Addis Ababa University
College of Natural Sciences
School of Information Sciences

Software Requirement Engineering Process Improvement for Outsourced Projects in the case Ethio Telecom: Towards Identifying Improvement Areas

By

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June, 2018

Addis Ababa, Ethiopia

ADDIS ABABA UNIVERSITY
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SCHOOL OF INFORMATION SCIENCE

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A Thesis Submitted to the School of Information Science of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Science in Information Science

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DECLARATION

I Eden Getachew, declare that the work presented in this thesis paper entitled “Software Requirement Engineering Process Improvement for Outsourced Projects in the case Ethio Telecom: Towards Identifying Improvement Areas” is the original work of mine. It is done and presented under the guidance of my advisor Dr. Workshet Lamenew. This thesis has not been presented for any scholastic achievement in the University and all other materials used in this study are fully acknowledged.

Signature _____

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This thesis has been submitted for examination with my approval as university advisor.

Signature _____

Date _____

Dr. Workshet Lamenew

DEDICATION

This work is dedicated to my mother Aselefech Mamo who have been encouraging me to learn and reach higher position in educational life so that I will participate in valuable decision making process for the good of my country Ethiopia. And above all, to the Father God who show me the direction.

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Above all I would like to thank father God for this plan to bless me in every aspect of my life and give me wisdom to work this thesis. God as you did previously, you were with me to support in this MSC academic journey. As you are my resource, I will boost on you forever.

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I am so thankful for my supportive and caring husband Dawit Tegene. Dave I know you always try your best to make my dream true and prepare all the necessaries condition. I always thank God for you.

Lastly, I am grateful for Ethio Telecom staffs, project managers and higher management, who show me their interest to use this research improvement recommendation so that they can improve requirement engineering process as they already believe requirement specification problem affect their software projects. In addition, they gave me their priceless time for responding interview questions and validating improvement recommendation suggestions. I have no works to explain the passion you have sown to discusses with me and to show other related evidence. To be specific I so grateful for Jonathan Samuel who was Ethio Telecom expert working in design team and support me whenever I require further explanation.

ABSTRACT

Lack of an adequate requirements specification, which is the product of a requirements engineering (RE) process, is the main reasons for the failure of software development. As a result, these days, organizations have begun to show interest towards improving their requirements engineering processes. In recognizing this fact, a lot of attempts have been done. This is also true for outsourced software development projects. There are at least two categories of RE practices that can provide to outsourced projects. The first category come from the basic RE practices which is studied by different researchers. Other set of RE practices is to overcome challenges faced by outsourced projects and few researchers studied on this area. However, little is known about the holistic conceptualization of issues for RE process in outsourced projects. Evaluation of the current state is the first step towards systematic process improvement. The aim of this study is to examine the current state of Ethio Telecom requirement engineering process for outsourced projects and identify improvement areas so that it can be improved.

This study employed combination of quantitative and qualitative single case study approach. In order to keep content validity both structured interview checklist and semi-structured interview outline contents were reviewed by selected interviewees and respondents before data collection began and the feedback is used to update the contents. In addition, for structured interview pilot test is conducted with selected respondents and checklist questionnaires are updated based on the feedback before structured interview began.

The quantitative study involved 70 respondents out of 105 potential respondents form different role such as FRS team, design team and project managers. Qualitative study involved 14 interviewees out of 20 potential interviewees form different role including TEP program manager and quality and process officer. In addition, as the third data source written and electronic documentations including Functional Requirement specification (FRS) documents is used. Content analysis method is employed to analyze qualitative data and descriptive statistics methods is used for quantitative data. Findings from this data source are triangulated to identify improvement areas.

After examining the current state of Ethio Telecom requirement software engineering process, seventeen improvement areas are identified, it is an area which require improvement effort in order to improve Ethio Telecom requirement engineering process for outsourced projects. In addition, Percentage of practice guideline applicability in Ethio Telecom context vary from 94.29% -100%. In key process area based requirement validation and management areas are identified to be the weakest RE areas as this RE areas practice usage value is 16.55% and 28.26% respectably and their practice guidelines usage lies between 0.5 to 0.83 which is very small as compare to others. The main reason for this is that, higher management are not aware of the importance of those practice. In order to improve the requirement engineering process, the researcher give practice improvement recommendation based on exhaustive literature review and REAIMS model practice implementation suggestions. After these improvement recommendations are validated by Ethio Telecom expert, the final improvement recommendation is given.

Keywords: Requirement engineering, Process improvement, Software development outsourcing, Key process area, Good practice, Improvement areas.

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LIST OF ACRONYMS AND ABBREVIATIONS

Table 1 : List of Acronyms and Abbreviations

Abbreviations/Acronyms	**Definitions**
BSS	Business support system
CBS	Convergence billing system
CRM	Customer relation management
ET	Ethio Telecom
FRS	Functional requirement specification
IPCC	IP contact center
KPA	Key process areas
RE	Requirement engineering
SDO	Software Development Outsourcing
SEI	Software Engineering Institute
SRS	system requirement speciation
TEP	Telecom expansion project
REAIMS	Requirements Engineering Adaptation and Improvement for Safety and dependability

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

These days a lot of organizations are becoming convinced that systematic software process definition is essential for developing successful systems (Rozum, 1993). Thus, many organizations interested in improving their software development process. According to this researcher producing quality software is important element to raise organization software's reliability, stability and usability. This means high quality software need improvement of software development process as improved production process lead to quality product. Requirements Engineering (RE) is one of the processes that needs significant attention.

Generally requirement engineering (RE) is defined as "a systematic approach to eliciting, organizing, and documenting the requirements of the system, and a process that establishes and maintains agreement between the customer and the project team on the changing requirements of the system" (Wahono, 2003, p. 57). Requirements are the basis for every project, it define the stakeholders and also it sate what the developed system have to do to satisfy that need. Thought there were little attention given in making sure that all relevant stakeholders are consulted, adequate and effective consultation of relevant stakeholders is vital in the RE (Sharp, Finkelstein, & Galal, 1999). According to Wahono (2003) and Sharp et al. (1999) stakeholder is famous term in RE and it can be any person or a system which has impact or affected over the prospective system. Stakeholders may be external individual who take contract to develop the system. Software Development Outsourcing (SDO) is a type of information technology outsourcing in which few or all activities of the software development are contracted out by a client to the vendors (Khana, Niaziabc, & Ahmadd, 2011).

Ethio Telecom (ET) in Telecom expansion program (TEP) majorly expanded and improved mobile and fixed networks. In addition, a lot of application software developed under this project. TEP have four programs which holds related projects like Business support system (BSS), Operation support system(OSS), Mobile value added service(MVAS) and Security. Under each program

there are a lot of software projects. TEP_1 information system domain project is officially closed on august 05 2017 and in 2018 TEP_2 Request for proposal (RFP) have been prepared.

In the case of Ethio Telecom software requirements engineering process, TEP projects initiated by preparing technology road map. Road map is higher level requirement of technology solution which contain major system features to achieve organization five year strategy. RFP mainly contents major modules and features to purchase of the solution. Commodity team is responsible for RFP preparation, which consist experts from Sourcing and facility division, Information System division and the system end user business division. The RFP will be floated for bidders.

Solution provider's technical proposal will be evaluated against each requirement by the commodity team and statement of compliant (SOC) document is prepared which contain Ethio Telecom requirement on RFP and vendor feedback as a remark. Once the vendor is awarded, project coordinator will send vender FRS and the function list planed for discussion one day before workshop or meeting for Ethio Telecom project team. All team members are expected to read FRS and list unambiguous and additional feature that have to be added. In the workshop or meeting vender present the system feature and function then Ethio Telecom project team will negotiate and discuss on each requirements. Discussed function or feature is logged in excel file with different status for example pending, rejected, closed and escalated. The escalated issue will be send to higher project manager and officer for a decision. In this way final agreed requirement specification document for functional part will be produce. Finally, the solution will be customized and developed according to the design documents signed by both parties.

When there is a change or new requirement requested by system end user after the application software implemented, the requirement will be filled by system end user in Information Systems(IS) division's request form called "*IS BUSINESS REQUIREMENT REQUEST FORM"* which is available to all staffs and business units through Company's intranet portal and will be submitted to IS division's Business Requirement Management and Analysis section to check the feasibility of the functional requirement.

The Business Requirement Management and Analysis section in coordination with other two Technical sections, Information Architecture management and The Requirement Engineering section will prepare technical requirement so that vender will implement accordingly.

Commonly Ethio Telecom follow waterfall or traditional development method, but sometimes when the project cannot complete based on the time frame, the development method is changed somehow it looks incremental. When functional requirement and system design completed in sequential manner coding, testing and implementation or launch is done on phased approach in which the most critical modules are implemented first and the other module will continue. Ethio telecom do not follow well known standard of software development method since the development process is not fully waterfall or incremental.

A lot of software projects have failed because of poor requirements (EI Emam & Madhavji, 1995).If the requirements poorly defined, software project cannot meet delivery times, costs and product quality (Kotonya & Sommerville, 1998). RE related problems are the main reason for the failure of SDO projects (Lopes, Prikladnicki, Aud, & Majdenbau, 2005). To develop software which fulfill stakeholder requirement great attention must be given to the RE process (Niazi , 2000). Lack of a complete or adequate requirement is one of the major reason for project failure. Since requirements specification is a direct output of the requirements engineering process ,it stands to reason that an inadequate specification is a result of a requirements engineering process with a low maturity level (Gorschek, Svahnberg, & Tejle, 2003). The area of RE is often underestimated in the area of software engineering, though the fact that requirements problems are the largest cause for the failure of the project (Gorschek & Wohlin, 2003; Gorschek & Tejl, 2002).

However, from Information Architecture (2017) report Ethio Telecom face a lot of problems regarding RE process. there are incomplete requirements, requirements may not have validated by system end users, functional and nonfunctional requirement may be mix-up, ambiguous description of scope and inconsistence on using defined template. Process which is not well defined cause to produce product having quality problem (Rozum, 1993). Thus it is clear those mentioned problem have an impact on the quality of the system requirement speciation (SRS) product.

There is no standard RE process that suites to all organization as processes varies based on type of projects, organization context, expert experience involved on the RE process (Belsis, Koutoumanos, & Sgouropoulou, 2014). Thus it is necessary to evaluate current Ethio Telecom RE process effort to identify an improvement area and to give improvement recommendations.

This research was conducted in order to know the current Ethio Telecom software RE practices and to identify an improvement area so that it can be improved. For the identified improvement areas, the researcher suggested to introduce or standardize best practices. The suggested improvement ideas were validated by expertise in considering Ethio Telecom context thus the researcher made an appropriate amendment. Finally, improvement recommendation is prepared.

1.2 Statement of the problem

A lot of software development projects are outsourced in order to reduce the cost and accessibility to high-quality capabilities, but a lot of risks happen in this process (Khan, Niazi, & Ahmad, 2009). As the Industry surveys reveled even if SDO trend becoming popular, only half of SDO projects are successful (Gefe, Wyss, & Lichtenstein, 2008). Problem related to RE are the main reasons for the failure of SDO projects because most of the issue or factors contributing to such failures are related to the requirements (Lopes et al.,2005).

From software development life cycle RE is vital for every successful software development since many software fail because of inconsistent, incomplete or simply incorrect requirements specifications (Wahono, 2003). As Nguyen et al. (n.d) argued RE process is taken as the most critical software process since it is the most determinant factor for software development effectiveness and software quality. Leffingwell & Widrig (2000) noted lack of system end user input, non-complete requirement specification and changing requirement are the most commonly cited factors that caused projects to be fail.

For outsourced projects where stakeholders are dispersed at different locations, the requirement problems are expected to increase many times. “Lack of communication or improper communication, different working hours, rare head to head meetings, language issues and dissimilar working practices are some of reasons for requirements problems” because of this most of outsourced software project face a lot of challenges (Iqbal, Ahmad & Noor, 2013, p. 1).

Thus a well-defined RE process is vital for the success of the outsourced software development projects in terms of cost, time and quality (Edwards & Sridhar, 2005). As Kabaale, Kituyi & Mbarika (2014) mentioned RE process improvement helps to discover errors early in system

development, to early discovery of differences among stakeholders and it improve quality and productivity.

These days many software development organizations initiated software process improvement (SPI) efforts to improve the quality of products by improving the processes that produce products (Rozum, 1993). Kauppinen & Kujala (2001) evaluated RE process maturity on three organizations and recommend improvement practices. Niazi (2002) develop RE process improvement framework in five key process area (KPA)s named "Requirements Elicitation, Analysis and Validation Method (REAVM)". This model has a prescriptive nature because "a good method should be prescriptive enough to be able to recommend what development activity to do next" (Nuseibeh, 1994, p. 26).

The most vital activity in systematic processed improvement is to assess the state of current practice (Kauppinen & Kujala, 2001). Based on study Kabaale et al. (2014) lack of user involvement, lack of management support, ambiguous requirements, changing requirements and stakeholder's expectation are some of the issue or challenges for RE process improvement. However, these studies were inadequate in providing deep understanding about the organization context and issues which affect RE process improvement. For the organization which outsource software project, the phenomena become more complex involving multiple issue like communication, working hour difference in addition to RE issue for in-house development (Iqbal et al., 2013).

Furthermore, there are few studies which look at software outsourced RE process issues. Iqbal et al. (2013) and Iqbal (2016) divided software outsourced RE process issues into four categories which are cultural diversity, inadequate communication, knowledge management and time difference. Iqbal et al. (2013) develop framework in order to handle four issues, framework is developed by identifying Sommerville and Sawyer (1997) RE practices which are significant for outsourced project. Again Ahmad, Nasir, Iqbal & Zahid (2015) identified twenty-eight high perceived-value or critical RE practices from Sommerville and Sawyer (1997) RE practice framework so that it can be recommended to solve outsourced software projects. Iqbal (2016) identified top ten frequently occurring RE issue for SDO then find best practices to address those issues from literature. Finally, "Requirement Engineering Practice (REP)" Model is developed.

However, little is known about the holistic conceptualization of issues for RE process in outsourced project. Researchers who work to improve RE in outsourced project focus mainly on the communication, cultural and knowledge management issue (Iqbal et al., 2013; Iqbal, 2016). In the other direction researcher who works to improve RE for in-house development only focus on RE process of elicitation, analysis, specification, validation and managements (Kauppinen & Kujala, 2001; Niazi, 2002). Ahmad et al., (2015) on their study said that "this study enables us to recognize that there can be at least two categories of RE practices that can cater to outsourced projects. One set can come from the basic RE practices which have essentially been identified in Sommerville's framework. Another set of RE practices should try to focus on the specific challenges faced by outsourced projects." (p. 14). And these researchers stated on their future work that they will work to develop framework for RE process improvement for outsourced projects by including outsourcing issues. Therefore, there is a gap in finding research which incorporate both RE and outsourcing issue.

