection of relevant information. To assess the major project procurement practices that influence performance of power transformers after defect liability period under EEP's ENREP project, a desk study approach and questionnaire survey were carried out.

The desk study was mainly carried out to obtain actual data from the source documents which included policy documents, company procedures, office memos, annual reports, newspapers, and

magazines of the company that were related to the study. The other instrument employed was to solicit professional opinion and relevant data through questionnaires. The primary data were collected through structured questionnaire. The structured questionnaire was developed to capture the procurement practices of the case project based on opinions of senior management, project managers, project supervisors and technical experts from key stakeholders involved in the project. Sufficient reference was made to empirical researches in the literature and benchmarks were made in developing the questionnaire. Accordingly, the questionnaire has captures various variables which were assessed under respective research objectives: -

i. To assess the influence of procurement planning on performance of power transformers in EEP's substation projects, after defect liability period, the following variables were considered: -

- Identifying the purpose
- Development of the procurement statement of work, specifications, product description and WBS (work breakdown structure)
- Determining customer requirement (user needs)
- Laying out the major milestones and the timing/schedule
- Cost estimating, including life-cycle costing
- Determining whether qualified sellers exist
- Identifying the source mechanism
- Preparing a listing of possible project procurement risks (i.e., a risk register)

ii. To examine the influence of supplier selection on the performance of power transformers in EEP's substation projects after defect liability period, the following variables were considered: -

- Quality of the product
- Delivery schedule of the suppliers
- Performance of sources of the supplier/manufacturer
- Warranty and claim conditions of the supplier/manufacturer
- Production facilities and capacity of the supplier/manufacturer
- Price offer of the supplier
- Financial position of the supplier
- Identifying Risk Factors
- After sales service of the supplier/manufacturer
- Total Cost of ownership
- Reputation and Position of the supplier in the industry
- Management and organization of the supplier

iii. To investigate the role of contract management on the performance of power transformers in EEP's substation projects, after defect liability period.

- Change management
- Specification interpretation
- Adherence to quality requirements
- Inspections and audits
- Warranties
- Performance reporting
- Records management
- Contractor (seller) management
- Contractor (seller) performance report card
- Documenting seller's performance (for future source selection teams)
- Production surveillance
- Approval of waivers
- Breach of contract
- Claims administration
- Resolution of disputes
- Payment schedules
- Project termination
- Documented verification that the output was accepted by the buyer
- Debriefing the seller on their overall performance
- Documenting seller's performance (documentation will be used in future source selections when evaluating contractor's past performance)
- Identifying room for improvement on future contracts
- Archiving all necessary project documentation
- Performing a lessons-learned review

The questionnaire survey method is adopted because it is usually cheap, easy to administer to many respondents, and normally gets more consistent and reliable results.

3.4.1 Validity and Reliability

The research instrument used in this study was subjected to expert judgement including the research's advisor at Addis Ababa University. Walliman (2001) recommends that questions should be pre-tested on a small population or pilot study. In accordance with this recommendation, the questionnaires for this research were pre-tested on 10 (ten) respondents to obtain their comments regarding any items that they had difficulty in understanding and to determine the time it takes to complete the document. The pilot test showed that the questionnaire can easily be understood, and it is not time taking.

3.5 Data Collection Procedure

The researcher has obtained approval from the relevant authorities to conduct the study on the case project. Self-administered questionnaires were distributed to respondents in hard copy as

well as by email. All the respondents (the target population) are literate who were able to read, understand, give responses to questions and capable of handling email correspondences.

3.6 Method of Data Analysis

The collected primary data was first processed by organizing, editing, coding, classification, and tabulation of the data. The organized data was then validated during which data collection instruments were checked for completeness, accuracy and to determine the required number of is submitted for analysis. Up on organization and edition of the collected data, special emphasis was given to ensure that there were no errors and/or omissions. The data was also checked for legibility and whether the submitted responses were adequate. Finally, organized data were then coded as appropriate in preparation for data analysis.

Following Creswell (2003), analysis of qualitative data followed the following procedures,

1. The data were read several times to identify points that are significant for the study
2. Thematic contents were formulated based on the major research questions
3. Emerging theme titles were listed out on a separate sheet in to find connection between them.
4. A master list of themes was produced and ordered coherently
5. Sub-themes, which go with each master theme, were identified
6. The relevant information was organized under each theme and analyzed.

The quantitative data, on the other hand, was analyzed using descriptive statistics based on advanced excel tool. Analysis and interpretation of data results was conducted using descriptive statistics such as percentage comparisons, calculation of averages, frequencies, and related mathematical matrices.

3.7 Ethical Issues

In research, there is an ethical responsibility to do the work honestly and with integrity. According to Leedy and Ormrod (2010), the basic principle of ethical research is to preserve and

protect the human dignity and rights of all subjects involved in a research project. Accordingly, the researcher of this study assured that the respondents' information is confidential and used only for the study purpose. The researcher has also committed to report the research findings in a complete and honest manner, without confusing others about the nature of the results. As a rule, therefore, the study did not raise any ethical anxiety. Moreover, the researcher was careful about professional theft.

CHAPTER FOUR – ANALYSIS AND DISCUSSION OF RESULTS

4.1 Questionnaire Distribution and Response Statistics

A total of 60 questionnaires were distributed among the respondents of program/project directors, project managers, supervisors and different level of expert level staff working on ENREP. Out of the 60 questionnaires distributed, 53(88.3%) were returned indicating a significant size of response rate.

4.2 Respondents' Age, Gender, and Educational Qualifications

As indicated in the table below, majority of the respondents are in the active working age range i.e. 25-49 which is an ideal age for handling and enduring challenges.

Table 3: Respondents' Age Mapping

Age Range	Staff Size	%age
Up to 25	3	5%
25-29	18	30%
30-39	28	47%
40-49	6	10%
50 years and over	5	8%
Total	**60**	**100%**

Regaring the gender distribution, majority of the repondents are male, the size of female project workers is not fair enough i.e. 5% (as indicated in table 4 below).

Table 4: Respondents' Gender

Gender	Number of Staff	Number of Staff
Male	95%	57
Female	5%	3
Total	**100%**	**60**

4.3 Respondents Academic Background, Primary Role and Experience

As can be referred from Table 5 below, 44% of the respondents are qualified in undergraduate degree, while 35% have technical qualifications and 20% are qualified in graduate degrees. This

implies that the project is sufficiently equipped with qualified personnel necessary to accomplish its deliverables.

Table 5: Respondents Academic Background

Educational Qualifications	Number of Staff	%age
Technical qualification	21	35%
Undergraduate Degree (BA/BSC)	26	44%
Master's certificate or equivalent (MA/MBA/MSC)	12	20%
Other	1	1%
Total	**60**	**100%**

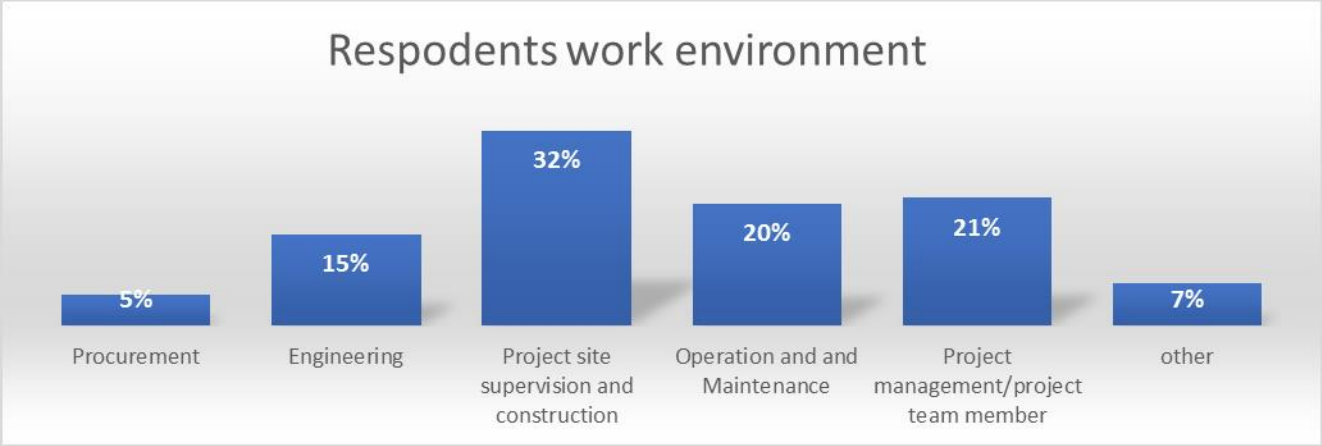
In terms of overall role and years of experience, majority of the respondents in the study are Project/Procurement Managers or Engineers of the project team. Most of these job categories are held by individuals with strong work experience in the range of 10 to12 years. In addition, the respondents having senior managerial roles have richer work experiences in the range of 10 to 16years of experience (refer table 6 below).