The second gap which has been identified, despite there are a lot of RE process improvement practice or frameworks, most of the organization challenged on the implementation of theoretical recommended practices. Since there is no standard RE process that is suite to all organization, Process varies based on type of projects, organization context, expert experience involved on the RE process (Belsis et al., 2014). The real benefit to industry cannot be gain if SPI research conducted is not based on problems identified in industry, and if the proposed solutions are not tested in an industrial environment prior to "release" (Gorschek et al., 2003). Gorschek et al. (2003) mentioned that one of the challenges in RE is the ability to improve the process and establish one that is compatible with the company. Since there is no prior study to improve Ethio Telecom RE process, it is necessary to evaluate current RE process effort to identify improvement areas and then recommend best practice in order to improve RE process.

The third gap is, as far as the researcher understanding most of RE process improvement research conducted by using prescriptive (Model-based) process assessment and this assessment method does not give in deep information about the current state but it is easy to identify weak areas and the evaluation result can be used for decision support material, improvement planning or activities and used for further reassessment (Gorschek, Svahnberg, & Tejle, 2003). Also Nuseibeh (1994)

argued that prescriptive method is good to recommend what improvement activity to do next. Despite, there was little RE process improvement research conducted by using Inductive Process Assessment, it is in-depth evalutation of the current RE practice in the organization and identify the issues critical to organization, however this approach do not give maturity measure and difficult for finding improvement proposal (Gorschek & Wohlin, 2003). Therefore, as researcher understanding, there is no prior study which combine both process evaluation method, thus this research used inductive assessment to acquire in-depth information about the current RE practice in Ethio Telecom and use prescriptive assessment so that to easly idenify weak KPA's and recommend best practice so that Ethio Telecom RE process will be improved.

Lastly, this kind of RE process improvement research is not studied yet in Ethiopia organizations in general and Ethio Telecom in specific. Even if, there is one research which have collaborative learning oriented approach to software development and process improvement, this research not focused on RE process (Biru, 2008).

RE best practice recommended to other company cannot be the best solution for Ethio Telecom unless it is studied in Ethio Telecom context. Ethio Telecom is the only internet service provider in Ethiopia. Ethio Telecom have a plan to be a world-class provider of telecom services and to provide world-class, modern and high quality telecom services for all citizens equitably so as to transform the multifaceted development of the country to the highest level. Thus, examine the current state and knowing improvement areas of software RE process help Ethio Telecom to work for improving software RE process and to have quality SRS document which in turn produce software product which satisfy users need.

As, the aim of this study is to improve Ethio Telecom RE process this research attempts to answer the following questions: -

- What is the current state of Ethio Telecom RE process for outsourced projects?
- Which KPA is the weakest as compare to other KPAs?
- What are improvement areas?
- How Ethio Telecom RE practices can be improved?

1.3 Objective of the Study

1.3.1 General Objective

- The general objective of this research is to evaluate the current status of Ethio Telecom RE process for outsourced projects in order to come up with improvement

1.3.2 Specific Objective

To achieve the above general objective, the following specific objectives is address in the research work.

- To evaluate the current state of Ethio Telecom RE process for outsourced projects.
- To compare the requirement KPAs so that to identify weakest KPA.
- To identify improvement areas.
- To suggest improvement recommendation in order to improve Ethio Telecom software RE process for outsourced projects.

1.4 Scope and Limitation

This research is single case study research, which bound only in one organization, Ethio Telecom. As the title implies the scope of this study is limited on examining the current state of Ethio Telecom RE process for outsourced project by accessing software RE process observed on TEP_1. After evaluation improvement areas were identified, and then practices guidelines are suggested in order to improves the RE process.

Even if the research provides good insight for RE process improvement for offshore outsourced project, below are limitation of the study which show gap for further study.

- This research does not cover all software development process for example feasibility study, design, coding, Testing, maintenance and operation phase.
- This research does not identify the critical successes factor for RE process improvement. Because of this each practices evaluated equality.
- There is no training or discussion session with structured interview respondents to explain about the model in order to prepare respondents for the work during RE process evaluations.

So based on pilot test feedback, structured interview is conducted in order to explain practice benefit so that misunderstanding will be avoided. However, researcher presence by create a little bit Bias.

- Crombach aplpha reliability test is not performed KPA basis because there are few question under each KPAs, as the number of checklist questions in each KPA have to be fair enough to test internal consistence by Crombach aplpha unless few question will lead to lower Crombach aplpha value which may not reflect the actual reliability (Tavakol & Dennick, 2011).
- Improvement recommendation is not implemented in the organization; thus reassessment is not performed in order to compare the second evaluation with the initial study to quantify the actual RE process improvements made.

1.5 Significance of the Study

Ethio Telecom have a plan to be a world-class provider of telecom services and to provide world-class, modern and high quality telecom services for all citizens equitably so as to transform the multifaceted development of the country to the highest level, thus assessing and knowing the gap of software requirement process help ET to work for improving software process which lead to have quality software product. In addition, to the above significance, conducting this research can also give the following benefits

- It will help to identify good RE practice which will be applicable in Ethio Telecom software development context.
- This research help Ethio Telecom CXO and IS top management understand current state of the Ethio Telecom software requirement process and start planning to move to better software development process.
- This research can be used as an input for further research in assessing general software process improvement effort in Ethio Telecom software projects and plan for improvement. By this Ethio Telecom can understand the organization software process improvement maturity level and plan for better maturity level.

1.6 Organization of the thesis

Including this introductory chapter, this thesis report comprises five chapters. Chapter one present chapter, give general introduction for the study and state about research problem, research questions, objective of the research, significance along with scope and limitation of the study. chapter two, this chapter is dedicated to present the ideas found on the previous literatures. Basically this chapter present about definition of RE, RE process, software development outsourcing, significance of RE process for outsourced projects, related work. Finally gaps on the literature are reported.

Chapter three present the methodology used in this research. It describes research approach and methods along with justification. In addition, this chapter state techniques used to analyze the data and present how study validation and reliability tested. Chapter four, report the analysis of both qualitative and quantitative study along with findings. After the study finding are triangulated, detail discussions are presented. Chapter five the last chapter present conclusion and future research recommendation by acknowledging the research limitations.

CHAPTER TWO: LITERATURE REVIEW

2.1 Overview

The main goal of this chapter is to review related literature in RE process improvement and issue that happen on the requirement definition process because of the outsourced nature of the projects. Fist this chapter give insight about RE and software development outsourcing along with deeper description of requirement engineering process. Issues happen while requirement is defined in outsourced project also the models used to conduct this study are briefly explained. lastly, this chapter end up by identifying the gap in the literatures.

2.2 Introduction

According to CMMI Product Team (2006), these days more than ever, service providers want to deliver products and services better, faster, and cheaper. To improve the way organizations doing their business, there exist different maturity models, standards, methodologies, and guidelines. Software Engineering Institute (SEI) has found a number of dimensions that an organization can focus to improve its business and develop and maintain quality products and services. This repot mentioned the three critical dimensions that organization have to give more focus, which are procedures and methods, people and tools and equipment (2010, p. 15) as it is shown on Figure 2.1.

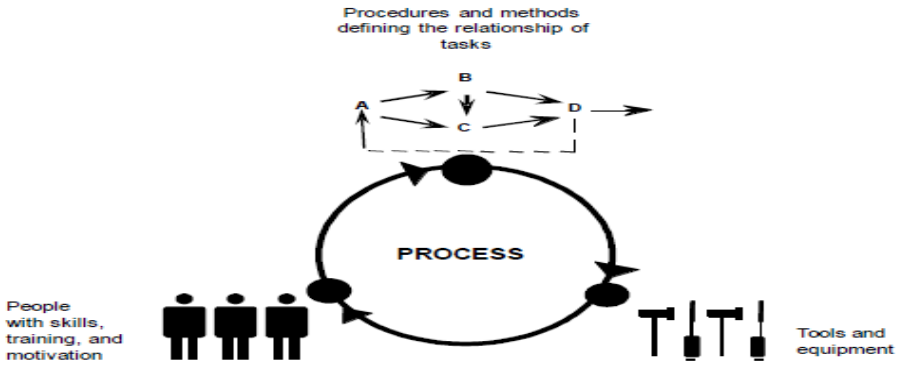

Figure 2. 1 The Three Critical Dimensions

Source: Adopted from CMMI Product Team (2006)

Though people and technology are important dimension, CPT (2006) focus on process because it holds everything together. Process helps an organization's workforce to meet business objectives by helping to work smarter, not harder, and with improved consistency. In addition, process provides the infrastructure and stability necessary to deal with an ever-changing world and to maximize the productivity of people and the use of technology to be competitive. Today many organizations realize the importance of effective, efficient and quality processes (p. 16).

What is Software process improvement (SPI)?

SEI defines process as "The organization of people: automated support, procedures and standards into work activities designed to produce a specific end result" (Software Engineering Institute[SEI], 2017). Based on SEI definition The process integrates the people, tools and technology, and rules and method.

Software is computer instruction or program which fulfill the need of individual people or a general market and used to operate computers and related devices (Awan, 2005). According to SEI Software process defined as "The set of activities, methods and transformation that people use to develop and maintain software and the associated products, for example: product plans, designs documents, code, test cases and user manuals*"* (SEI, 2017). Ul Islam & Zhou (2011) argued that the software product quality is depend on the quality of the software process. if the organization process is well defined, managed, controlled, measureable and effective, the end result will be according to the expectations. This means if the process is not well defined, organized and well-disciplined for example uncontrolled requirements, poor testing procedure, uncontrolled release, will result in a low quality software product or sometimes even a fail product.

SPI is used to set the method to improve software development process including project management, eliciting and managing requirements and testing (SEI, 2017). Ul Islam & Zhou (2011) stated that many software organizations start using SPI framework to improve software process capability and identify their software process strength, weakness, improvement areas and take measures to make improvements wherever needed. By this an organization can try to advance from a pre-maturation level of process to an improved and mature process.

2.3 Defining Requirements Engineering

As Dick et al. (2017) said defining requirement engineering is quit challenging because of its inter-connectedness with other aspects of systems engineering and project management.

2.3.1 Definition of a Requirement

A requirement is a capability of the system must be ensuring that a solution meets the needs of its stakeholders (Sparx Systems & Stephen Maguire, 2016). According to SEI a requirement is "Function or characteristic of a system that is necessary...the quantifiable and verifiable behaviors that a system must possess and constraints that a system must work within to satisfy an organization's objectives and solve a set of problems" (Awan, 2005, p. 8). In general, one can say requirement is specification which base design choice, acceptance test, risk management and change control (Wiegers & Beatty, 2013).

Requirements are the basis for every project, it define the stakeholders and also it sate what the developed system have to do to satisfy that need. Dick et al. (2017) recommend in addition of defining the problem to be solved and the solution, one must consider the risks of failing to provide a satisfactory solution. Requirements give both the "navigation chart" and the means of directing towards the selected destination.

2.3.2 Definition of Requirements Engineering

Generally RE is defined as "A systematic approach to eliciting, organizing, and documenting the requirements of the system, and a process that establishes and maintains agreement between the customer and the project team on the changing requirements of the system" (Wahono, 2003, p. 3). When RE defined in the selected key activates it is "the subset of systems engineering concerned with discovering, developing, tracing, analyzing, qualifying, communicating and managing requirements that define the system at successive levels of abstraction" (Dick et al., 2017, p. 8).

2.4 Type of Requirement

“Requirements are a specification of what should be implemented. They are descriptions of how the system should behave, or of a system property or attribute. They may be a constraint on the development process of the system” (Wiegers & Beatty, 2013, p. 6). this definition state requirement is supposed to contain divers information for example it may defines the user’s view of the external system behavior and the developer’s view of some internal characteristics. Therefore, not all your project stakeholders share a common notion of what requirements are. Requirement type can be categorized on based on the types of information contents. Below is major type of requirement.

Business requirements define the reason why an organization implementing the system and the overall business benefits the organization expecting to achieve. This information can be reference for making decisions about proposed requirement changes and enhancements. Business requirements have to be defined before the functional and nonfunctional requirements can be fully specified. business objectives, success metrics, a vision and scope are the major constitute of Business requirements (Wiegers & Beatty, 2013).

User requirements this information tells about what the software application must or should do in order to satisfy user needs or it tells about the problem domain, the world of the user. It is list of user wish or features describe what the user does with the system or it can be considered as tasks users must be able to perform with a system. This requirement is documented in a User Requirements Document (URD) using narrative text. Lastly URD signed off by the user and used for preparing system requirement.

System requirements “describe the requirements for a product that is composed of multiple components or subsystems” (Wiegers & Beatty, 2013, p. 9). The system in this context indicate all software or both hardware and software subsystems. This requirement is lead the business analyst to derive specific functionality.

Functional requirements state the behaviors the product will show under specific conditions, state how the system should react for a particular input. According to “Software Requirements" (2004) functional requirment defined what the developers must implement to enable users to

perform their tasks (user requirements), thus the business requirements will be satisfied. The business analyst state functional requirements in a software requirements specification (SRS).

SRS also contains **nonfunctional requirements** (also known as **quality requirements)** which define the property, characteristic that a system must exhibit or a constraint that it must respect document (Parker, 2012; Wiegers & Beatty, 2013). Nonfunctional requirement commonly include efficiency, reliability, usability, delivery, Implementation and Interoperability information (Software Requirements, 2004).

2.5 Requirements Development process

There are many different RE process models which have different structure like linear, iterative and process used for RE differ depending on the organization, stakeholders involved and the application domain. Within these different models, there are a number of generic activity common to all process, such as requirement elicitation and analysis, specification, validation and verification and management (Martin, Aurum, Jeffery, & Paech, 2002).

2.5.1 Requirement Elicitation

Requirement elicitation is usually considered as the first phase of RE or the heart of requirement development where the requirement is discovered from different source so that the domain problem and constraints will be understood. it is not simply collecting all stakeholders and gathering requirements, rather it is a collaborative and analytical process of collecting, discovering, extracting, and define requirements. By this business analyst (BA) will understand why the system must perform certain functions and understand process behind the requirements the users stated. Business analyst have to use the vocabulary of the business domain instead of forcing user to use technical words (Awan, 2005; Wiegers & Beatty, 2013).

Though the technique of discovering requirement is depending on the type of the project the company is dealing, generally prototyping, interviews, questionnaire and use case scenarios are the most appropriate requirement elicitation techniques in the case of global software development (Sabahat, Iqbal, Azam, & Javed, 2010). In addition of both face to face and synchronous text based

communication mediums is useful for effective communication during requirement elicitation and negotiation for geographical dispersed stakeholders (Kumari & Pillai, 2013).

The business analyst should plan the project approach to requirements elicitation. This plan covers issues like elicitation objectives, elicitation strategy, schedule and resource estimates (identify stakeholders for each elicitation activity), documents, systems needed for independent elicitation, expected products of elicitation efforts and identify elicitation risk. BA have to select elicitation techniques based on characteristic of the project. Figure 2.3 show few suggested elicitation techniques by project characteristic (Wiegers & Beatty, 2013). Despite requirement elicitation have to be done in cyclic, figure 2.2 depicts the activities for a single requirements elicitation session.

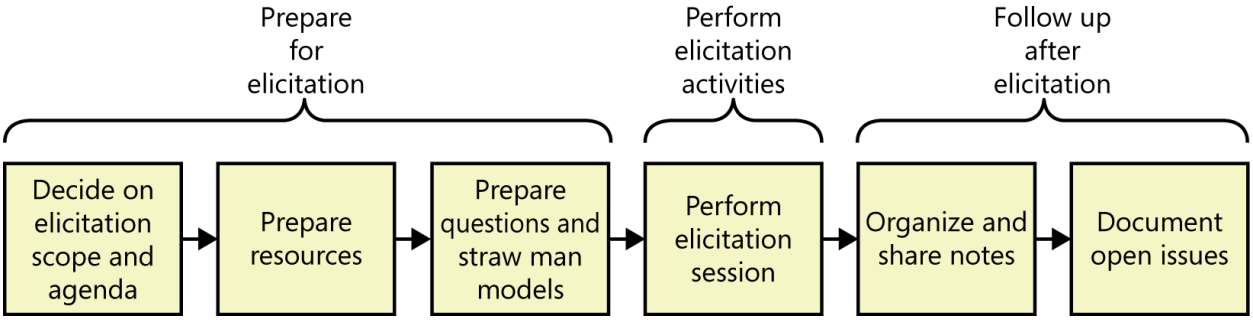

Figure 2. 2 Activities for a single requirements elicitation session.

Source: Adopted from Wiegers & Beatty (2013)

	Interviews	Workshops	Focus groups	Observations	Questionnaires	System interface analysis	User interface analysis	Document analysis
Mass-market software	×		×		×			
Internal corporate software	×	×	×	×		×		×
Replacing existing system	×	×		×		×	×	×
Enhancing existing system	×	×				×	×	×
New application	×	×				×		
Packaged software implementation	×	×		×		×		×
Embedded systems	×	×				×		×
Geographically distributed stakeholders	×	×			×			

Figure 2. 3 Suggested elicitation techniques by project characteristic.

Source: Adopted from Wiegers & Beatty (2013)

Prepare for elicitation: In this activity BA have to decide on the scope of the session and communicate agenda and draft materials that might be useful during the session. As much as possible BA has to prepare question that lead towards specific answer (Wiegers & Beatty, 2013).

Performing elicitation activities: In order to easily discover users need BA is recommended to educate stakeholder about the elicitation approach and why the approach is selected (Wiegers & Beatty, 2013).

Following up after elicitation: In the elicitation session users do not explain their needs in well-organized manner, thus BA has to classify requirements in different category so that BA can document and use it appropriately. The elicited requirements have to be shared among stakeholders. If there are items that need escalation or further exploration, have to document as open issue (Wiegers & Beatty, 2013).

2.5.2 Requirements Analysis and Negotiation

Once the requirement is elicited, it should be analyzed in order to refine the requirement to insure that all stakeholders arrive in common understanding or shared- vision of what the system will be after production or development. In addition, analysis ensure that the elicited requirement have been expressed correctly with the correct format and level of detail (Sparx Systems & Stephen Maguire, 2016). Analysis process used to find error, conflicts, overlaps, omissions, inconsistencies and other deficiencies. This phase includes decomposing high level elicited requirement to appropriate level of detail, defining bounders of requirement to eliminate unnecessary requirement. requirment negotiation is used to keep most important requirment in SRS document. Assiging priority for the requirment helps to negotiate easilty and if there is a change in requirment or introduction of new requirment, reprioritization have to be made. Most of the companies use check lists for conflict resolution and completeness checking. The general goal of analysis and negotiation is to develop agreed set of requirement which is sufficient, complete, consistent and quality (Awan, 2005; Sparx Systems & Stephen Maguire; 2016; Wiegers & Beatty, 2013). Relationship Matrix and the Traceability window are well known tools used to show omissions and issues with requirements (Sparx Systems & Stephen Maguire, 2016).

2.5.3 Requirement specification

Once the problem is understood, requirement of different type has to be recorded on software requirement specification document in a consistent, accessible way so that the document has to be specified in a way everyone can understand easily. Specification document describes the software product to be deliver, not how it will be delivered. Requirement can be described in natural language, chart, figure, graph. Adopting standard template will help to have consistent structure while documenting the requirement for example scope, version, use case template (Awan, 2005; Wahono; 2003; Wiegers & Beatty, 2013).

Regardless how well the functional requirement is defined and implemented, if the nonfunctional requirement and quality attribute not clearly specified and implemented, the developed system unlikely to get users acceptance. Mostly quality attributes are grouped under performance, reliability and security. Requirements package can be used to group these elements together which provides a convenient categorization for SRS preparation (Sparx Systems & Stephen Maguire, 2016).

The IEEE 830 standard defines the benefits of a good SRS: Establish the basis for agreement between the customers and the suppliers on what the software product is to do thus it used as the basis for contract with our clients, Minimize the development effort, foundation for estimating costs and schedules, Provide a baseline for testing , validation and verification and it serves as an input to the design specification (Japenga, 2003). SRS have to address or include information's like functionality, external interfaces, performance, security/privacy (Japenga, 2003; Vie,2010).

SRS document typically includes three ingredients: first is template, since there is no standard specification template which fit to an organization or project, each company have to modify it to fit your project requirements. Second in SRS each requirement has link their source and each requirement be labeled with a unique identifier requirement identification (ID) number. lastly requirement traceability matrix, which is a document in the form of table used to determine the completeness of the relationship for example it used to keep track of each requirement against each test case, fine the origin of each requirement and used to track the changes made on the requirement (Vie, 2010).

2.5.4 Requirement validation and verification

Precisely looking, validation and verification are two different activities in software development. Verification mean checking of product meets its requirement (doing the thing right) or have the requirements written right. Validation is checking whether product stratifies user need (doing the right thing) or whether you have written the right requirements: which trace back to business objectives (Wiegers & Beatty, 2013).

Requirement validation is the process of making sure that requirements are of a high standard sufficient for the design or implementation and the correct requirements are defined. Form the best practice there are number of way requirement can be validated for example firstly, team reviews: that allows team members to collaborate and review the contents of the requirement. Secondly, to assign test cases to the requirements. Test Cases acts as a double check on the quality of requirements as test designer bring their own unique view of the requirements. Best practice suggests that the testing team should be independent and isolated from the requirements team. Thirdly Requirement Checklist: it is a way of visually recording whether requirement is high quality or not (Sparx Systems & Stephen Maguire, 2016).

Fourlty, Acceptance criteria is defining the minimum conditions for an application to be considered business-ready. In addition to asking user in the elicitation process “what do you need to do with the system?” it is necessary to ask “How would you judge whether the solution meets your needs?”. also, it is good practice to think of “rejection criteria,” conditions or assessment outcomes that would lead a stakeholder to deem the system not yet ready for delivery. Lastly, Defect checklist support reviewers look for typical kinds of errors in the products they review, develop a defect checklist for each type of requirements document your projects create (Wiegers & Beatty, 2013).Below figure 2.4 show defect checklist for reviewing requirements documents.

Completeness

- ❑ Do the requirements address all known customer or system needs?
- ❑ Is any needed information missing? If so, is it identified as TBD?
- ❑ Have algorithms intrinsic to the functional requirements been defined?
- ❑ Are all external hardware, software, and communication interfaces defined?
- ❑ Is the expected behavior documented for all anticipated error conditions?
- ❑ Do the requirements provide an adequate basis for design and test?
- ❑ Is the implementation priority of each requirement included?
- ❑ Is each requirement in scope for the project, release, or iteration?

Correctness

- ❑ Do any requirements conflict with or duplicate other requirements?
- ❑ Is each requirement written in clear, concise, unambiguous, grammatically correct language?
- ❑ Is each requirement verifiable by testing, demonstration, review, or analysis?
- ❑ Are any specified error messages clear and meaningful?
- ❑ Are all requirements actually requirements, not solutions or constraints?
- ❑ Are the requirements technically feasible and implementable within known constraints?

Quality Attributes

- ❑ Are all usability, performance, security, and safety objectives properly specified?
- ❑ Are other quality attributes documented and quantified, with the acceptable trade-offs specified?
- ❑ Are the time-critical functions identified and timing criteria specified for them?
- ❑ Have internationalization and localization issues been adequately addressed?
- ❑ Are all of the quality requirements measurable?

Organization and Traceability

- ❑ Are the requirements organized in a logical and accessible way?
- ❑ Are all cross-references to other requirements and documents correct?
- ❑ Are all requirements written at a consistent and appropriate level of detail?
- ❑ Is each requirement uniquely and correctly labeled?
- ❑ Is each functional requirement traced back to its origin (e.g., system requirement, business rule)?

Other Issues

- ❑ Are any use cases or process flows missing?
- ❑ Are any alternative flows, exceptions, or other information missing from use cases?
- ❑ Are all of the business rules identified?
- ❑ Are there any missing visual models that would provide clarity or completeness?
- ❑ Are all necessary report specifications present and complete?

Figure 2. 4: A defect checklist for reviewing requirements documents.

Source: Adopted from Wiegers & Beatty (2013)

Requirement validation is not single phase which perform right after elicitation and documentation, rather it will be performed throughout the iterative elicitation, analysis, and specification processes. Contrast to requirement analysis it is more formal process in which requirements document is formally inspected and reviewed. Generally, Requirements validation activities attempt to ensure that: (Awan, 2005; Wahono; 2003; Wiegers & Beatty, 2013).

- ❖ requirements accurately describe the intended system capabilities and properties that will satisfy the various stakeholders' needs.
- ❖ requirement have quality standard like complete, feasible, consistent and verifiable
- ❖ Requirement are correctly derived from the business requirements, system requirements and business rules
- ❖ All requirements are necessary, and the entire set is sufficient to meet the business objectives.

- ❖ The requirements give adequate foundation for the reaming phase of design and implementation.

2.6 Requirement management process

This is the process of managing the change of system requirement so those volatile and global requirements are identified and defining change management police. Requirement management is used to maintain the integrity and accuracy of requirements agreements throughout the project. Most of the time BA take the leading responsibility for requirement management. BA will setup the requirements storage mechanisms, define requirement attributes, coordinate requirement status and trace data updates, and monitor change activity as needed. The process description also shows who has right to modify the requirements management process and how exceptions will be handled. Requirement management help to ensure requirement development effort is not wasted.

After the approval of requirement, any defined subset of items constitutes a requirements baseline. requirements baseline is a set of requirements that stakeholders have agreed to and that will can change only through formal change control procedures. Baseline have to be create with unique name thus project team can refer to it unambiguously. Creating requirement baseline using requirement management(RM) tool and adding requirement on it used to manage the changes to that baseline and requirements in that baseline (Wiegers & Beatty, 2013). Figure 2.5 Show four categories of major requirement management activities from (Wiegers & Beatty, 2013)

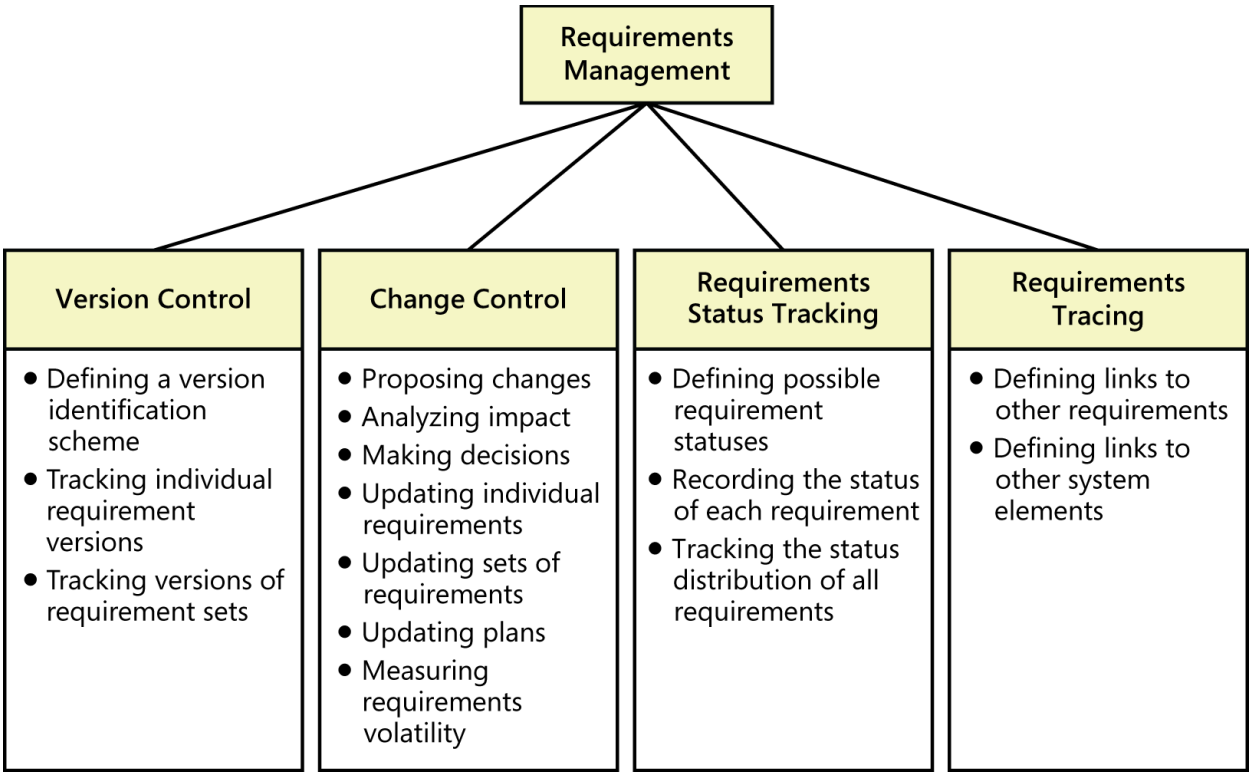

Figure 2. 5: Major requirements management activities.