Table 6: Respondents' Work Experience

Current Position/Level	Years of Experience						
	1 to 3	4 to 6	7 to 9	10 to 12	13 to 15 years	More than 16 years	Total
Team Member	4	6	5				15
Project/Procurement Manager/Engineer		5		15			20
Programme Manager / Director					5	8	13
Other roles in Project Management	7			5			12
Total	11	11	5	20	5	8	60

Regarding specific area of expertise (i.e. specialization), the respondents were asked to indicate what best describes their respective activities/specialization. Accordingly, 73% of the respondents indicated that they are engaged in either engineering and/or project areas, as highlighted in figure 3 below.

Figure 3: Respondents' Work Specialization



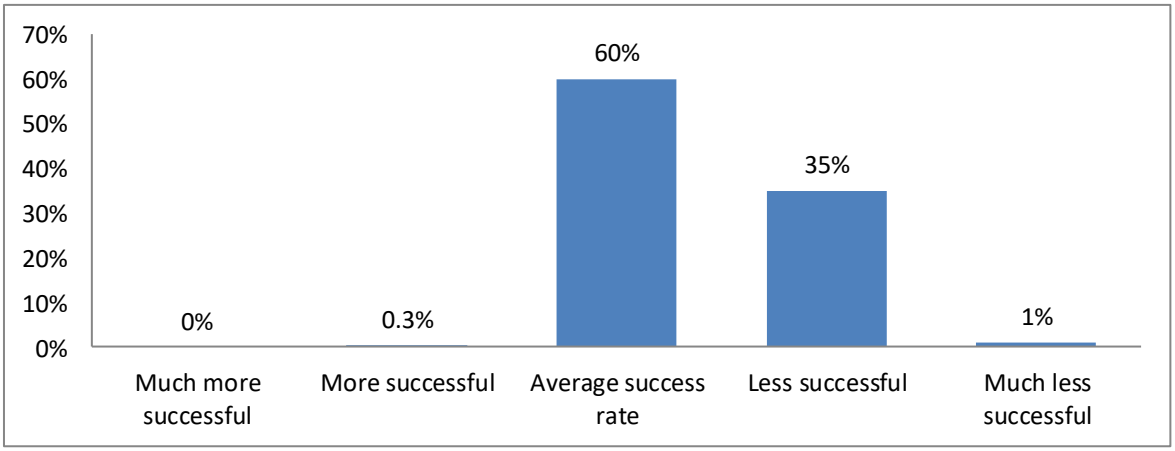
4.4 Analysis of Survey Results

4.4.1 Findings on Overall Project Nature

In this section, analysis of project procurement practices based on the opinion of respondents to various project procurement management questions is presented.

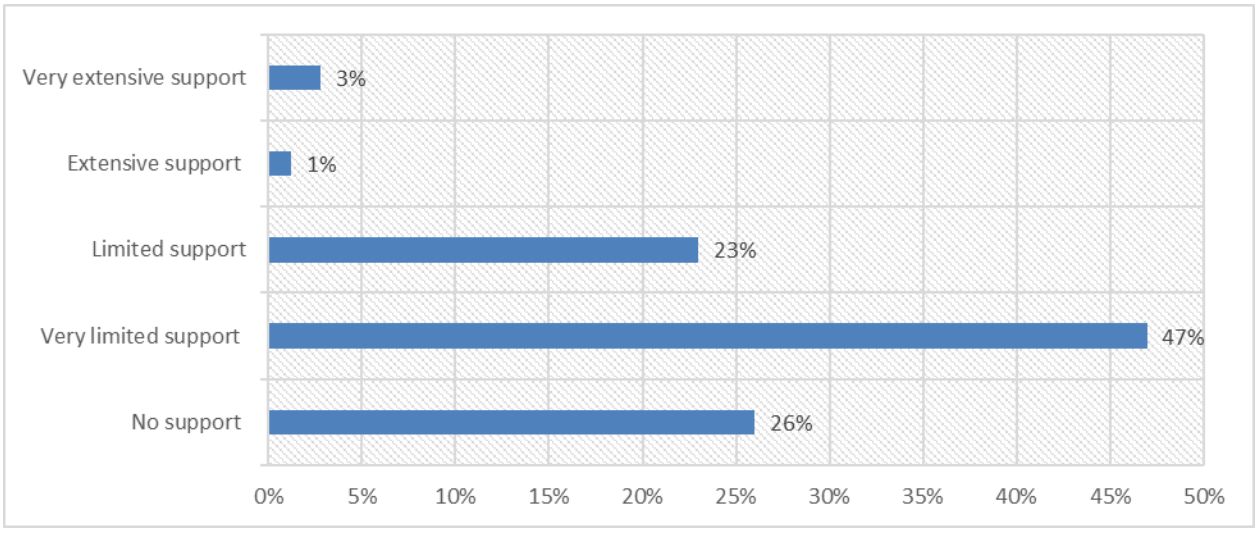
Respondents were asked to rate the success rate of the project they are engaged with compared to other similar project in their organization. About 60% of the respondents answered that ENREP has an average success rate compared to other similar projects. 35% of respondents answered that the project is even much less successful. Only 0.3% of the respondents answered that the project is perceived to be more successful compared to other projects and 1% of them said the project is much less successful compared to other similar projects (figure 4).

Figure 4: Success Rate of ENREP



Respondents were also asked if their organization supports their use of tools or techniques with templates, trainings, detailed instructions and procedures. As indicated in figure 5 below, Near 95% of the responses indicate that such support is either limited, very limited or no such support exists at all. Only about 5% of the responses indicated that there is such support from their respective organizations.

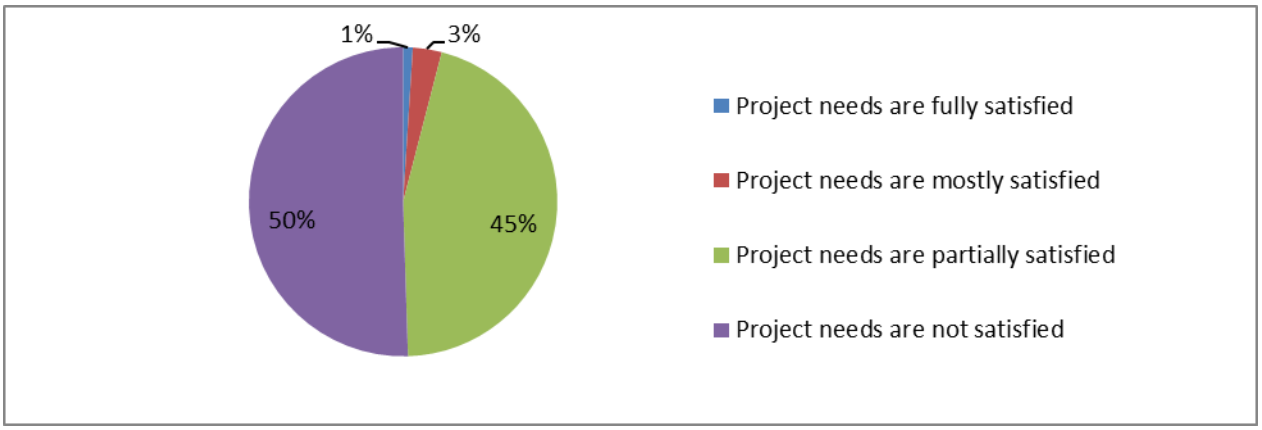
Figure 5: Support Towards Use of Tools or Techniques with Templates, Training, Detailed Instructions, and Procedures



When respondents were asked if competent project personnel were available for the ENREP project, more than 90% responded that project needs are either not satisfied, or they are partially