Source: Adopted from Wiegers & Beatty (2013)

Requirements version and change control

Version control is the process of uniquely identifying different versions of an item which applies at the level of both individual requirements and requirements sets. As the best practice according to Wiegers & Beatty (2013) version control has to be started when requirement is drafted so that a history of change made can be retain. Wiegers & Beatty also advice that, in order to diminish confusion and miscommunication, permit only chosen individuals to update the requirements, and make sure that the version identifier changes whenever an update is made. Each circulated version of a requirements have to include revision history that identifies the changes made for example the date of each change, the individual who made the change, and why the change made. This change history is relevant when revering the requirement to earlier version is needed and to track history of change. The most appropriate way for version control is to store requirements in requirement management tool or using the word processor's revision marks feature to track changed if the requirement is stored in documents (Wiegers & Beatty, 2013).

While managing requirement, project team may want to view selected subsets of requirements based on their attribute values, thus each requirement has to associate few attributes in addition to textual description. Example of potential requirement attributes is Date the requirement was created, Current version number of the requirement, Author who wrote the requirement, Status, Priority, Rationale behind the requirement and Release number (Wiegers & Beatty, 2013).

Tracking requirements status

"Tracking status means comparing where you really are at a particular time against the expectation of what 'complete' means for this development cycle" (Wiegers & Beatty, 2013, p. 464). Wiegers & Beatty (2013) recommend that rather than, monitoring the project percentage completion of requirements or total release of baseline it is better to classifying requirements into several statuses. Below is some of suggested requirement status.

Status	Definition
Proposed	The requirement has been requested by an authorized source.
In Progress	A business analyst is actively working on crafting the requirement.
Drafted	The initial version of the requirement has been written.
Approved	The requirement has been analyzed, its impact on the project has been estimated, and it has been allocated to the baseline for a specific release. The key stakeholders have agreed to incorporate the requirement, and the software development group has committed to implement it.
Implemented	The code that implements the requirement has been designed, written, and unit tested. The requirement has been traced to the pertinent design and code elements. The software that implemented the requirement is now ready for testing, review, or other verification.
Verified	The requirement has satisfied its acceptance criteria, meaning that the correct functioning of the implemented requirement has been confirmed. The requirement has been traced to pertinent tests. It is now considered complete.
Deferred	An approved requirement is now planned for implementation in a later release
Deleted	An approved requirement has been removed from the baseline. Include an explanation of why and by whom the decision was made to delete it.
Rejected	The requirement was proposed but was never approved and is not planned for implementation in any upcoming release. Include an explanation of why and by whom the decision was made to reject it.

Figure 2. 6: Suggested requirement status

Source: Adopted from Wiegers & Beatty (2013)

Requirement tracing

Requirement tracing is the process of describing and following the life of the requirement in both forward and backward direction (Wiegers & Beatty, 2013). If traceability relationship is well defined it will show the requirement dependency and how changed in one requirement affect other requirement and the whole project. Completes, consistency and traceability of requirement will be negatively influenced unless project implement requirement traceability approach. (Requirement traceability, 2006). For example, in the scope management requirement REQ 1.1 is identified and decomposed to functional requirements. Each functional requirement is then defined within a design specification document and then coding work is performed. requirements tracing will identify and link design specification document to functional requirement and then to first defined requirement of REQ1.1 then follow each requirement through testing and eventually product delivery (Requirement traceability, 2006).

2.7 The need for RE process improvement

Measuring the benefit RE process improvement is not easy because in requirement and implementation phase there is long time gap, thus it is difficult to know how RE techniques affect developed system. However, Kabaale et al. (2014) mentioned below listed benefits that is consequent from RE process improvement:

Early Error Detection: RE helps detect error early in software development process, it will save both time and human effort than detecting on the later stages. As Davey & Cope (2008) argued detecting and fixing error early in requirement phase reduce 75% of all error removal cost.

Early Detection of Differences among Stakeholders: It is obvious that stakeholders may have different interest, but with RE in place such interest difference can be detected and fixed early in the development process so RE help to produce agreed requirement.

Solid Foundation for Later Phases: RE process output is SRS which is the basis for later stages for example contract between client and developer**,** used for implementation and system testing

Improved Quality and Productivity: Rozum (1993) argued that high quality software need improvement of software development process as improved production process lead to quality product.

Improved Management Visibility and Control: project managers can use RE practice to estimate project delivery time this make company chance to get another contact with the same client.

2.8 Software development outsourcing

2.8.1 Introduction to Outsourcing

As Herbsleb (2007) stated the world become a village so that people in different location can communicate easily and an emergence of internet technology creates grate opportunity for information technology(IT) field, thus IT outsourcing a great attainment of globalization. This researcher also listed key factors for global offshoring such as" globalization of trade in service", emerging a lot of engineers specially from china and the standardization of software development process and practice (Herbsleb, 2007).

SDO is a type of information technology outsourcing in which few or all activities of the software development are contracted out by a client to the vender (Khana et al., 2011). Ko, Kirsch, & King , (2005) mentioned most of companies do not have capabilities, knowledge, expertise to develop and launch a complex system.

Iqbal et al. (2013) categorized IT outsourcing basically under four scenarios: (a) when service provider delivers a service at the location of client organization. (b) On Shoring outsourcing the contractor not provide the service at the client location, rather service provider has office to operates from the same country. (c) Contractor provides services from another country: this approach will be done in two ways when the services are provided from the same region/nearby country; it is called Near Shoring. If a service provider provides the services from a faraway country which have different time zone, it is called Off Shoring. Both Offshore and nearshore are similar except, distance or the time zone is different (Thattil, 2016). (d) When multiple venders are involved: Distributed Software Development(DSD) scenario happen when the stakeholders are geographically dispersed and Global Software Development or GSD when the distance become stakeholders become global (Iqbal, 2016).

2.8.2 Outsourcing Background

The trend of outsourcing begins in 1990's when companies start to make new innovation product but computer and other related technology be very expensive. In addition, when companies face lack of technology and resources (Ul Islam & Zhou, 2011).

Ul Islam & Zhou (2011) described why outsourcing began: Even if, software development is complex process because of requirement change rapidly, technology advancement and complex process, customer want efficient, quality and flexible product in short time and low cost, thus to overcome those challenges companies, start to hire service from external parties. The service can be system development, management operations and innovation. This situation is called outsourcing or offshore development. Outsourcing make company to focus on building core products (p. 21).

According to Meresea (as cited in Worku, 2017) "improving service quality, acquiring innovative ideas, knowledge and skills, allowing more focus on core business, increase flexibility to match varying business conditions, deficiency of internal expertise" are the main reasons for Ethiopian's companies to outsource IT (P.14). Muluneh (as cited in Worku, 2017) sated that major motivation for ET for outsourcing is 'lack of internal expertise'. Lishan (as cited in Worku, 2017) stated that Ethio Telecom have been using offshore outsourcing.

2.8.3 Significance of the RE process improvement for SDO

A lot of Software development projects outsourced in order to reduce the cost and accessibility to high-quality capabilities, but a lot of risks happen in this process (Khan et al., 2009). As the Industry surveys reveled even if SDO trend becoming popular, only half of SDO projects are successful (Gefe et al., 2008). problem related to RE are the main reasons for the failure of SDO projects because most of the issue or factors contributing to such failures are related to the requirements (Lopes et al.,2005).

For outsourced projects where stakeholders are dispersed at different locations, the requirement problems are expected to increase many times. This phenomenon affects various activity in RE process such as communication, working hour difference, language issues, dissimilar working and

coordination issue. Therefore, in order to attain the expected benefit of the SDO, the issues of the RE process for SDO must be solved in addition to RE issues in non-outsourced project (Iqbal et al., 2013).

2.9 RE process improvement frameworks

REAIMS is developed by Sommerville and Sawyer in 1997. This model is developed for requirements engineering processes and as a method for process assessment. REAIMS help organizations to compare their RE processes against industrial good practice in order to identify possible process improvement areas. This model is developed in a way it complements the SEI's Capability Maturity Model, which does not cover requirements engineering processes and model use CMM-compatible terminology. Therefore, REAIMS proposed three levels of RE process maturity corresponding to the first three levels in the CMM. Initial level when the RE process is inadequate, and depend on the skills and experience of individual. Repeatable level when RE process have explicit standards and defined level when RE processes are documented, standardized and integrated into a standard process (Sommerville & Sawyer, 1997, pp. 7-44)

The model is developed on the idea that the level of process maturity reflects the extent that good RE practices used and standardized in a company. Generally, REAIMS have sixty-six good practice guidelines under three categories of basic, intermediate and advanced. There are thirty-six basic practice which focus on fundamental activity to control RE process, there are twenty-one intermediate practices concerned on the use of methodical approaches to RE and the use of tools. Lastly there are nine advanced practices focus method like formal specification and organizational change. Good practices are associated with each key process areas. Below is Sommerville's framework key process area description:

Requirements Documentation: Requirements document is used to communicate system requirements to customers, managers, system users, and system developers. Guideline recommend practice is used to improve the structure and organization of requirement document.

Requirements Elicitation: It is the process of discovering the requirements for a system from customers, system users and other who have a stay in the development process. This process request organizational, application and specific problem knowledge.

Requirement Analysis and Negotiation: Elicited requirement have to be analyses for checking conflicts, overlaps, omissions and inconsistencies requirements. When there is any conflicting information, system stakeholders have to negotiate to reach on consensus. On this step basically conflicts must be resolved and requirements have to be prioritized.

Describing Requirements: Requirement have to described in concise, understandable and unambiguous manner. This process area focuses on how to write these descriptions

System Modelling: This guideline focused with the development of abstract system models which is part of a detailed system specification.

Requirements Validation: It is formal process done after SRS preparation and this guideline concerned with checking the requirements for omissions, ambiguities and conflicts and to ensure that the requirements follow quality standards.

Requirements Management: Is focused with all of the guideline which facilitate the processes of changing system requirements.

Iqbal (2016) develop Requirements Engineering Practices (REP) Model to address the frequently issues of RE process for SDO. Below is REP model issue category definition which hold top the ten issues:

i) Communication issues: "The issues associated with communication among the various stakeholders that are scattered across different countries and times zones."

ii) Knowledge management and awareness issues: "The issues that are resulted from improper management of the required knowledge and unawareness of the stakeholders from this knowledge at right time."

iii) Management and coordination issues: "The issues that are initiated because of the poor management of RE process and poor coordination among the stakeholders."

To sum up, this research used REAIMS and REP model to address compressive the nature of ET RE process for outsourced projects.

2.10 Related work

As Gorschek et al. (2003) stated most of requirements engineering evaluation methods are often large, costly and time-consuming to use. Therefore, they introduce requirement engineering practice model (REPM) which is fast, easy and coat effective evolution of requirement engineering process. For this researcher introduce a lightweight evaluation method. REPM have five level of maturity and three key process areas of: Elicitation, Analysis & Negotiation and Management. Each process areas holds different action. In order to test REPM applicability for industry and to introduce model evaluation method researcher conduct multiple case study under four companies using structured interview with checklist question by following their framework actions. Checklist question can be answered with one of the three answers: completed, uncompleted and satisfied-explained (not applicable for industry under study). Finally, the researchers suggest that the proposed evaluation method is useful for all company and for all companies among three major process areas requirements management is the one that require most improvements (pp. 1-9).

Gorschek and Wohlin (2003) presented lightweight triangulation approach to identify RE process improvement issue. Through they have used four data sources, project and line case study interview and project and line documentation. This variety of data source is used to validate case study data by document review. This method is used to get different perspective so that reduce the chance of missing critical issues. After performing semi-structured interviewing of different stakeholders having different role in the project under study, the researcher identified nine RE issue and give improvement recommendation practice for each issue. “Abstraction level & Contents of requirements”,” Requirements prioritization” and” Requirements upkeep during & post project” are issues get most support by interviewed peoples (pp. 1-12).

Kauppinen & Kujala (2001) used REAIMS model which is developed as a requirements process maturity model. The maturity level is calculated by summing up of each practice of having the maximum of three points, this model reports the organization RE process maturity under three level are called initial, repeatable and defined and is used to perform qualitative analysis so that the respondent will be interviewed to collated the data. The model can report the organization RE maturity level and also can compare eight process Ares so that to identify the relatively weak and strong areas for further improvement planning. if an evaluated organization get less than 55 score,

it will be in initial level. This study also assessed RE process of three organizations and all are found to be in initial level by scoring 29,24,20 points. In addition, researchers assess how well do the REAIMS practices suit for the organization and they conclude an assessment with the result stated "REAIMS model can be particularly useful for organizations that are just starting improvement of their RE process. However, the researchers did not make any recommendation RE process improvement (Kauppinen& Kujala, 2001, pp. 1-7).

Sommerville & Ransom (2005) used 66 good RE practice guidelines from REAIMS in order assess RE process improvement effort and to determines the RE maturity level of an organization. The researcher conducts the RE maturity assessment on 10 different organizations and based on the result of their study the researchers found all organization was in initial level. However, the 5th and 6th Company made extensive use of good RE practice whereas Company 2 essentially did not perform any requirements engineering in their systems' procurement processes.

To make improvement recommendation the researchers develop report called Area/strength matrices where all eight practice are listed and indicate their weakness or strength state with in table format in which the right most cell is strongest (pp. 1-31).

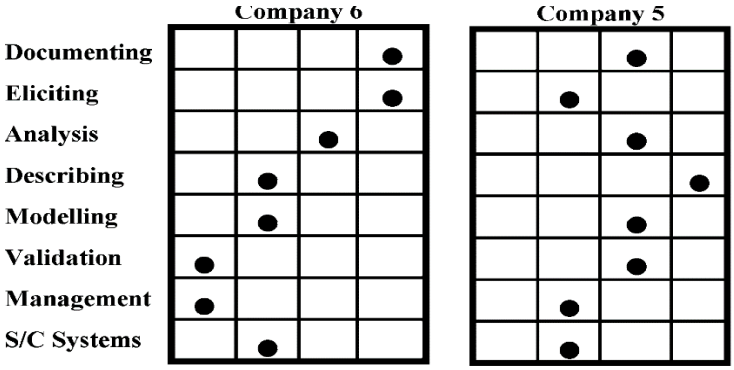

Figure 2. 7: Area/strength matrices

Source: Adopted from Sommerville & Ransom (2005)

Since Intermediate and Advanced practices need extra training, their costs of introduction is fairly high, thus the researchers recommend basic practice to be introduced or standardized in the organizations to strengthen the foundation for requirements engineering. After introducing the recommendation practice all of the organization showed significant improvement for example Company 5 moved from Initial to Repeatable by introducing 14 new Basic guidelines.

Ahmad et al., (2015) identified high perceived-value RE practices specifically for outsourced software development projects from REAIMS framework. Researchers used questionaries' survey method. They meet respondent with face to face in order to give more clarification if need. Among sixty-six practice, twenty-eight RE practice are identified to be critical for outsourced software projects. Some of them are "Define and follow a standard document structure"," prioritize requirements and Define operational processes" (pp. 1199-1215).

Iqbal (2016) identified RE issues for SDO. Based on this issues the researcher identified seven categories of SDO RE process issues and rank it based on the frequencies occurring as communication, management and coordination, knowledge management and awareness, Requirements centric, Cultural diversities, Processes and tools and Relationship among stakeholders. In order to give more attention for critical issue the researcher rank and identified top ten issue and from top ten issues five issue is belongs to communication, three issues from management and coordination and three issues from Relationship among stakeholder's categories. Then the researcher performs root cause analysis to know the root causes for frequently occurring issues and suggest relevant RE practices which gathers from literature to address the issues and develop Requirements Engineering Practices (REP) Model to address the frequently issues of RE process for SDO (pp. 1-179).

Author [year]	Objectives	Method	Key finding
Gorschek et al. (2003)	-Introduce lightweight evaluation method (REPM model). In this paper the researchers outline the evaluation method -second objective is to test REPM for quick assessment.	--Multiple cases study (on four industry) --used structured interview following REPM actions	--The key process areas of Requirements Management is generally the one needing most improvements. --The results suggest that the proposed evaluation method is useful.
Gorschek & Wohlin (2003)	Present lightweight triangulation approach to identify RE process improvement issue	--Several data source case study -- used semi-structured interview for data collection	- develop RE process improvement approach. -for the organization under study researchers identified nine RE process improvement issue and give recommendation best practice to improve the process.
Kauppinen & Kujala (2001)	--To evaluate three organizations RE maturity level so that they can be improved. -- check the applicability of REAIMS model for the organization assessment.	--Multi case study in ten different industry --used interview	- All three organizations is found to be in the initial maturity level - prove REAIMS model is useful for organizations

Sommerville & Ransom (2005)	To introduce the use of Sommerville and Sawyer 1997 REAIMS model and evaluate its applicability in the industry.	--Multi case study in ten different industry --use semi-structured interview	--They have shown the way to assess RE maturity level in organization -- proven that model is capable to improve RE process in the organization
Iqbal (2016)	to develop a model in order to overcome the frequently occurring issues of the RE process in case of SDO.	--constructive research approach has been employed --an extensive Systematic Literature Review, -questionnaire-based surveys and Delphi method	Identified RE issues for SDO and categorize under seven categories. Then from literatures suggest best RE practice to address frequently accusing issue and develop Requirements Engineering Practices (REP) Model.

Table 2. 1: Summary of related work

2.11 The Gaps in the Literature

From the above exhaustive literature review on RE process improvement for outsourced project the researcher identified below valuable gaps:

The first gap in the reviewed literature, few study performed about the holistic conceptualization of issues for RE process in outsourced project. Researchers who work to improve RE process in outsourced project focus mainly on the communication, cultural and knowledge management issue (Iqbal et al., 2013; Iqbal, 2016). In the other direction researchers who works to improve RE for in-house development only focus on the basic RE practices such as elicitation, analysis, specification and validation (Kauppinen & Kujala, 2001; Niazi, 2002). Ahmad et al., (2015) Recommends research have to be conducted by considering both basic RE practice and outsourcing issue. Therefore, there is a gap in finding RE process improvement research which address both basic RE practice and outsourcing issue.

Secondly, literatures show that most of RE process improvement research conducted by using prescriptive (Model-based) process assessment and this assessment method does not give in deep information about the current state (Gorschek & Wohlin, 2003). Despite there was little RE process improvement research conducted by using Inductive Process Assessment, it is in-depth evalutation of the current RE practice in the organization and identify the issues most critical to organization, (Gorschek & Wohlin, 2003). Therefore, as the researcher understanding, few study performed combining both process evaluation method, thus this research used inductive assessment to acquire in-depth information about the current RE practice in Ethio Telecom and use prescriptive assessment to easly idenify weak KPA's and practices.

Thirdly, though there are a lot of RE process improvement researches there are few studies considering outsourcing issue. As the Industry surveys reveled, even if SDO trend becoming popular, only half of SDO projects are successful (Gefe et al., 2008). Thus this research can be input for the RE process improvement for outsourced projects research in future.

Lastly, another important gap which has been identified is that there is few RE process improvement research for both in-house and outsourced project in developing country. To the best of researcher understanding, this kind of RE process improvement research is not studied yet in Ethiopia organizations in general and ET in specific. Even if, there is one research which is have collaborative learning oriented approach to software development and process improvement in Ethiopia ,but this research not focused on RE process (Biru, 2008).

Therefore, this study is conducted to fill the above deficiencies. This case study research, thus, generally attempt to evaluate RE process effort for outsourced projects and identify improvement areas so that it can be improved in Ethio Telecom which is located in one of developing country Ethiopia.

2.12 Chapter Summery

The purpose of this chapter is to give insight about RE process improvent for outsourced projects by referring different article, books and other source relevant to the particular study. This chapter give detail insight about software requirement, RE and software development outsourcing. Exhaustive literatures are reviewed to explain about requirement engineering process along with their best practices. On top of the concepts related work of this study and RE process improvement frameworks used on this study is presented. Lastly gaps on the existing literature is declared. It was revealed that there is lack of study on holistic conceptualization of issues for RE process in outsourced project.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Overview

This chapter give an overview of the research approach used to conduct the study, how the research is conducted in a systematic way to solve a problem. According to Creswell (2014) among divers methodologies, the researcher has to select appropriate approach based on nature of the research problem or issue being addressed, research goal and research questions. In the following section the research method: research approach, research model: describe the overall framework to look the reality, research design: data collection methods, data analysis techniques are described and justified.

3.2 Research Method and Case Approach

According Togia (2017) study, most of information system researches use quantitative and qualitative approach while there are few researches which applied both approach in combination. Generally, this research adopts both qualitative and quantitative method in combination in order to acquire each method strength, answer all research questions and triangulate findings. From SPI terminology this research used both inductive and prescriptive assessment method. Inductive is similar to qualitative whereas prescriptive is similar to quantitative approach (Harwell, n.d).. Below is the explanation with justification about which research approach is adopted for each research questions:

Generally, both qualitative and quantitative approach used to answer the first research questions. The second research question is answered by quantitative study. The third research question is answered by triangulating the finding from both approaches. Finally, the last research question is answered by providing improvement recommendation from literatures for those identified improvent areas.

Gorschek & Wohlin (2003) clearly showed that qualitative or inductive assessment method used domain expert experience and view, thus assessment evaluation become “in-depth evaluation of the current state- of practice regarding RE in an organization”. Mainly qualitative study is used to deeply examine the current state of Ethio Telecom RE process. It also employed to accurately

identify RE practices which is applicable in Ethio Telecom context based on participant work experience in Ethio Telecom as the qualitative approach focus on discovering experience and opinion of participant with their justification (Harwell, n.d). In addition, in the qualitative study improvent issue are identified from the information collected in semi-structured interview and document analysis.

Generally, quantitative research method is used in order to quantify findings. This study indicates the percentage of practice guideline applicability for the organization understudy, indicate the status of each practice in range between zero (never used) to three(standard), compare KPAs to identify the weakest RE area and identify relatively weak practice so that improvement areas can be easily identified. Gorschek & Wohlin (2003) argued that this method is easy to identify weak areas and the evaluation result can be used for decision support material, improvement planning and used for further reassessment. Also Nuseibeh (1994) argued that quantitative or prescriptive method is good to recommend what improvement activity to do next

Case study is selected as the strategy of this research in combination of quantitative and qualitative methods for the collection and analysis of the data. "Qualitative Research Methods " (n.d) clearly stated that “Case study is a method used in both qualitative and quantitative research methodologies”.

Yin (2009) argued that case study is appropriate when there is insufficient earlier study, to understand complex phenomena and when in-depth investigation is needed within its real life context. As the main purpose of this study is to get comprehensive and in- depth information about RE process for outsourced projects in Ethio Telecom real life context, where there are few prior studies, case study strategy best suits a situation under the study. According to Yin (2009) case study can be conducted by single or multiple case strategy. As the aim is to reveal or represent organization RE process so that it can be improved, single case study strategy is chosen. Single case study is suitable when the case represents an extreme case or a unique case and also when the case is representative and critical.

In the single case study, the case for the study can be selected if it can be representative of the border population of cases (Gerring & Cojocaru, 2015), if the case is revelatory case when the investigator gets opportunity for observation and analysis of a phenomenon not accessible before

and also if the case contains extreme case or a unique case (Yin ,2009; Shakir, 2002). Therefore, Ethio Telecom is selected for the single case study as Ethio Telecom can be exemplary company which exhaustively experienced outsourced system developments, ET is revelatory cases, since RE process improvement research is not studied before in Ethiopia in general and in Ethio Telecom in specific and as Ethio Telecom software development projects are big in size, this help studies to acquire unique and extreme case for the study. Generally, ET is giant company which exhaustively experience different RE and outsourcing issues as compare other Ethiopian companies.

3.3 Research model

Research model is used to describe the overall framework to look at reality. Based on the extensive literature review, Requirements Engineering Adaptation and Improvement for Safety and dependability (REAIMS) maturity model is selected to evaluate Ethio Telecom basic RE process. According to Kauppinen & Kujala (2001) and Sommerville & Ransom (2005) researches, REAIMS model is proven to be useful in supporting maturity assessment and in identifying process improvements. In addition, Gorschek & Wohlin (2003) used it for their study to identify RE process improvement issue. From Sommerville's sixty-six RE practice Ahmad et al., (2015) identified twenty-eight high perceived-value RE practices which is applicable in outsourced project and solve outsourcing issues. Therefore, this research uses those twenty-eight high perceived-value RE practices as an input practice in order to prune and develop interview guideline.

However, practice to solve outsourcing issue is not covered in Sommerville's framework (Ahmad et al., 2015). Thus, to address Ethio Telecom RE outsourcing issue the researcher use REP model. As top ten issues are under the first three categories communication, management and coordination, knowledge management and awareness, this study used this three issue category and suggested good practice to overcome the three issue as the framework.

3.4 Research Design

The Main purpose of research design is “to ensure that the evidence obtained enables us to answer the initial question as unambiguously as possible” (“Research Design”, n.d, p. 9). Therefore, it describes potential respondents and how to take sample. Below is the description and justification in the logical structure that the research followed in regarding to sample determination, unit of analysis.

3.4.1 Unit of Analysis

The unit of analysis is the major entity that is analyzed in your study (Trochim, 2006). The unit of analysis defines what a “case” is in a case study. A unit of analysis (case) may be an individual, group, department of an organization, organization and process (Yin, 2009). This research used holistic design since objective of this research is to know Ethio Telecom RE process and identifies improvement areas so that the process can be improved in organization level. Holistic design has been used, if the case study examined only the global nature of an organization, (Yin, 2009). Therefore, the unit of analysis is process improvement at Ethio Telecom information system software project team level and at individual level.

3.4.2 Research Population

The study population is “from whom the required information to find answers to your research questions is obtained” and from this the researcher can select appropriate respondents (Kumar R. , 2011). According to Gorschek & Wohlin (2003), Sommerville & Ransom (2005) and Gorschek et al. (2003) the required information for RE process improvement study is found on experts who fully involve in requirement definition process, “who know the practices used”. Therefore, the study population are those who were responsible in requirement definition phase and used SRS document for the design purpose under four IS TEP_1 programs which are BSS, OSS, MVAS and security. The main reason from selecting TEP_1 software projects for the study is that, most critical and major projects have been conducted under TEP, TEP software process practices can represent whole Ethio Telecom software process effort and TEP_1 was officially closed so that TEP_1 is most appropriate to study organization RE process.

Potential data sources are Quality and Process Officer, Program Manager, IS Project Managers, IT Service Design and FRS team members worked under the four programs. These techniques create the chance to get adequate information from people in various roles and functional hierarchies (Eisenhardt & Graebner, 2007). Though, there was different application projects done on TEP_1 all projects follow the same approach this means the study population have homogenous nature. Based on the data gather from TEP_ project managers, there are 119 potential respondent who were involved in requirement definition process.

3.4.3 Sampling Techniques and Sample Size

For qualitative study purposive sampling techniques is used, which is highly recommended in the case study where only a little is known (Kumar, 2011). As purposive sampling techniques allow researcher to use personal judgement to identify key participants who will provide adequate information to answer research question, thus the qualitative study consist of process and quality officer, program manager, Project Manager, IT Service Design and FRS team members because all this key participant can give detail information about Ethio Telecom software RE process.

Based on the data from project manager, for the qualitative study there are twenty potential data sources and the researcher select only convenient participants. Regarding sample size determination on qualitative study Kumar (2011) noted that "you are guided by your judgement as to who is likely to provide you with the best information" (P.193). In addition, for homogeneous population , sample size can be relatively small (BusinessAdvocacyNetwork , n.d). Therefore, the sample size of semi-structured interview is fourteen.

For quantitative study disproportional stratified sampling techniques is used. Stratified sampling is recommended if the population under study have different attribute or characteristics and to ensure that each sub group in the population have representation on the sample (Saunders, Lewis, & Thornhill, 2009). The whole IS domain software project team members is stratified based on their role on the project so that different perception can be collected. TEP IS domain software project requirement is defined by FRS team and Design team. In addition to participating in requirement definition process design team used FRS to develop design document and prepare test cases. FRS team formulated both by technical persons and system end users. Coordinator are assigned from technical team. Having this context Ethio Telecom software RE process can be

evaluated by FRS team (technical person + system end user), FRS team coordinator, IT Service Design team and project manager. There are five stratums which are project manager, IT Service Design, Technical_FRS team, user_FRS team and FRS team coordinators. The main reason for disproportional sampling is that the knowledge of each participant about requirement definition process is depend on their role on the project l.e Technical_FRS team know more than user_FRS team because Technical_FRS team members are more experienced in requirement definition and have knowhow about requirement engineering practice so that they can easily understand practices.