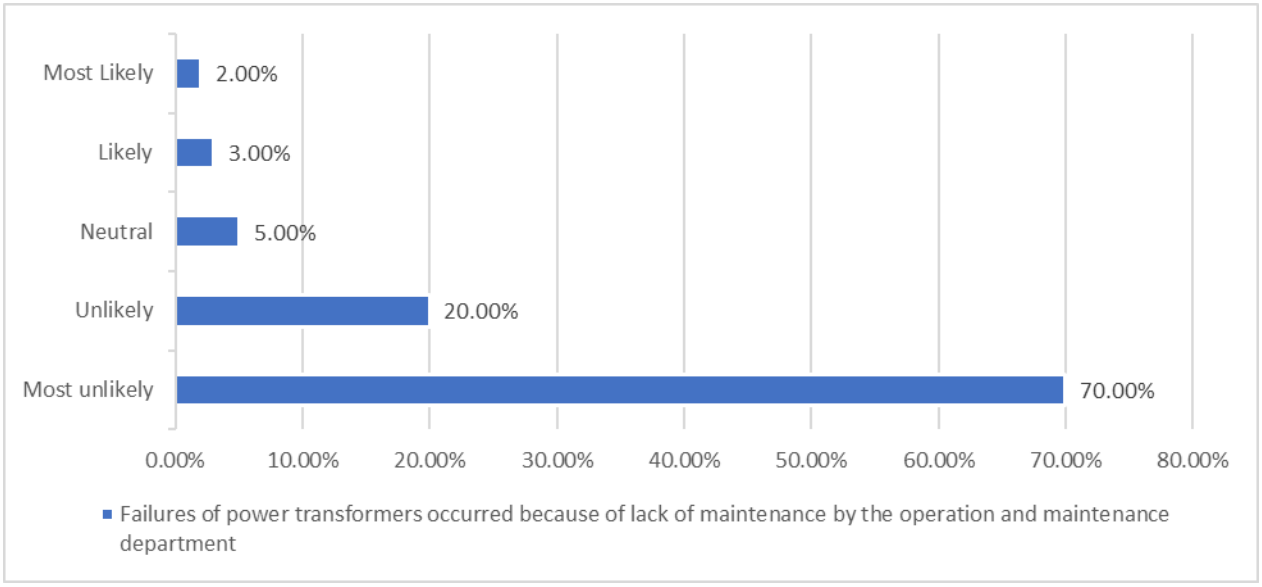
satisfied. Only less than 10% of respondents replied that project needs are mostly or fully satisfied (figure 6)

Figure 6: Project Personnel Need



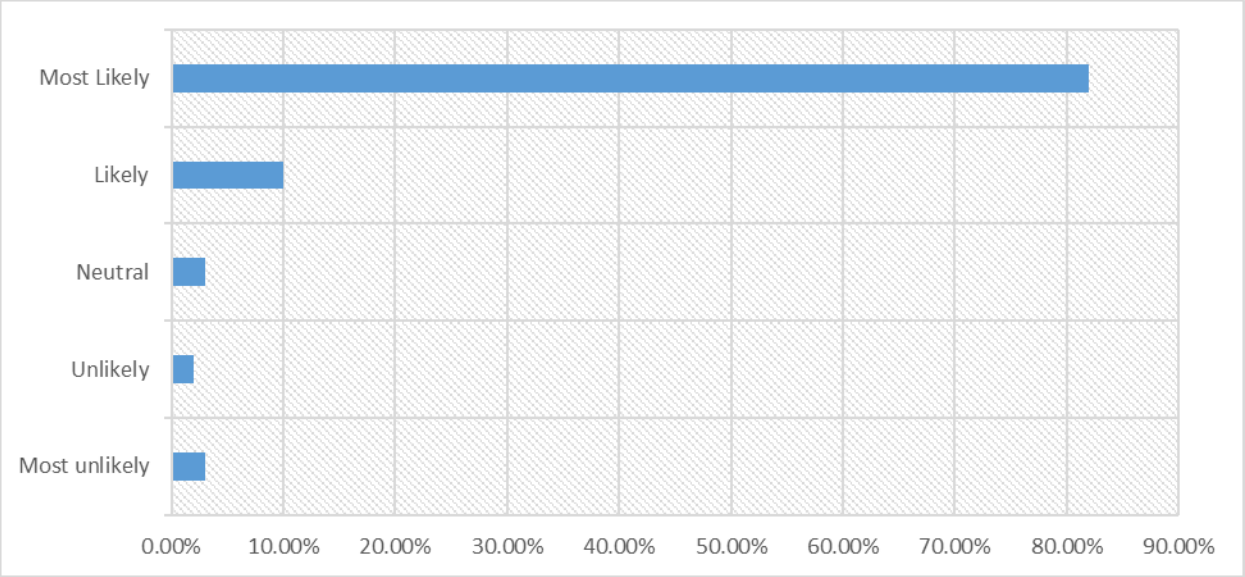
Respondents were asked to reflect on two potential causes of power transformer failures. As indicated in figure 7 below, about 90% of the respondents indicated that failure of power transformers most unlikely or unlikely occurred because of lack of maintenance. (Figure 11)

Figure 7: Causes of Failures for Power Transformer



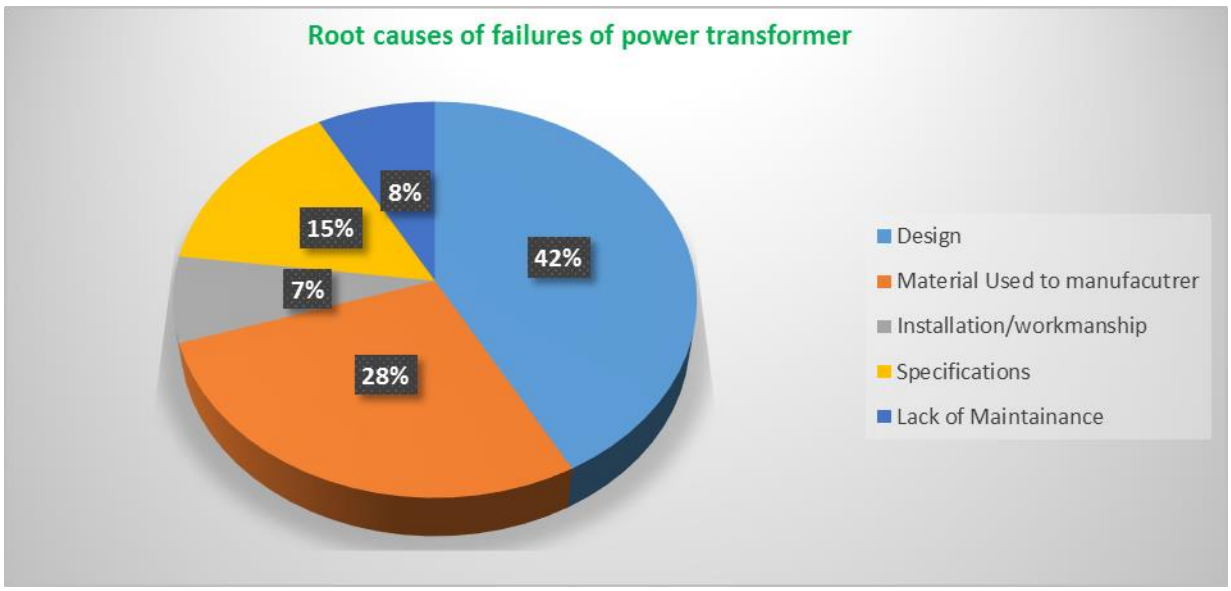
On the other hand, 82% of the respondents indicated that procurement practices of EEP have played a significant role and are the most likely causes of early failures of power transformers purchased under ENREP (Figure 8).

Figure 8: Influence of Failures of Procurement Practices on Failure



When respondents requested to choose among the possible root causes for the premature failures of power transformers in the case project, about 42% replied that it is design of the manufacturer where as 28% responded that it is the material used to manufacture the product. This leads to the conclusion that about 70% is related to the inherent quality problem of the power transformers (figure 9).