The actual sample size has been determined from total targeted populations using Yamane formula shown below as this formula assume 95% confidence level which is used often in the research and P = .5 which is maximum variability (Israel, 1992). As study population is somehow homogenous, the formula makes the sample more representative. Thus, sample size (n=70) determined by considering a target population of 105 individual define TEP_1 IS software requirement with 7% confidence interval or level of precision.

$$n = \frac{N}{1+N(e)^2} \qquad (3.4.3.1)$$

Where n is the sample size, N is the population size, and e is the level of precision. Below table shows the sample size under each strata.

	User_FRS Team	**Technical _FRS Team**	**FRS Team Coordinators**	**Design Team**	**Project Manager**	**Total**
Population size	36	46	8	7	8	105
Percentage of the strata from the total target population size	28.6%	40%	11.40%	10%	10%	100%
sample size of the strata	20	28	8	7	7	70

Table 3. 1: Sample size under each strata.

Source: Own survey, 2018

3.5 Methods of Data Collection

Case study relies on multiple sources of evidence, an evident collected form one or more source makes the study exhaustive and complete also it used for triangulation purpose (Yin 2009). This study used multiple data source to answer different research question and to triangulate findings. In addition, Yin (2009) argued that using multiple data source for the study make the study more reliable and exemplary also Harkins & Petty (1987) stated that the research done using multiple sources received greater scrutiny than did the same information presented by a single source. This study used semi-structured and structured interview, document analysis data collection method in order to address research questions.

3.5.1 Interview Design

Researcher with domain experts pruned the identified Sommerville's twenty-eight high perceived-value RE practices which is applicable in outsourced projects (Ahmad et al., 2015) and twenty-five practiceas checklist is selected to guide semi-structured, structured interviews and document analysis. In the same way among thirty-two suggested practice form REP model twelve practiceas is selected to guide data collection. All the interview question is categorized under ten KPA named Requirements Documentation, Requirements Elicitation, Requirement Analysis and Negotiation, Describing Requirements, System Modelling, Requirements Validation, Communication, Knowledge management and awareness and Management and coordination. On top of this there are warm-up question to know the respondent role, experience and others.

3.5.1.1 Semi-structured Interview

For qualitative study, semi-structured interview is adopted for data collection. Semi-structured interview is most common in qualitative and case study research (Runeson & Martin, 2009). Semi-structured interview is useful for acquiring participant's opinions, ideas and experiences. According to Eriksson and Kovalainen (2008), semi-structured interviews are appropriate for answering what and how open-ended questions, which are common in the interview guide. Thus semi-structured interview helps to understand current Ethio Telecom RE process for outsourced project from participant experience. Beside, semi-structured interview "allows depth to be achieved by providing the opportunity on the part of the interviewer to probe and expand the

interviewee's responses" (Rubin & Rubin, 2005: 88). Semi-structured interview allows for the interviewer to have discussion with key participant to identify RE practice which are applicable in Ethio Telecom context.

All the selected practice is converted to semi-structured interview guide. Mostly Interview guide use how and why questions in order to find out what tasks were performed in Ethio Telecom RE process for outsourced projects. Qualitative interview is conducted with FRS and IS design team who was fully participated on requirement definition process. In addition, interview is continued with quality and process officer, program and project managers in order to get insight about RE process strategy and policy in general and RE practice in specific. In the interview detail information is capture on the state of Ethio Telecom RE process and best practice for Ethio Telecom RE process for outsourced project is identified.

Before the qualitative interview conducted, researcher identified willing participant and make them aware of the objective of the study and interview question is send via E-mail so that participant can get a chance to study the framework practice and prepare themselves for the interview. This trend is most common on RE process improvement case studies (Gorschek et al. 2003; Sommerville & Ransom, 2005; Gorschek & Wohlin, 2003).

The interview was conducted with in the span of one month and each interview took between one and half hour to two hours. Interview is conducted on the participant office in order to look evidence from documents and Email conversations. In order to capture full opinion of participant, the interview is conducted by Amharic language. And then the researcher translates it to English and sent it vial Email in order to check whether the researcher capture ideas in the way participant said and to check translation errors. After receiving their feedback and reach on consensus, the data become ready for qualitative analysis.

3.5.1.2 Structured Interview

For quantitative study, structured interview is adopted to collect the data. Structured interview is "used to collect quantifiable data it is also referred to as 'quantitative research interviews'" (Saunders et al., 2009, p. 351). There are some reasons for using structured interview. Firstly, from pilot test the respondents face difficulties to understand practice and they recommend researcher

to interpret each practice. Lastly, Sommerville and Sawyer (1997) who are the developer of REAIMS suggest researcher to conduct structured interview to define current state of the RE process.

This technique gives a chance for interviewer to explain the question to avoid misinterpretation. This trend is followed by most researcher who conduct RE process improvement evaluation study (Gorschek et al., 2003; Sommerville & Ransom, 2005; Gorschek & Wohlin, 2003). All selected practice is converted to structured interview guideline which can be weighted with one of the three scores: Never used (Score = 0), Discretionary—used at the discretion of individuals (Score = 1), Normal—used by many teams but in different ways (Score = 2), Standardized—used throughout the company in a standardized way (Score = 3).

Most interviews were made on-site and this approach brought to collect more evidence. However, this approach may have negative aspects like the researcher may be influence the respondents which may create bias. But by strictly adhering to the pre-planned structure of the interview, the Researcher only arguing when further explanations were necessary and show practice guideline description note for respondents only when there is confusion. The Researcher believe that the risk that bias has occurred is low. Each interview took between 35 to 45 minutes. During the interview researcher surprised by respondents' effort to give evidence by showing documents and explain their working experience.

3.5.1.3 Document Analysis

Using multiple data source for specific issue is used to achieve higher level of validity (Bratthall & Jørgensen, 2002). Usage of multiple data source is not only used to decrease the possibility of missing vital information, acquire different perspective and get more idea but rather to have a confirmation of the identified process by checking against the other data sources (Gorschek & Wohlin, 2003).

In this study, different kind of valuable recorded data is used such as Email conversation between project team to see how project team members classified according to this task, Signoff FRS document, report for program manager and meeting minutes. Practice from those two model is used to guide document analysis. Majorly interview data is taken as the leading data source because the semi-structured interview reflects the view and opinion of respondent about the case.

Document analysis is used for additional information and to cross check whether identified process actually did in the origination or not.

3.5.2 Pilot Test

Checklist used for the case study (structured interview) is validated by pilot test. There are seven respondents purposively selected for pilot test. Pilot test is used to correct poor wording in checklist questions, correct ambiguity and irrelevant items. Thus researcher read each question in English and explain the benefit of each practice guideline and if the respondents require further explanation the researcher explain orally or read the guideline description note. While the feedback is collected, respondents gave score on each practice questions. According to the feedback both structured and semi-structured interview checklist is updated to improve the clarity, minimize data interpretation bias. Moreover, expertise reviewed semi-structured interview guideline and their feedback incorporated before data collection begin. On top of this reliability test was conducted to measure the internal consistency of the checklist questionnaires'. Minimal acceptable alpha value to prove the internal consistency and reliability is 0.7 (Tavakol & Dennick, 2011). The pilot test Cronbach's alpha coefficient value is 0.890 as it can be seen on table 3.2. Therefore, structured interview checklist questionnaires are reliably which can be used for the study or full scale data's.

Cronbach's Alpha	**N of Items**
.890	**37**

Table 3. 2: Reliability Statistics based on the Pilot test data

Source: Own survey, 2018

3.6 Data Analysis

Among different methods that can be used to analyze qualitative data, this study adopts content analysis method. This method is widely used in qualitative study and used to find common patterns across a data set (Braun & Clarke, 2006). Content analysis method is more appropriate for this

study as it preserves better meaning of the qualitative data. The analysis presents the current Ethio Telecom RE process improvement effort and revealed improvement issues.

After the structured interviews, the collected quantitative data is analyzed using SPSS and Microsoft excel. Descriptive statistics methods such as frequency distribution, mean calculation and graphical representations are used to summarize the collected data.

Mean guideline usage is calculated to understand current Etio Telecom RE process state or to analyze the state of thirty-seven RE practices. Also Mean guideline usage is approximated so that it can be laid in one of the four value category of never used (0), Discretionary (1), normal (2) and standard (3) as it is defined by model developer (Sommerville & Ransom, 2005). Meaning of each of value explianed below

0) **Never used:** Practice is not used in the organization

1) **Discretionary**: Practice used at the discretion of individuals for example some project managers may have introduced the practice but it is not widely applied.

2) **Normal:** Practice used by many teams but in different ways or practice is widely used but it is not mandatory.

3) **Standardized**: The practice used throughout the company in a standardized way or practice has a documented standard in the organization and it is checked as part of the quality.

In order to compare KPA by their extent of good practice usage so that to identify weakest RE areas. So actual point of each KPA is calculated by adding the numerical scores of its RE practices and dividing the actual score of the area by its maximum points. REAIMS practice have the maximum of three points (Sommerville & Ransom 2005). To take an example form Requirement Elicitation KPA there are five practice, so its maximum score is fifteen. In order to make the result logical as RE areas have various number of practices, the proportional scores were used. This means practice usage percent is calculated in each RE areas.

However, it is not mean that all practices under relatively weak RE area have low guideline usage value as the areas usage is calculated by the mean of its' guideline practices. Sommerville explained that "REAIMS do not have numerical threshold value to identify weak practices rather he suggested researcher to discuss with organization expertise to identify relatively weak practices which require further improvement based on projects criticality "(personal communication, April

26, 2018). Thus researcher discussed with expert and decide to consider practices which the mean guideline usage value less than 1.5 as relativity weak practice.

Finally, improvement issue gained from qualitative study and relatively weak practice identified from quantitative analysis is triangulated in order to find the final improvement areas.

3.7 Reliability and Validity

The quality on an empirical research including case study, depend on validity, and reliability (Edmonds & Kennedy 2012, cited in Baskarada, 2014, p.9). Generally, to ensure validity and reliability, the interview guidelines used for both structured and semi-structured interview was validated through pilot testing and proofreading by experts on the domain, this help to avoid erroneous formulation and eliminate poor wording in the questions. In addition, it has been used proper sampling techniques, which is purposive sampling so that researcher gains deeper understanding about the case from purposively selected experts. On top of this to ensure internal validity attempt has been made to base all conclusions on the empirical data.

For quantitative study: Mohajan (2017) suggests that for quantitative study reliability tests should be done to evaluate consistence, reputability and stability of a research result. Heale & Twycross (2015) recommend the commonly used cronbach Alpha Coefficient test for quantitative study. The number of questions under each KPA is very few which range from two to five and it is known that low number of question may have a low value of alpha which do not show the correct reliability (Tavakol & Dennick, 2011). Therefore, cronbach Alpha Coefficient was used to measure the reliability in full data sets. The reliability test on the full scale data result 0.856. It revealed internal consistency and reliability of the survey instrument as it is greater than 0.7 which is the minimal acceptable alpha value.

Thatcher (2010) suggests that validity tests should be done to know the extent to which a research instrument (questionnaire) measures what is expected to measure. Creswell (2014) recommend content validity for quantitative study, therefore after the objective of the study explained, questions are given to selected expertise so that they can judge whether the questions are covers all relevant items needed to answer the research question and whether the intended structured

interview guidelines is relevant to the intended research issue. All of the expertise noted it is relevant to the study, as a result based on their feedback structures interview taken as question which can measure what is expected to measure.

For qualitative study: Gibbs (as cited in Creswell, 2014, p.201) suggests that reliability tests should be done to know whether the researcher's approach is consistent across different researchers. The assessment process of this research follows five phases of Sommerville and Sawyer (1997) model and many of researcher in this area follows this approach (Kauppinen & Kujala, 2001; Gorschek & Wohlin, 2003). Other strategy used to achieve reliability is documenting procedures and steps used in the research work (Yin 2009, cited in Creswell, 2014, p.204).

In addition, validity is when a research uses certain procedures to check for the accuracy of the research findings (Gibbs, 2007 cited in Creswell, 2014, p.201). For this regard validity is carried out by triangulation strategy, evident are collected from multiple sources for the same phenomena (Creswell, 2014; Simon, 2011). Thus the study is conducted by using different data sources such as semi-structured interview, structured interview and documents. Information from semi-structured interview is check against structured interview finding and interview result is checked against document evident. In addition, triangulation is used in the study to control bias (Simon , 2011).

Lastly study validity is insured by using expert view strategy, provide expert with some guide to ensure that they critique the important aspect on the study (Creswell, 2014; Simon, 2011). Therefore, this study advice expert to prune best practice lists which was converted for interview question in order to eliminate non applicable practice in Ethio Telecom context on top of this expert judgment techniques used to validate improvement recommendation so that improvement recommendation is checked for its sufficiently accurate for the purpose at hand or whether improvement recommendation fulfils the initial criteria (Beecham et al., 2005). Finally, the researcher update and state appropriate improvement recommendation accordingly to expert judgment.

3.8 Chapter Summery

This chapter has described general approach the researcher taken to conduct the research. In addition, all selected approach is well justified based on previous researches and accepted documents on the subject maters. In general, all the approach is used to make the research more efficient and effective to answer research questions. As the study strategy single case study is followed and a combined qualitative and quantitative research approach is used. In this chapter an outline of combined qualitative and quantitative research approach along with its justification is described. Mainly this approach helps the study to quire both approach strength and overcome one approach weakness by other.

To guide the data collection process REAIMS for basic RE practice and REP model to overcome outsourcing issue is employed. Therefore, semi-structured interviews, structured interview and document analysis is used as a data collection method. This method is employed to answer research question and to make triangulation between different data source in order to make the study more reliable. Regarding data analysis, for qualitative data, qualitative content analysis is selected to be the appropriate technique and for quantitative data descriptive statistic is judged to be appropriate to compare different KPAs and practice so that relatively weak area can be identified. Finally, methods used for ensuring the quality of the study by using validity and reliability test is descried.

CHAPTER FOUR: DATA PRESENTATION, ANALYSIS, FINDINGS AND DISCUSSION

4.1 Overview

The goal of this section is to present the findings from the analysis of qualitative and quantitate case study. Semi-structure interview is conducted with selected experienced individual to understand Ethio Telecom experience on requirement definition process in TEP_1 IS software projects. Accordingly, semi-structured interview is conducted with 14 individuals from different roles. Semi-structured interview result and document study evidence are used to analyze the state of the RE practices so that improvement issues can be identified. In order to cover the identities of interviewees, analysis will be presented by replacing interviewees name by their role along with ID number.

Role	Pseudonyms	Number of Participants
FRS Team	FRS Team_1	4
	FRS Team_2	
	FRS Team_3	
	FRS Team_4	
Design team	Design Team_1	3
	Design Team_2	
	Design Team_3	
Project Manager	Project Manager_1	5
	Project Manager_2	
	Project Manager_3	
	Project Manager_4	
	Project Manager_5	
Program Manager	Program Manager _1	1
Quality and Process officer	Quality and Process officer_1	1

Table 4. 1: Interviewees for qualitative study

Structure interview is conducted with experienced individual to understand state of Ethio Telecom RE process for outsourced projects. Accordingly, structured interview is conducted with 70

individuals for different roles. Data from structured interview is used to analyze the state of the RE practices so that improvement areas can be identified.

The case study analysis is organized using the research question of the study. As indicated in chapter three, qualitative analysis result is the primary finding to research question one as this question require further discussion with expertise and evidence. The research question two is answered by quantitative analysis result only as this question require mathematical calculation to compare the status RE areas. The analysis is organized under ten KPAs so that reader can easily visualize how requirements are elicited, analyzed, validated and managed in the organization.

4.2 Characteristics of the respondents

This section illustrates the demographic or background of the respondents which have some implication about their experience on requirement engineering process.

4.2.1 Distribution of respondents by job role on TEP_1 software project

The distribution of the respondents with respect to their role on TEP_1 software project is depicted in Figure 4.1. FRS team members, who were the main responsible to define the requirement covers 68.6% of the sample size. This indicate most of the respondents are FRS team members. FRS coordinators who coordinate FRS team members cover 11.4% of the sample size. Both Design team and project managers constitute 10% as the population of design team members and project managers are very few as compare to other roles. Generally, form this category all kind of information can be gathered.

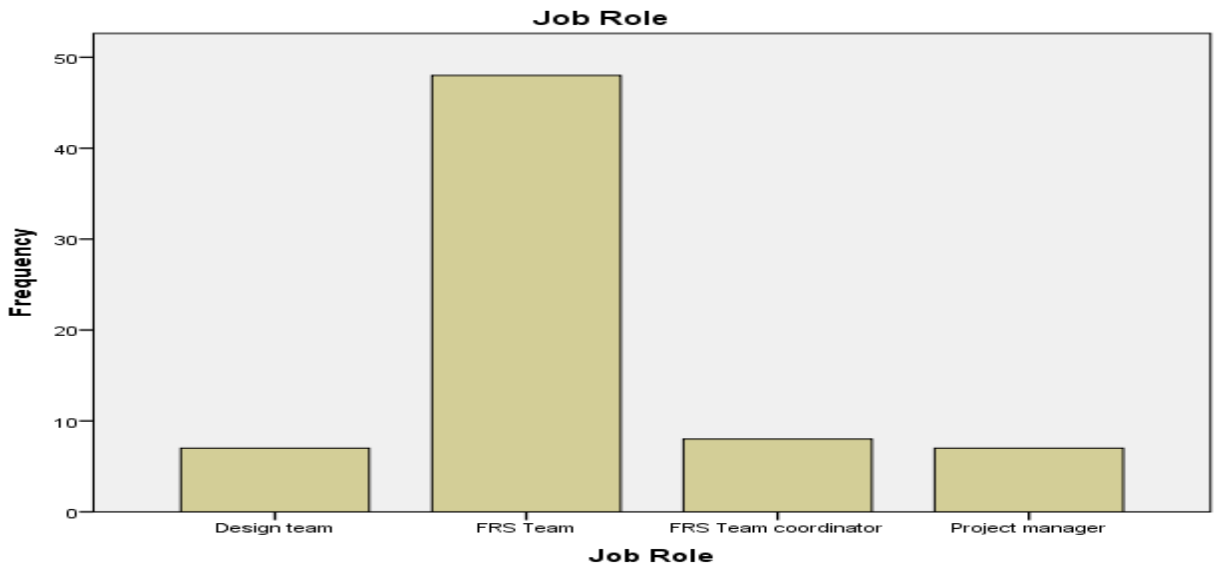

Figure 4. 1: Job role on TEP_1 software project of the respondents (Source: Own Study, 2018)

4.2.2 Distribution of respondents by TEP_1 software project programs

The distribution of the respondents with respect to their involvement on the four TEP_1 software project programs is depicted in Figure 4.2. Respondents from BSS program covers almost half of the sample size (47.1%) as BSS program contain a lot of projects as compare to other programs. Respondents from OSS, MVAS and Security program accounts 25.5%,15.7%,11.4% of the sample respectively.

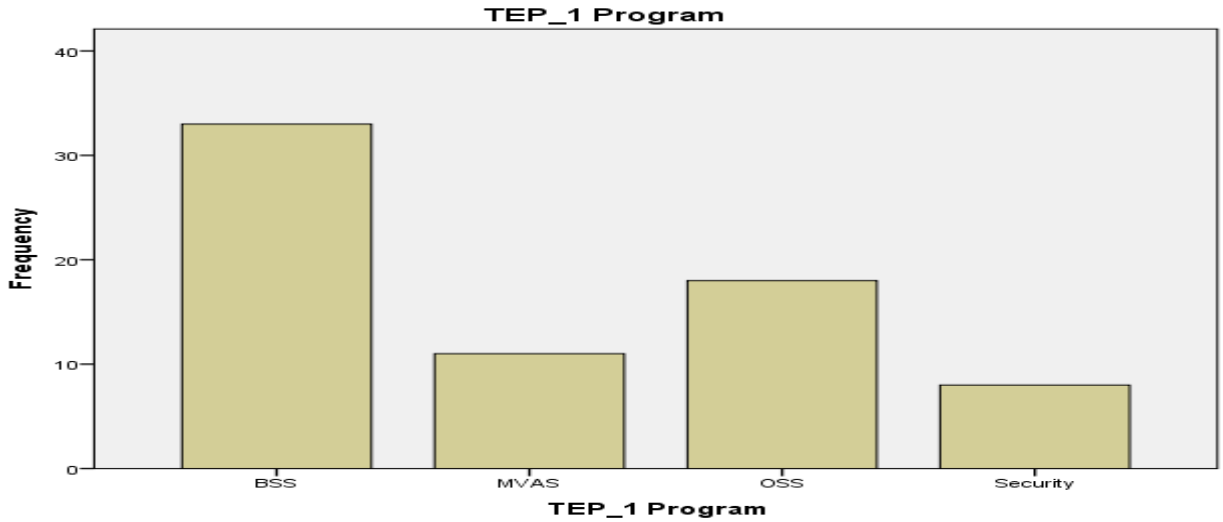

Figure 4. 2: Distribution of interviewees by TEP_1 software project programs (Source: Own Study, 2018)

4.2.3 Distribution of respondents by the membership duties

The distribution of the respondents with respect to their membership duties in TEP_1 software project is depicted in Figure 4.3. This question used to show respondents responsibility while requirement definition process. For this research technical team members are much important than user since technical team members are more familiar and were responsible to RE process. Thus 70% of the sample is covered by technical team members and the remaining is users who join FRS team just to explain their requirement, they were not responsible for technical issues.

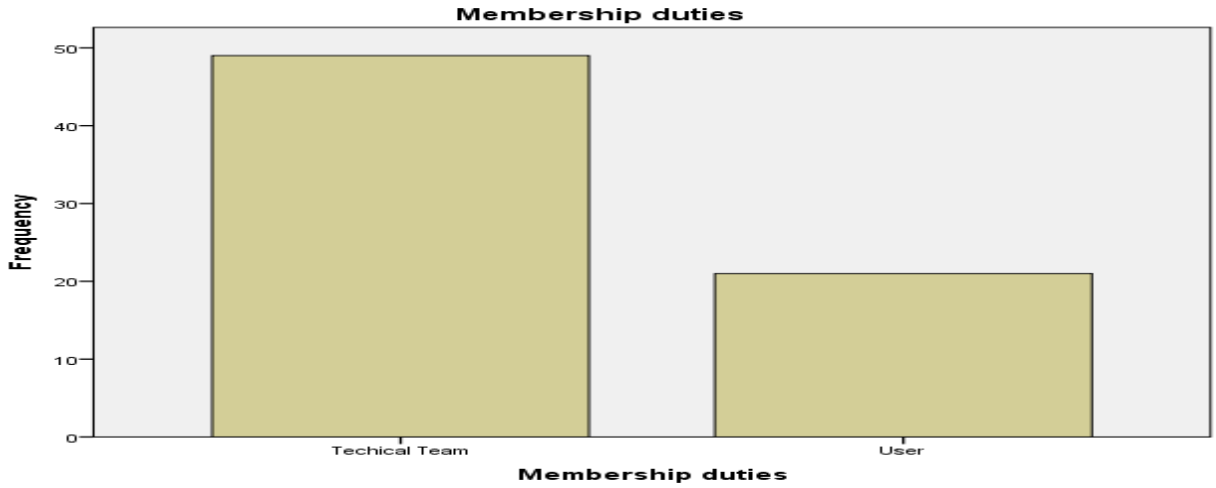

Figure 4. 3: Distribution of interviewees by the membership duties

(Source: Own Study, 2018)

4.2.4 Distribution of respondents by seniority/ Service year in IS software projects

The distribution of the respondents with respect to their seniority/ service year in IS software projects is depicted in Figure 4.4. This question used to show respondents seniority and experience in Ethio Telecom software project process in the company. 40% of the respondents are experienced between 2-5 service years in Ethio Telecom IS software project. 31.4% of the respondents are experienced between 6-10 service years. 25.7% of the respondents have less than two years experienced b and only 2 % of the respondents are experienced between 11-15. more than 70% of the respondents are experienced between 2-10 years. This indicate most of the respondents are well experienced in Ethio Telecom software projects including requirement definition process.

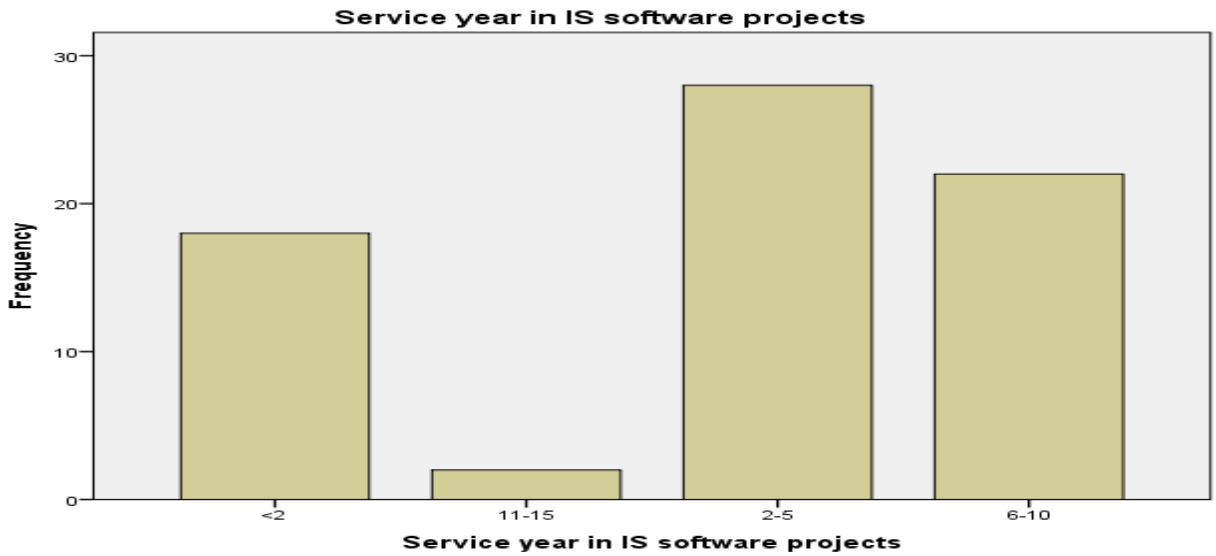

Figure 4. **4**: Experience of the respondents working in IS software projects
(Source: Own Study, 2018)

4.2.5 Distribution of respondents by seniority/service year in Ethio Telecom

The distribution of the respondents with respect to their seniority/ service year in Ethio Telecom is depicted in Figure 4.5. This question used to show interviewees seniority and experience in Ethio Telecom to know their overall experience for the company culture regarding the systems they have used. 64.3 % of the respondents have experience between 6-10 years. 24.3 % of the participant have experience between 11-15 years. 7.1 % of the participant have experience are greater than 15 years and 4.3% of the participant have experience between 2-5 years. This distribution indicates most of the participate are well experienced in the company, thus 88.6 % of the patricians have experience between 6-15 years.

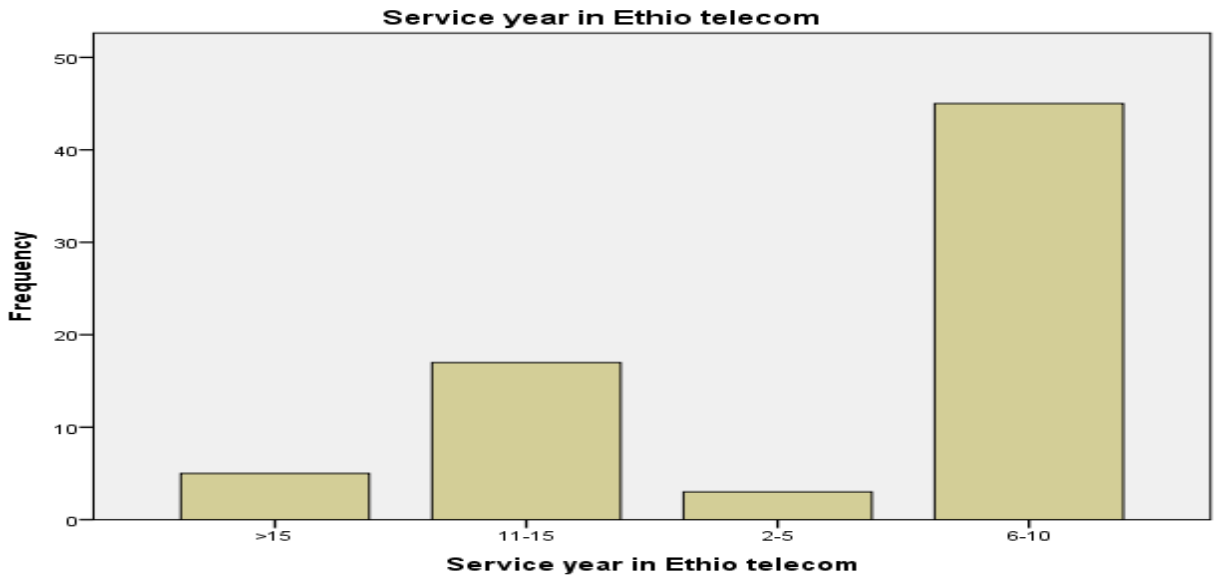

Figure 4. 5: Experience of the respondents working in Ethio Telecom
(Source: Own Study, 2018)

4.3 The current state of Ethio Telecom RE process and the identified applicable RE practice

Research question one: What is the current state of Ethio Telecom RE process for outsourced projects?