Figure 9: Root Causes of Failures of Power Transformers



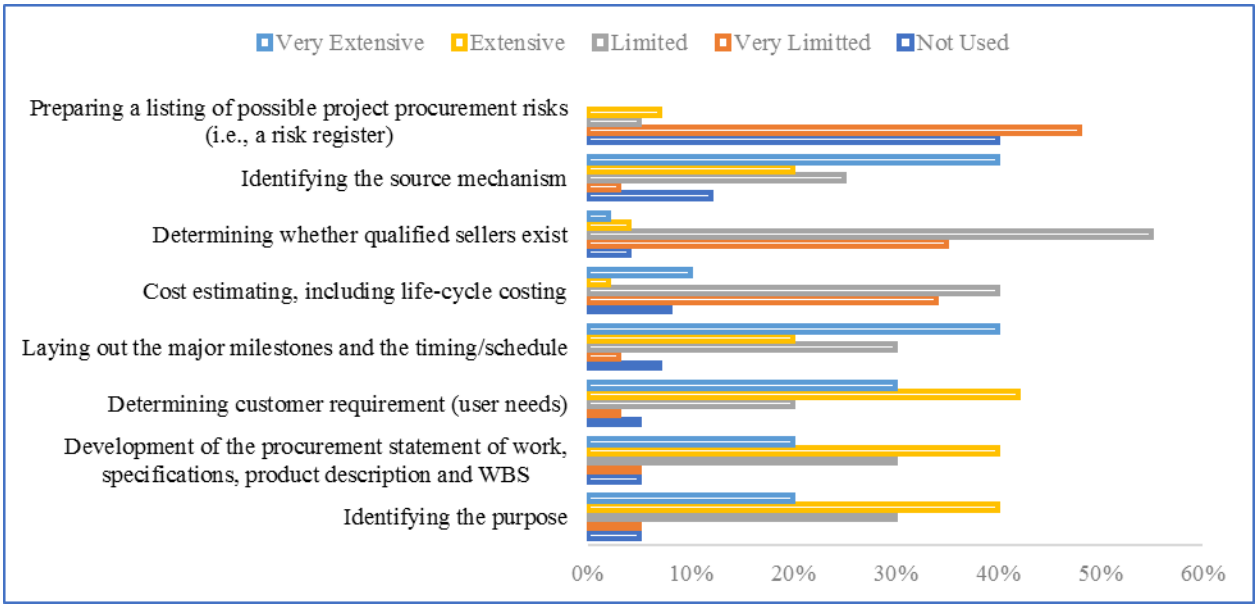
4.4.2 Findings on Project Procurement Planning Practices

Respondents were asked to indicate the level of use of key project procurement techniques while planning. As indicated in figure 14, on average, more than 80% of them indicated that the following planning practices are largely adopted and/or used.

- *Identifying the purpose*
- *Development of the procurement statement of work, specifications, product description and WBS*
- *Laying out the major milestones and the timing/schedule*
- *Identifying the source mechanism.*

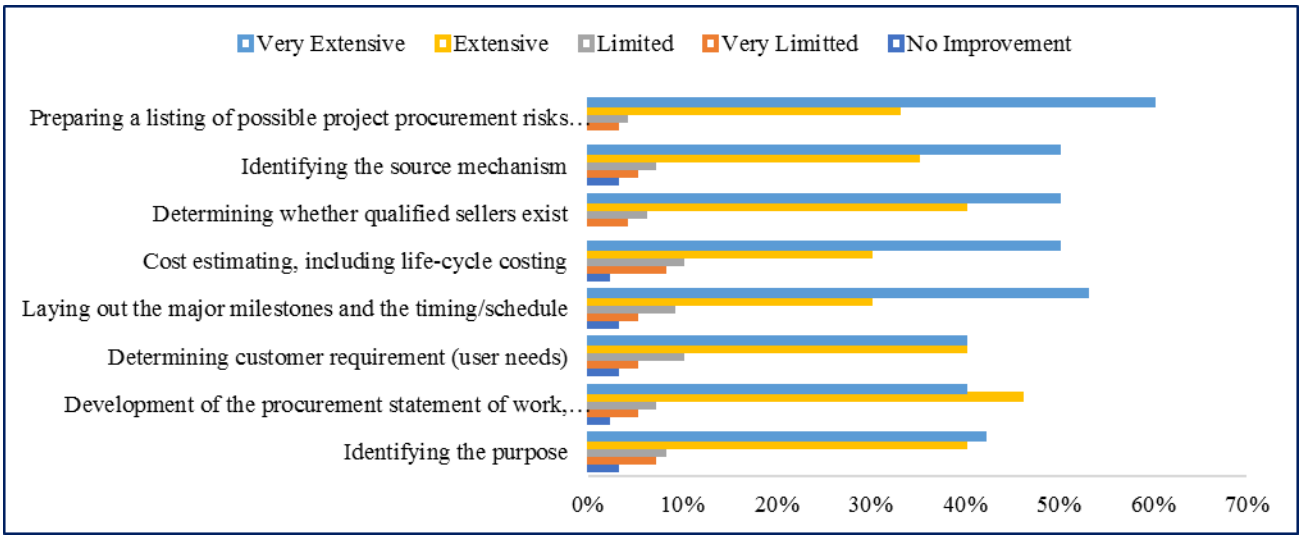
To the contrary, more than 90% of the respondents indicated that each planning practices like LCC-cost estimating (including life-cycle costing), determining whether qualified sellers exist, identifying the source mechanism, and preparing a listing of possible project procurement risks (i.e., a risk register) are rarely utilized or adopted.

Figure 10: Level of Use of Project Procurement Planning Practices at ENREP



On the other hand, when the respondents were asked whether more extensive or better use of these procurement planning practices that were not used fully could have improved failure incidence on power transformer due to latent defects (defects after warranty liability period) on power transformer by ENREP, majority of the respondents on average replied that they anticipate a very extensive and/or extensive improvement i.e. it would have been much less failure (figure 11).

Figure 11: Improvement from use of Project Procurement Planning Practices at ENREP

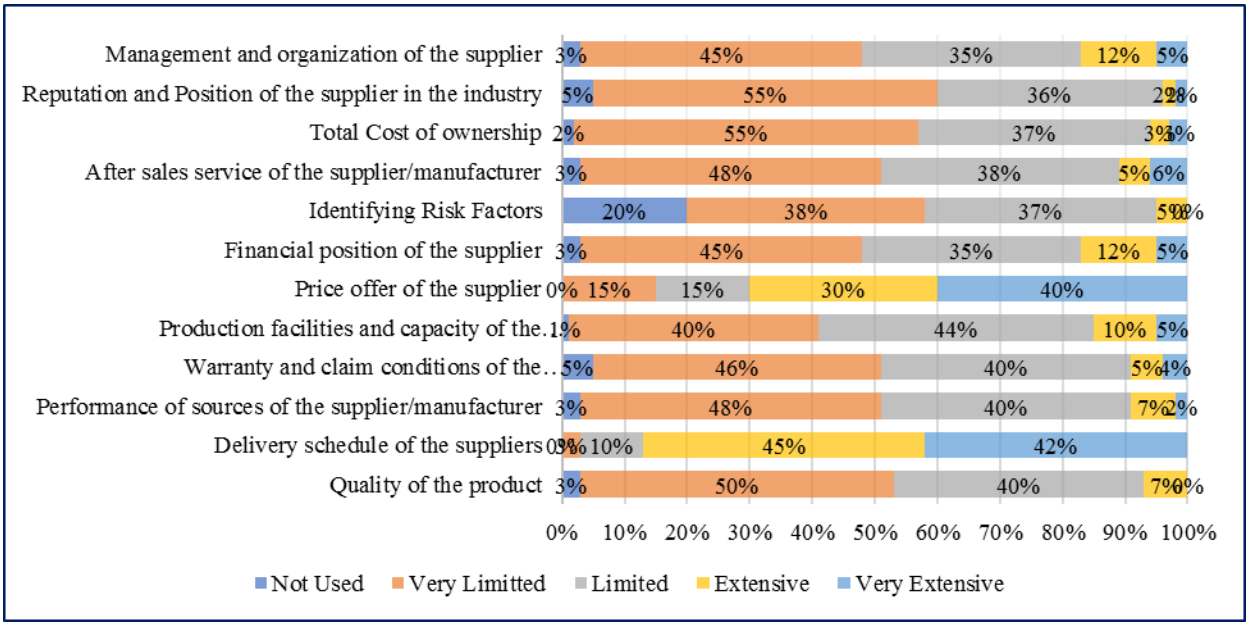


4.4.3 Findings on Supplier Selection Practices for Project Procurement

Respondents were asked to indicate the focus on or the level of use of key supplier selection practices during the procurement process. As indicated in figure 12, more than 85% of the respondents on average answered that supplier selection practices are solely focused on delivery schedule of the suppliers, price offer of the supplier, financial position of the supplier, and management and organization of the supplier. On the other hand, the following supplier selection practices are either not used, or their application is very limited, or their use was limited.

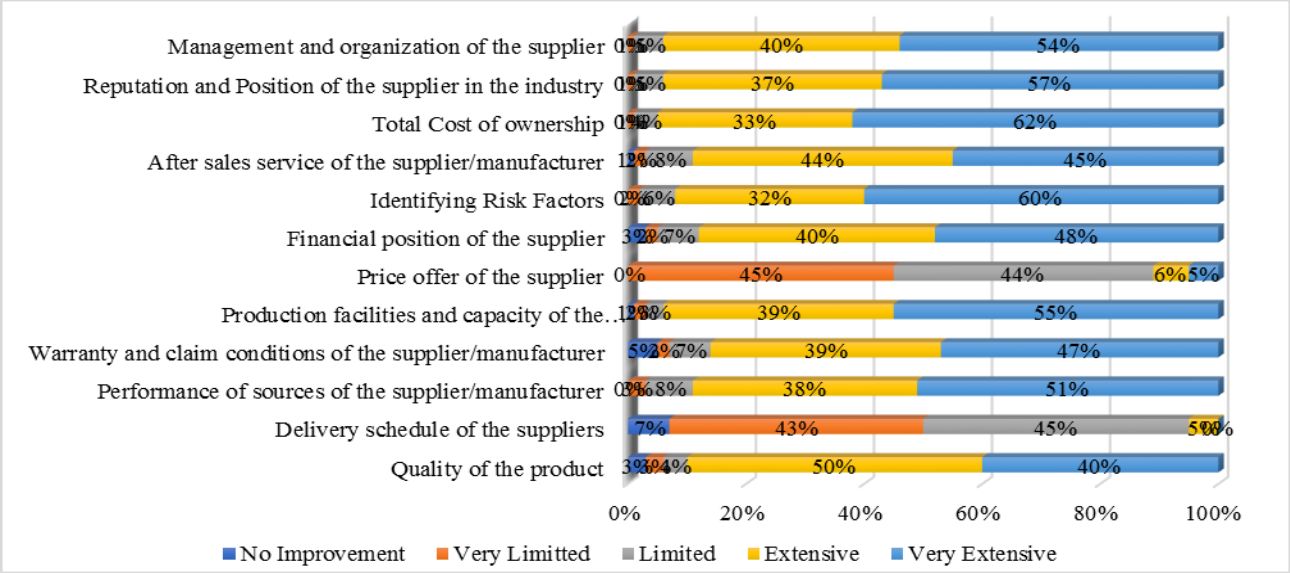
- *Quality of the product,*
- *Performance of sources of the supplier/manufacturer,*
- *Warranty and claim conditions of the supplier/manufacturer,*
- *Production facilities and capacity of the supplier/manufacturer,*
- *Identifying Risk Factors,*
- *After sales service of the supplier/manufacturer,*
- *Total Cost of ownership and,*
- *Reputation and Position of the supplier in the industry.*

Figure 12: Level of use of Supplier Selection Practices at ENREP



To the reverse, when respondents are asked to indicate the level of improvement they anticipate from refocus on key supplier selection practices, more than 95% of the respondents on average expect a very extensive or an extensive improvement or at least some sort of improvement on power transformer failure due to latent defects except for the practices of delivery schedule of the suppliers, and price offer of the supplier (figure 13).

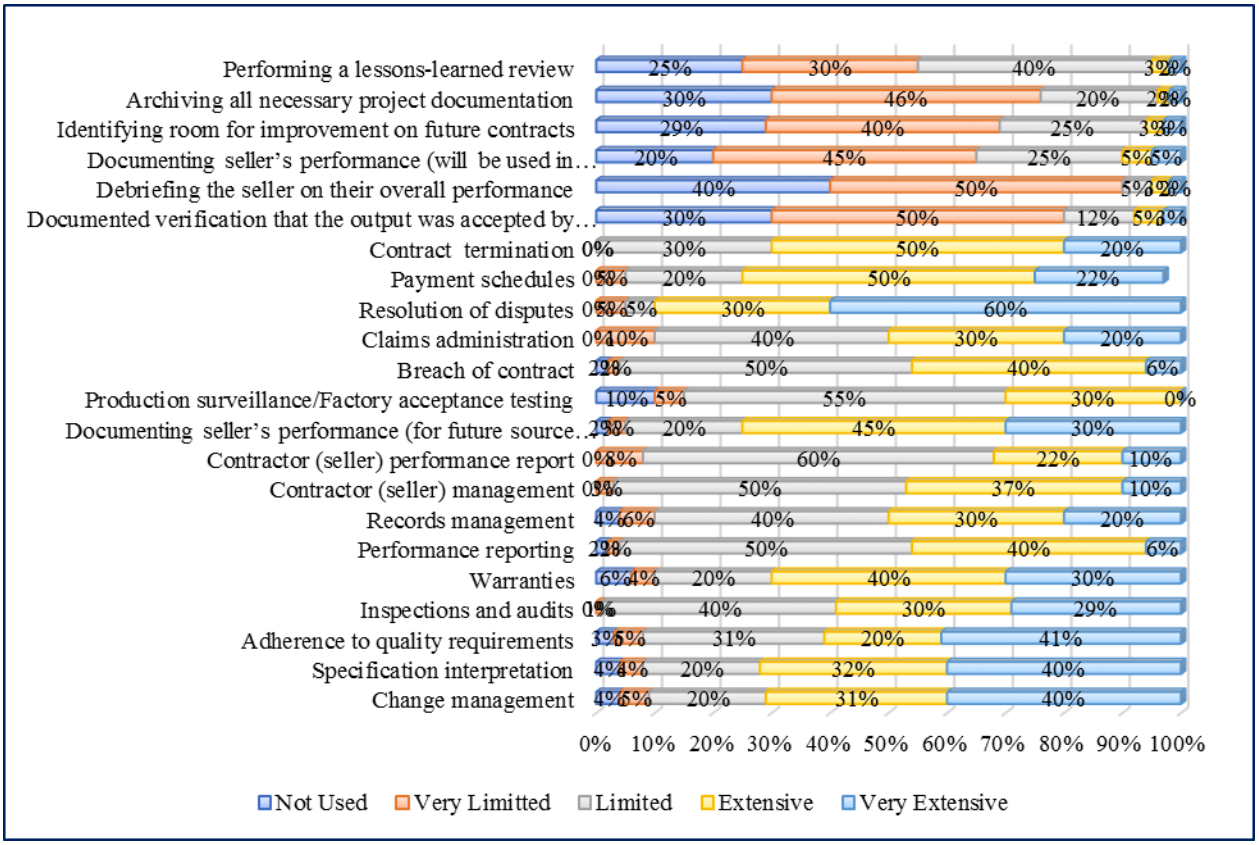
Figure 13: Level of Improvement from Use of Supplier Selection Practices at ENREP



4.4.4 Findings on Procurement Contract Management Practices: Control & Closure

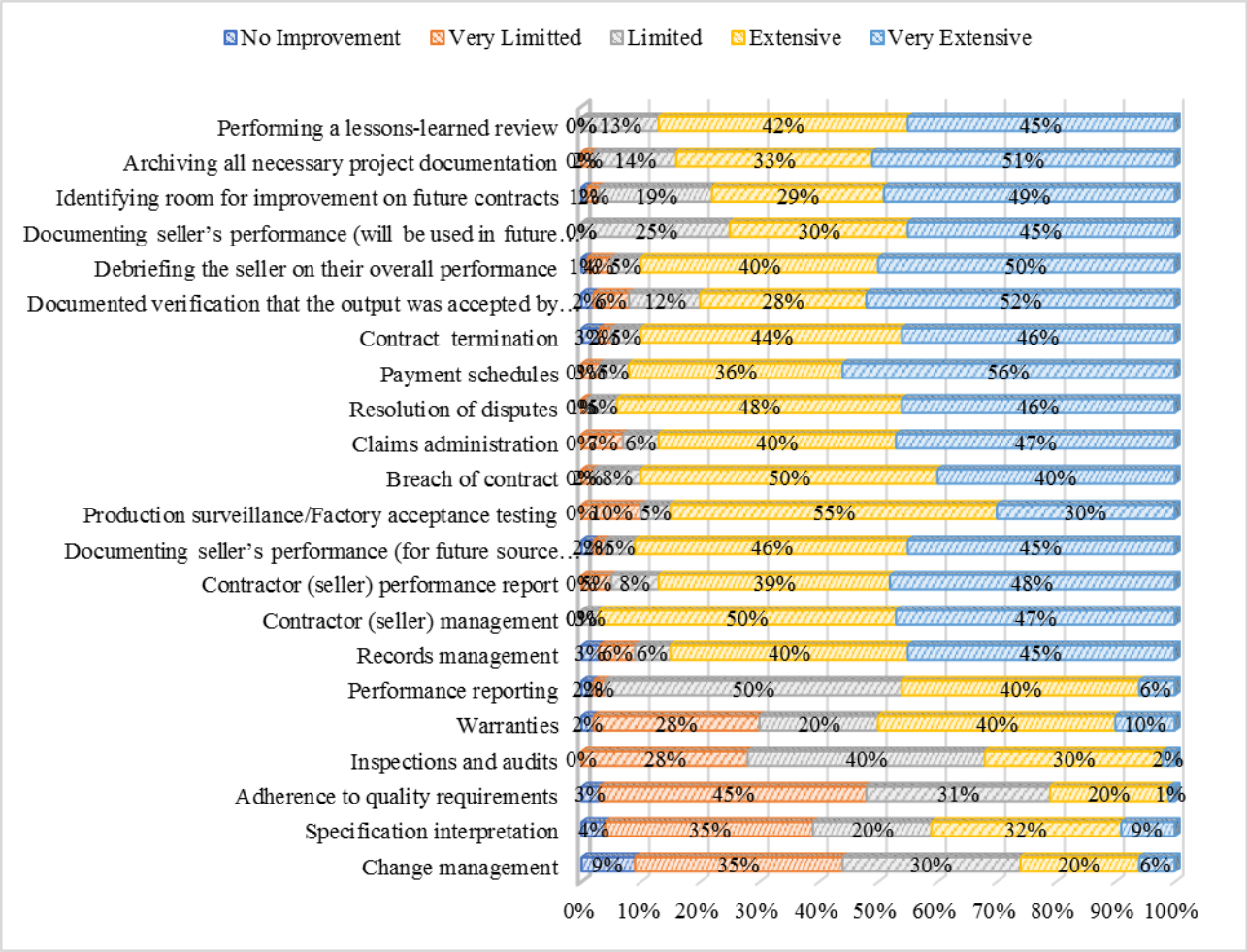
Respondents were asked to indicate the level of use of key procurement contract management practices in terms of procurement control and procurement closure. As indicated in figure 14, more than 70% on average indicate that the procurement control aspects are fairly adopted while the closure aspects of procurement contract management are either not used, or their use is very limited or limited.

Figure 14: Level of use of Procurement Contract Management Practices at ENREP



When asked if adoption of the procurement contract management practices (i.e. procurement control and closure) can make improvement, about 88% on average answered that adoption of these contract management practices can generally bring in very extensive or extensive improvements in terms of decreasing power transformer failure due to latent defects (refer figure 15 below).

Figure 15: Level of Improvement from Use of Procurement Contract Management Practices at ENREP



4.4.5 Other Findings

Respondents were requested to specify any factors in the procurement process of the Ethiopian Electric Power that might have contributed to the failures of Power transformers and other critical substation equipment after the warranty period is passed. Accordingly, out of the 53 respondents, 7 of them gave their opinion as follows;

- **2 of the 7(about 29% respondents) replied that**, major causes of failures of power transformers and other critical substation equipment has to do with quality of specifications, they further asserted that improving the specifications of the bidding document could help in minimizing the occurrence of failures.

- **Of the 7 (about 71% of the respondents)** replied that the likely causes of failures of power transformers after warranty period is due to poor products manufactured by incompetent manufacturers of the power transformers and EEP's focus on price rather than quality has contributed to early failures of power transformers, hence they advised that prequalification of manufacturers could help to minimize the failures

The findings from the respondents to the open ended question revealed that the frequent failures of power transformers and other critical substation equipment is one way or another related to the project procurement practices of the Ethiopian Electric Power and the best way to remedy is improving the procurement practices of the Ethiopian Electric Power, particularly through prequalification process.

4.5 Case narratives and Analyses of desk study

4.5.1 Background on ENREP

Electric Network Reinforcement and Expansion Project (ENREP) is a project planned to reinforce the existing grid of the Ethiopian Electric Power. Due to several substations were overloaded, EEP was unable to provide further power to its customers. Therefore, a project was initiated, finance for the project was secured from external financier.

The project includes several Contracts under one package with total contract value more US$86m. Out of these Contracts in two of the contracts, 4 cases of failures of power transformers were reported once put into operation. Two of the failures were report in substations located in Addis Ababa, whereas the other two were in Alamata and Debremarkos. The total price of the failed transformers is approximately US$13Million. Of the two contracts one is supply only of power transformers where the installation is done by EEP's own force team whereas the other is EPC turnkey of upgrading and expansion of existing substations.

The desk study includes separate investigation reports done by the main contractor & the client. Furthermore, official correspondences were made between the main contractor & Project office, correspondences between the main Contractors and the Consultant, evaluation report, contract documents, annual reports, test and commissioning reports, FAT-factory acceptance reports and drawings related to those 4 cases of failures of power transformer were reviewed.

4.5.2 Desk study of each failures of Power Transformers included under the study

Case-1, at Mekanissa Substation (Addis Ababa), 132/15kV, 31.5MVA Power Transformer failure

The main contractor and the manufacturer are different companies. Once the operation and maintenance department reported the incidence of failure of the power transformer to the project office, the main contractor informed the incidence to its manufacturer. The manufacturer then sent its experts and did its own detailed analysis with regard to causes of the power transformer failure.

The factory expert, based on its technical analysis, concluded that the failure has mainly occurred due to the Ethiopian Electric Power grid is unstable in its very nature which resulted in internal fault of the power transformer. Once the internal fault had happened, it has been put into operation without clearing the already happened internal fault, hence essentially, he concluded that its failure has to do with operation skill of the Ethiopian Electric Power.

Furthermore, mentioning that it will give support, proposed that the cost of remedy shall be taken care of by the Ethiopian Electric Power (EEP).

Case-2, at Geferessa Substation (Addis Ababa), 132/15kV, 50MVA Power Transformer failure

The main Contractor of the power transformer, after doing its detailed technical analysis, it has concluded that the failure could be due to lightning at night. As the other equipment designed to discharge such kind of over voltage such as surge arrestor was old, it didn't protect the fault hence, resulted in the failure of the power transformer.

In its conclusion the supplier notified the employer that the transformer was supplied as per the technical specifications indicated in the contract agreement, hence argued that failure didn't happen due to poor quality of power transformer.

The main contractor further argued that, as the cost of replacement of the power transformer is huge, the Contractor was not ready to accommodate the cost of replacement and further suggested that it was ready to defend its technical explanation in the presence of the Ethiopian Electric Power Engineers.

Case-3, at Debremarkos Substation, 230/66/15kV, 63/40/20MVA, Power Transformer failure

The transformer was installed at existing Debremarkos substation. It was failed after about 4years since put into operation. The contractor was contacted through the project office to remedy the defect as it didn't serve the lifetime it was designed to serve which is estimated to be at least 40years. The Contractor, then sent its experts to investigate the situation and concluded that, due to it had already delivered the equipment as per the specifications indicated in the

contract agreement, and the defect liability period is also already passed, it argued that it has no obligation to replace it. He further referred to the relevant contract clauses which says" *The Defect Liability Period shall be five hundred and forty (540) days from the date of Completion of the Facilities (or any part thereof) or one year from the date of Operational Acceptance of the Facilities (or any part thereof), whichever first occurs".*

In this situation, EEP didn't have other mechanisms to get support from the Contractor and took its own action that it replaced at its own cost by taking as a loan from other active projects.

Case-4, Alamata 132/66/15kV, 40/20/20MVA, Power Transformer failure

The Alamata Power transformer has failed recently, in 2020, about 3 years after defect liability period. Or 4years after energization. Similarly, effort was made through the client to contact the contractor to help in addressing the issues, however, mentioning long time has passed since the power transformer had energized, he even was not interest to get involved in the issue. He just gave verbal explanation that the Ethiopian Electric Power has no contractual and legal ground to request for such kind of support from the Contractor.

As a result of the failure of the power transformer large areas around Lalibela & Sekota and their surroundings are under partial power shading, Due to the temporary solution given from other substation has not enough capacity to provide power to these areas, this is expected to be continued at least for the next one to one and half years until the replacement is made.

Analysis, argument and Remedial action taken by EEP about failed Power transformers

With regard to Case-1 & 2, the Ethiopian Electric power, had set up a team of experts to investigate the causes of the failures of power transformer at Geferssa and Mekanissa, and has concluded as follows

The reports of EEP's team, after giving its own justification, has concluded that failure reports prepared by the Contractors/suppliers are not acceptable. Furthermore, argued that the likely cause of the failure was due to poor quality of the products. Therefore, the Contractors shall take responsibility and do the replacement without additional cost to the Ethiopian Electric Power.

After long dispute between the client and the main contractors, both transformers were replaced without additional cost to the Ethiopian Electric Power, though one of them is again failed after working for a couple of years.

About Case-3 & 4, Regardless of effort from the Ethiopian Electric Power to get support and explanation from the main Contractor, mentioning the contract clauses, the supplier replied that there is no contractual ground to provide support.

From the insurer side, as their expectation was that it would serve as per the industry practice, it has been a while since investigating the issue, however, the issues are still pending.

In the meantime, the Ethiopian Electric Power has given temporary solution to those areas by supplying power transformer from other active projects.

4.5.3 General Case Summary & Observation

All the Power transformers were installed in existing substations, as the objective of the project was to reinforce the existing systems. In all the existing substations there were power transformers of similar nature but produced by different manufacturers. They are operated by the same respective operators, who have solid experience in similar operations and the load conditions is also more or less applied to all the equipment in the substations.

With regard to specifications, the Ethiopian Electric Power has been using the same standard bidding document by updating for new conditions and technology. All the other conditions of the contract were compared with other projects, it is more or less similar. The evaluation was done on ICB (International Competitive basis) without any pre-qualification as that is the standard practice in the Ethiopian Electric Power.

The technical and financial evaluation reports were checked, it seems there was no deviations on the technical evaluation. In the financial evaluation report however, when prices comparison of different suppliers was made, the economic analysis only considered the capital cost, and losses of the power transformers during the next 5years. This seems against the best practices in other utilities which consider other economic parameters such as maintenance and operation costs and risk of failure and other consequential costs.

As observed from the correspondences, the FAT" Factory Acceptance Test" has been done as per the requirement in the bidding document and approved procedures. The client representatives and the Consultant's representative also attended and witnessed the Factory acceptance test. This was also confirmed by signature of the experts.

From the internal reports and correspondences, it was confirmed that experienced civil and electrical engineers were assigned to supervise the installation and civil works respectively.

The site test & commissioning work also was done as per the approved procedure, with experts from operation & maintenance department, the Contractor and the project office's staffs. It is well recorded in the report that all the necessary testing was done at site and all were successfully passed. There was no major remark written in the test and commissioning report.

4.5.4 Possible Gap found from the desk study

In general, the overall process of the case projects, when compared with the practice of the Ethiopian Electric Power, the process seems in line with the standard procedure of the Ethiopian Electric Power project procurement practices. However, the practice of the Ethiopian Electric Power itself seems questionable, due to the following major observations

- There are no special requirements and criteria to qualify the manufacturers of critical and strategic equipment such as power transformers. The main Contractors were allowed to propose any manufacturer as far as it has provided three customers certificates issued in the last 10years. However, the practice in other countries, is that they put in their bidding document special criteria for critical equipment such as power transformers. Any Manufacturer to be considered as sub-supplier need to provide the products from manufacturer who has at least 25years of experience or more, so that the unproven and unreliable products could be excluded. Some of the third world countries who demanded more than 25 years of proven experience for manufacturers of critical substation equipment include Myanmar power utility-YESC, Sirilanka Power Utility-CEB, Bangladesh Utility-PGCB and Mozambique Utility-EDM (respective bidding documents, 2019).

- The other serious gap found was that the cost of ownership was not exhaustive enough, for instance, the costs of maintenance, risk of failures and other consequential costs of failures were supposed to be estimated and included in the evaluation.

- The other possible gap is that the companies who manufactured were new ones. Their product has never been used in the EEP's system before this project. However, there was no effort from EEP side to consider the risk associated with accepting new supplier for such a critical products. Besides, there was no documentary evidence that showed efforts made to verify the experiences certificates submitted by the suppliers to protect potential counterfeit documentation.

CHAPTER 5–SUMMARY, CONCLUSIONS & RECOMMENDATIONS

5.1Conclusion

Based on foregoing desk study and analysis of the survey results, the following conclusions are made;

- The level of use of procurement planning practices such as Cost estimating (including life-cycle costing), Determining whether qualified sellers exist, preparing a listing of possible project procurement risks were found to be low. The study further showed that the increment in the level of uses of these practices might reduce the incidences of failures

- The practices of supplier selection in EEP substation projects particularly power transformer is more focused on price, financial position of the supplier, delivery schedule and management and organization of the supplier. However, the focus on quality of products, performance of manufacturer, warranty and claim conditions of manufacturer, identifying risk factors, consideration of after sales service of the manufacturer, consideration of total cost of ownership, reputation and position of the supplier in the industry seems very low.

- Though the failures of power transformers occurred once the projects were completed and put into service, the study result showed that their causes of failures is traced back to the procurement practices of the Ethiopian Electric Power, rather than to lack of proper operation and maintenance procedure.

- The failure of equipment in substations especially power transformer has been prevalent, however the study showed that the practice of applying lesson learned to next project was in general weak, which resulted in failures of critical equipment.

- The possible root causes of premature failures of power transformers is related to material used to manufacture the power transformers and the design capability of the manufacturer.

- The calculation of total cost of ownership during evaluation was not done fully as the costs only considered the capital cost and the cost of operation (load loss and no load loss) were considered. Outage cost, cost of corrective and planned maintenance, cost of erection, cost of refurbishment or replacement and cost of disposal were not considered at all.

- Compared with other projects of the same project nature in other organization, most respondents replied that the project has average success.

Apart from these, the case study of ENREP project showed that even though the failures of transformers were occurred after several years after put into operation, the causes are likely related to the procurement practices of the Ethiopian Electric Power.

The study reinforced the idea that the root causes of failures of power transformer in the case project is likely related to the inherent quality of the material used to manufacture the power transformers and design capability of the producer and hence it suggested that it is related to unqualified manufacturers of the power transformers.

The desk study of procurement documents of the case also revealed that there was visible gap in terms of considering the total cost of ownership such as operation and maintenance, the costs of risk of failures of the power transformers and its consequences.

Furthermore, the experience from other countries as assessed through literature reviews indicated that power transformers are considered as national security assets, due to the fact that they need special raw material and manufacturing process and the consequences of failures are severe hence, they follow strict procurement process to purchase these items, among others long process of prequalification of capable manufacturers.

Therefore, from the study it can be concluded that by improving the procurement practices, such as using rigorous prequalification process, applying strict evaluation of total cost of ownership including the risk of failures and its consequences, the failures of power transformers in the Ethiopian Electric Power can meaningfully be reduced.

5.2Recommendations

Due to their peculiar nature, the purchase of critical equipment such as power transformer shall be considered as sensitive as other equipment and technologies used for national security purpose. Therefore, in order to procure these and other strategic assets, robust system shall be put in place. One of them is rigorous prequalification process and keeping data base of the critical prequalified manufacturers and update it regularly for new and innovative products.

Based on the result of the study, implementation of the following strategic recommendations are forwarded for action to be used to procure power transformers and other critical substation equipment, by EEP management, the procurement office, and the transmission and substation engineering office and the operation and maintenance department of the Ethiopian Electric Power;-

A. Recommendations on Procurement planning

Project procurement success is dependent up on whether initial planning is conducted the right way the first time. Accordingly, appropriate procurement planning is required to address issues such as

- To clearly integrate purchases with strategic objectives of the project
- improve Source selection method

- To clearly analyze all the sources in the market
- Cost estimating including LCC (life-cycle costing),
- Determining whether qualified sellers exist,
- Preparing a listing of possible project procurement risks

B. Recommendations on Supplier Selection Aspects

Regarding supplier selection, particular focus shall be given to the following points when selecting supplier, in order to avoid premature failures of power transformers due to latent defects

- Apply appropriate Cost estimating during supplier selection process, i.e costs related to the total cost of ownership over the lifetime of the power transformers: which is the sum of capital costs used to procure the power transformers, Maintenance & Operational costs and Costs of failure of risk (consequential costs as a result of premature failure of the power transformer.
- Focus on selection of reliable manufacturers who have good track record of providing after sales services for critical items, identify manufacturers who assure better warranty and claim conditions, manage risk factors, and position of the supplier in the market
- Preparation of database of capable manufacturers after carrying out due diligence of the factories, their products and processes before the actual procurement is started and force Contractors to consider only those pre-qualified transformer manufacturers, as his is also in line with the procurement regulation of the country and procedure of the Ethiopian Electric Power.

C. Recommendations on Contract Management Aspects

- Set procedure for post project impact evaluation several years after the defect liability, to evaluate whether the project is serving the intended purpose.
- Debriefing the seller on their overall performance
- Documenting seller's performance (will be used in future source selections)
- Performing a lessons-learned review
- Production surveillance/Factory acceptance testing

5.3Recommendation for Future Study

Power quality in Ethiopia is not in a good shape. One of the causes for this is failures of power transformers because of latent defects as indicated in the study. Though the problem happened

after the project is completed and transferred to operation department, the result of this research showed that the problem is traced back to procurement process of the project. However, substation is just part of a fairly complex power system and power transformer is just one component in a substation, though critical one, hence improvement in quality of power transformer will play its own unique role, however, the improvement in other parts of the substation equipment and the whole power system including the generation, transmission and distribution systems have their own significant contribution, therefore in order to improve the quality of power, further study is required with regard to the consideration of reliability during procurement and construction of the projects. Hence, researchers are recommended to do further research in this aspect.

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APPENDEX

SURVEY QUESTIONNAIRE

A STUDY ON CAUSES OF FAILURES OF LARGE POWER TRANSFORMERS IN THE ETHIOPIAN ELECTRIC POWER

Dear Respondent,

My name is Destalem Hailu. This questionnaire forms part of a MBA research project which aims to investigate influence of project procurement practices on the failures of large power transformers after defect liability period in the Ethiopian Electric Power.

I would like to invite you to participate in the above project. Completion of the questionnaire is completely voluntary and returning the completed questionnaire will be considered as your consent to participate in the survey. The questionnaire will take you about 20minutes to complete.

All data held are purely for research purposes and will be treated as strictly confidential.

In the event of questions or queries, please do not hesitate to contact me. Thank you for your time and valid contribution in advance.

Yours faithfully

SECTION I – DEMOGRAPHIC QUESTIONS

Direction - Please tick or provide necessary information as appropriate

1) Are you Male or Female? Put[x]

1) Female [ ]
2) Male [ ]

2) What is your age group? Put [x] to indicate your designation

1) up to 25
2) 25-29
3) 30-39
4) 40-49
5) 50 years and over

3) Please Put [x] to indicate your educational level

1) Diploma vocational/ Technician ☐
2) Undergraduate Degree (BA/BSC) ☐
3) Master's certificate or equivalent (MA/MBA/MSC) ☐
4) Graduate degree (PHD)☐
5) Other (please specify) _____

SECTION II – PROJECT PROCUREMENT EXPERIENCE

Direction – Answer the following questions (4 to 16) by circling the answer of your choice.

4) Please indicate the level of project management experience you have by recording the total number of years you have been engaged at each level.

Current Position/Level	**Year of Experience**					
	1 to 3 years	**4 to 6 years**	**7 to 9 years**	**10 to 12 years**	**13 to 15 years**	**more than 16 years**
Other roles						
Team Member						
Project/Procurement Manager/Engineer						
Programme Manager / Director						
Other roles in Project Management						

5) Which category best describes the activities/environment in which you work?

1) Procurement
2) Engineering
3) management/project team member
4) Project site supervision and construction
5) Operation & Maintenance
6) Specify if other_____

6) **Compared to other projects of the same type, how would you qualify the rate of project success in your organization, particularly success after project is done and defect liability period is passed?**

1) Much more successful
2) More successful
3) Average success rate
4) Less successful
5) Much less successful

7) **Does your organization support your use of tools or techniques with: templates, training, detailed instructions and procedures?**

1) No support
2) Very limited support
3) Limited support
4) Extensive support
5) Very extensive support

8) **Is competent project personnel available for the projects you usually work on?**

1) Project needs are fully satisfied
2) Project needs are mostly satisfied
3) Project needs are partially satisfied
4) Project needs are not satisfied

9) **Do you think the failures of power transformers occurred as a result of lack of maintenance by the operation and maintenance department**

1. Most unlikely 2.Unlikely 3. Neutral 4.Likely 5. Most Likely

10) **Do you think the procurement practices of EEP has played in the early failures of power transformers purchased under ENREP**

1. Most unlikely 2. Unlikely 3. Neutral 4. Likely 5. Most likely

11) **What is the most likely causes of the failures of power transformers in ENREP?**

1. Design 2. Material used 3. Workmanship/installation 4. Specifications 5.Lack of maintenance

SECTION III - FOR EACH TOOL PRESENTED BELOW (QUESTIONS 17 to 22), ANSWER THE FOLLOWING QUESTIONS

A – Use: Extent of use of this tool or technique.

B – Improvement: In your opinion, more extensive or better use of this tool or technique would improve failure on power transformer due to latent defects (defects after defects liability period) on power transformers

12) A. Extent of Use (1: Not used 2: Very limited 3: Limited 4: Extensive 5: Very extensive)

Procurement Planning practices	**1**	**2**	**3**	**4**	**5**
Identifying the purpose					
Development of the procurement statement of work, specifications, product description and WBS (work breakdown structure)					
Determining customer requirement(user needs)					
Laying out the major milestones and the timing/schedule					
Cost estimating, including life-cycle costing					
Determining whether qualified sellers exist					
Identifying the source mechanism					
Preparing a listing of possible project procurement risks (i.e., a risk register)					

13) B – Improvement from more or better use (1: No improvement 2: Very limited 3: Limited 4: Extensive 5: Very extensive)

Procurement Planning practices	**1**	**2**	**3**	**4**	**5**
Identifying the purpose					
Development of the procurement statement of work, specifications, product description and WBS					
Determining customer requirement(user needs)					
Laying out the major milestones and the timing/schedule					
Cost estimating, including life-cycle costing					
Determining whether qualified sellers exist					
Identifying the source selection mechanism					
Preparing a listing of possible project procurement risks (i.e., a risk register)					

14) A. Extent of Use (1: Not used 2: Very limited 3: Limited 4: Extensive 5: Very extensive)

Supplier Selection practices focus on	**1**	**2**	**3**	**4**	**5**
Quality of the product					
delivery schedule of the suppliers					
performance of sources of the supplier/manufacturer					
Warranty and claim conditions of the supplier/manufacturer					
Production facilities and capacity of the supplier/manufacturer					
Price offer of the supplier					
Financial position of the supplier					
identifying Risk Factors					
after sales service of the supplier/manufacturer					
total Cost of ownership					

reputation and Position of the supplier in the industry					
Management and organization of the supplier					

15) B – Improvement from more or better use (1: No improvement 2: Very limited 3: Limited 4: Extensive 5: Very extensive)

Supplier Selection practices focus on	**1**	**2**	**3**	**4**	**5**
Focus on quality of the product					
Focus on delivery schedule of the suppliers					
Focus reviewing past performance of sources of the supplier/manufacturer					
Focus Warranty and claim policies of the supplier/manufacturer					
Focus price offer of the supplier					
Focus on financial position of the supplier					
Focus risk Factors					
Focus after sales service of the supplier/manufacturer					
Focus total Cost of ownership					
Focus on reputation and Position in the industry					
Focus on management and organization					

16) A. Extent of Use (1: Not used 2: Very limited 3: Limited 4: Extensive 5: Very extensive)

Practices of Contract Management	**1**	**2**	**3**	**4**	**5**
Procurement Control					
Change management					
Specification interpretation					
Adherence to quality requirements					
Inspections and audits					
Warranties					
Performance reporting					
Records management					
Contractor (seller) management					
Contractor (seller) performance report					
Documenting seller's performance (for future source selection teams)					
Production surveillance/Factory acceptance testing					
Breach of contract					
Claims administration					
Resolution of disputes					
Payment schedules					
Contract termination					
Procurement closure					
Documented verification that the output was accepted by the buyer					
Debriefing the seller on their overall performance					
Documenting seller's performance (documentation will be used in future source selections when evaluating contractor's past					

performance)					
Identifying room for improvement on future contracts					
Archiving all necessary project documentation					
Performing a lessons-learned review					

17) B – Improvement from more or better use (1: No improvement 2: Very limited 3: Limited 4: Extensive 5: Very extensive)

Practices of Contract Management	**1**	**2**	**3**	**4**	**5**
Procurement Control					
Change management					
Specification interpretation					
Adherence to quality requirements					
Inspections and audits					
Warranties					
Performance reporting					
Records management					
Contractor (seller) management					
Contractor (seller) performance report card					
Documenting seller's performance (for future source selection teams)					
Production surveillance					
Approval of waivers					
Breach of contract					
Claims administration					
Resolution of disputes					
Payment schedules					
Project termination					
Procurement closure					
Documented verification that the output was accepted by the buyer					
Debriefing the seller on their overall performance					
Documenting seller's performance (documentation will be used in future source selections when evaluating contractor's past performance)					
Identifying room for improvement on future contracts					
Archiving all necessary project documentation					
Performing a lessons-learned review					

PART VI: OPINION

18) Please specify any factors in the procurement process of the Ethiopian Electric Power that might have contributed to the failures of Power transformers and other critical substation equipment failure (just after the end of the defect liability period) .

_____
_____
_____
_____.