Requirement Documentation

State of practice: "Define and follow standard document structure"

From the interpretation of collected data's all TEP_1 software projects were outsourced because of this requirement is defined twice. The prior one is called RFP where the major system features or requirements described for the contract. The second is detail functionality and non-functionality requirement. Because of this RFP and detail requirement have their own document structure. All of the respondent reply that even if there is no well-known standard structured, the company defined and use their own requirement document structure.

RFP document structure is defined by France(Safaricom) consultant and ET RFP preparation team by customizing other known RFP document structures. Program manager argued that: "*In the time when TEP_1 initiated ET was under France telecom management so that RFP document structure is defined by France consultant by considering RFP document structures from other ISP*." For detail requirement document structure, most of the respondent commented that: Vender bring their own document structure standard and ET FRS and design team give comment to include missed structures and to make it applicable for ET TEP software project context.

For this regard project manager 5 argued that "*Vender come up with their standard document structure and the structure is customized to be applicable for Ethio Telecom context in general and in specific for each projects."*

From document analysis the researcher observed that, there is a defined document structure but some FRS documents do not strictly follow the defined structure because of this some of description are missed.

State of practice: "how to use the document"

Almost all respondent explained that introduction is the first chapter of requirement document. on this chapter most of scribers give highlight for the purpose of system. In addition, there are few requirement documents which include intended audience or different types of readers who are most likely require the document for further task. Design team_1 commented: "*sometimes intended audience are listed in the introduction part based on their job for example this document is intended for information architect, tester and customer service.*"

However, there is no "how to use the document" section in the introduction part to describe technical background needed to understand parts and to guide different class of readers easily identify their most appropriate sections or find specific requirement which interest them. In line with this project manager_5 commented:" *in the introduction part there is no section to explain how to use the document that means all readers have to read whole document or refer table off content to identify which part interest them."*

Requirement Elicitation

State of practice: "Assess system feasibility"

All respondents commented, TEP is expansion program where the direction is given for IS TEP program manager to expand software application to achieve Ethio Telecom five-year business strategy. To achieve the goal TEP_1 software projects ware placed. Even if there is no clearly defined feasibility study phase having this direction in hand, RFP preparation team with Safaricom consultant perform feature level study. All in all, from the collected evidence it can be generalized that even if lower level or functionality level feasibility study is not that much satisfactory there was high level feasibility study. project manager_3 commented:

> "*As far as I saw there is no clearly defined feasibility study stage in TEP_1. For IS software projects RFP preparation team study existing system feature and check what feature is missed, what features are available in existing technology. By this the team make higher or feature level feasibility study."*

All of the respondent agreed that stakeholder's participation was not enough for TEP_1 RFP preparation, because of this a lot of system feature was missed. On top of this, some non-required system features ware incorporated in RFP as consultant's advice those features were well known on other worldwide ISP. In line with it, project Manager_2 commented: "*In the beginning Safaricom consultant and ET RFP preparation team study current business need and include system feature in which one ISP must have it."*

Once the vender selected, vender BA present different requirement which are under scope of work. Then ET FRS and design team members discussed to add missed requirements in studying the functionality feasibility in terms of cost, the benefit will gain and function applicability in existing technology with vender BA. Even if it is not common practice to remove unrequested requirement which already provided by vender, few individuals filter out non_required functionalities. But mostly as user cannot identify what specific function they actually require, there are a lot of feature and functionality developed and which are not used after implementation. Design team_2 said that:

> "*Lower level feasibility study is not performed because FRS team do not exactly know which function is required for the system while requirement elicitation phase."*

State of practice: "Use business concerns to drive requirements elicitation"

According to interview evidence most of respondent agreed that even if most of requirement derived from higher level business concern or objective, not all requirement drive from lower lever business need as TEP_1 projects started from the direction given by higher management and end user are not that much communicated to include their business concern while RFP peroration. RFP preparation team plan to include existing technology features, but this feature may not be used by users after implementation. In line with this project manager_2 commented*:*

> *" RFP is prepared from higher level business need but it is not fully derived from lower level business need as TEP project are expansion direction from higher management*."

Even if, system end user stakeholders become part of FRS team there were some functionality not derived from lower level business concern. FRS Team_4 commented:
" In FRS preparation business concerns is not fully followed to drive detail functionality requirement rather vender explained the futures come up with the system and FRS team may request additional requirement if it is not included in the vender solution. However, unrequired requirement may not be discussed to be removed."

State of practice: "Records requirements rationale"

In interpreting the empirical data, though end user explains their challenges and provide possible requirement, rationale is not documented. In line with this design team_1 commented: *"Even though, there is no formal record of the rationale for requirement and no record to associate requirement to the rationale for tractability purpose, while in the discussion user present their challenge and then requirement team propose different requirement to solve the problem."* However, from document analysis the research saw excel documents for few projects which log the division which bring the requirement along with the challenge system end user faced.

State of practice: "Use scenarios to elicit requirements"

In interpreting the empirical data, all of the participants noted scenario is used to elicit the requirement. In general, there are two situations where scenarios ware used. FRS team_3 stated:

"vender *BA will show demonstration videos or prototype of the system so that system end users understand flow of events. Or if the required function exists in the legacy system, end user simulate how they interact with the system"*

State of practice: "Define operational processes"

In interpreting the empirical data, all of interviewee agreed that for TEP_1 higher level Business process is defined before requirement definition process by non-project team members.
Manager_2 commented that business process is defined following to the best telecom companies' practices*" business process is defined using ETOM (*(Enhanced Telecom Operations Map) *standard because Ethio Telecom* develop system based TAM (Telecom Application Map) functionality standard which follow ETOM business process".
In addition, design team_3 explain how and when business process or rule is defined.
"business process or rule is defined when two or more systems interacted each other and mostly it is described in flow chart. The business process commonly defined to indicate responsible body in the process like actors who perform the activity, action and workflow how work will move with consecutive activities."

Requirement Analysis and Negotiation

State of practice: "Define system boundaries"

In interpreting the empirical data, all interviewee agreed the scope of work document is developed after RFP and before FRS and non-functionality requirement specification document prepared. Initial system scope is defined in statement of compliant (SOC) document which contain ET requirement on RFP and vendor feedback as remark. so while analysis stage boundary is defined in a way it is to be under previously defined scope of work document.Each requirement in SOC have mandatory and weighted status. The boundary definition process is based on the requirement status. In this regard manager_5 commented:" *if the requirement has mandatory status scope cannot be changed so that it is a must for a vender to provide the solution. but* for the requirement having weighted status *FRS team and vender will negotiate to define scope* "For an evidence the researcher saw how the system boundary is dined in SOC documented.

State of practice: "Use checklists for requirements analysis"

In interpreting the empirical data, Even if all interview agrees on the importance of this practice, almost all of them commented there is no checklist questionaries' as an organization level for analysis purpose. But ET FRS and design team try to discover problem by reading the whole requirement and comment their feedback to team so that identified problem can be corrected accordingly.

On this regard design team _1 sated:*" There is no checklist for analysis, FRS and design team just check whether all function item discussed are included in the requirement specification document or not.* "

State of practice: "Prioritize requirements"

In interpreting the empirical data, all of interviewees commented that function or module which is mandatory for core business have got first priority for implementation. For example, Basic service like voice and data service got first priority over fix line requirements for implementation and release in phase. FRS team_2 commented points considered to prioritize requirements:

> *"Requirement is prioritized for implementation based on business need, to solve critical existing problems, to generate highly revenue."*

Describing Requirements

State of practice: "Define and use standard templates for requirements description"

In interpreting the empirical data, mostly vender present initial requirement with their own template and then FRS and design team give a comment on the template to decide how to write each requirement, thus the vender developed agreed standard template for the project.

In this regard FRS team_2 stated:" *Requirement is described on standard template which is customized by FRS and design teams with vender. For example, mostly graphical user interface description, input output parameters, notification and restriction are defined to be write in the table format and business rule is commonly defined to be write in description format."* for an evidence research saw E-mail conversion between FRS team and vender so that ET FRS team list out the required contents along with the format under each defined structure.

State of practice: "Use simple, consistent and concise language to describe requirements "

In interpreting the empirical data, English is used for describing requirement, which is the second language for both ET and vender, thus describing the requirement in simple, consistent and concise manner depends on individual English writing skill.

Again design team_1 noted specifically that requirement description have problem of simplicity and consistency: "*Somehow technical terms used which crate difficulties for tester and system end user to understand simply. In addition, occasionally different words are used to represent same meaning. However, it is concise requirement explained in short."* From document analysis the researcher finds few FRS documents which are not simple to understand because of poor sentence construction.

State of practice: "Supplement natural language with other descriptions of requirements where appropriate "

In interpreting the empirical data, generally, using additional natation is not that much well matured practice in TEP_1 software projects, but sometime when the requirement is considering to be vague, scriber put additional explanation using scenario, interface design screen shoot and mathematical equation.

In line with this design team_2 commented:*" When the requirement is not easily understandable and when requirement require many sentence for description, different graphical images and sequential steps and Data-flow diagrams used to describe requirement so that requirement can be described in concise manner."*

State of practice: "Specify requirements quantitatively where appropriate "

In interpreting the empirical data, interviewees commented that, though there is no perfection, most of requirements which require to be specified quantitatively specified quantitatively. On this regard FRS team_3 commented:

" Most of the time nonfunctional and functional requirement which require to be specified quantitatively, specified quantitatively. However, there is some requirement which written in general word" From researcher document analysis, function and non-functional requirement is

described in different document and non-function requirement document is reach in quantitative information.

System modeling

State of practice: "Develop complementary system models "

All of the interviewee agreed that developing several system models to illustrate different aspects of the system specification is important practice. However, as few interview stated occasionally several system model is developed for main functions which have to be implemented in different way. in this regard design team_2 commented:

" When the requirement have many interactions to other system or functions, several system models is developed. For example, data type and number of attribute is defined which may be moved between systems. Mostly sequence diagram and use case and SID (shared information data model) is used.". From researcher document analysis though for appropriate function one model is developed, complementary system model is developed for few functions.

State of practice: "Model the system's environment "

In interpreting the empirical data, commonly in formal block diagram is used to model the system environment. main component is illustrated by box and relationship between system is illustrated by line linking. In addition, sequence diagram is developed to show external system with detail data flow sequences. In line with this design team_3 commented:

"If the function requires two or more systems integration in order to operate, external systems are modeled using SID standard which come from TAM forum." From researcher document analysis most of requirement document is reach in modeling the system environment by using sequence diagram.

State of practice: "Document the association between stakeholder requirements and system models "

In interpreting the empirical data, as most of the interviewees explained there is less trend to document the association between stakeholder requirements and system models. But some of the interviewees commented even if this there is no formal association documentation, when

requirement is described in textual format the model is place under that requirement so that it can associate requirement with model. In this regard design team_1 stated:

" Similar functions are combined as a module and model is developed for a module, this means association between module and model is documented in requirement document. In addition, if the model is use case diagram, in the table description the functions which constitute the module is listed."

From researcher discussion with interview, researcher realized the main problem on this traceability issue is that requirement is defined by requirement team and system model is developed by design team. If there is communication gap between the teams specially when there is change after requirement sign off, this change will not be communicated to design team as requirement team may not have the association document which indicate which requirement have a model.

Requirements Validation

State of practice: "Check that the requirements document meets your standard and Organize requirements inspection "

In interpreting the empirical data, except document structure standard, there is no other defined standard for requirements contents. In addition, the requirement is not validated by external person who is familiar with requirement standards but not participated in the system requirements specification process. Generally, document structure standard is validated by FRS and design team members. Manger_5 commented:" *the defined Standard document structure and template is used to check content omission*."

However, requirement description is validated by FRS and design team themselves so that team check the requirements for omissions, conflicts, inconsistency and ambiguities. FRS team themselves interactively check that the requirement document map with RFP and TAM functionalities. Design team_3 commented: *"There is no external person who validate requirement by using defined standard, however FRS and design team themselves validate their work by checking that all requirement mentioned in discussion and negotiation period are updated or included in the requirement document."*

Regarding to the suggested practice to organize requirements inspection group, which is chaired by person not involved in requirement definition session. This group aims to discuss problems on requirements with requirement team representatives and to fix it. But one interviewee design team_1 commented that the implementation of this practice will be challenging.

" *This practice is not applicable to ET, since TEP project are big in size it is challenging."* Even if, all of the project management convinced on the importance of the practice, for TEP_1 software projects there was no organized inspection group for validation purpose

State of practice: "Propose requirements test cases "

In interpreting the empirical data, in TEP_1 software project, test case is not proposed to validate the requirement.

In line with this Manager_5 commented:*" mostly test case not prepared for validation purpose however, there are few FRS documents include implementation flow of a function in step by step."*

Though, there are few interviewees commented that this practice is not applicable for TEP_1 software project context. On this regard Manager_1: *"It is not applicable for outsourced projects, since test procedure is defined based on interface design and requirement team cannot know it in requirement definition phase."*

Requirement Management

State of practice: "Define policies for requirements management "

In interpreting the empirical data, as most of the interviewees explained there is higher level police stated in project charter regarding who is responsible for a change management and overall project management activities. In this regard project manager_2 commented:

" *Higher level police is placed in project charter mean what to do is mentioned but how to implement the police is not defined for example project manager have responsibility to manage the change but it is not clearly stated how change is managed. This charter is communicated to project manager and higher level."*

Interviewees also commented that there are higher level change control police which define request for a change template so that user submit their requirement change proposals. However, there is

no formally defined police about change request process, but there is common trend almost all of stakeholder follow.

All in all, project charter defined higher level responsibility and not defined detail police for requirement management."

State of practice: "Define requirements traceability policies and Maintain traceability manual "

In interpreting the empirical data, all of the interviewees sated there is no defined requirements traceability policies also there is no traceability manual. Some of the interviewees commented even if, there is no defined police, some requirement traceability information is recorded in few projects. In line with this project manager _1 noted: *"In the beginning of requirement definition some of FRS teams record requirement with its rationale and source."*

State of practice: "Identify global system requirements "

In interpreting the empirical data, while requirement discussion and analysis session, global requirement is identified by personal judgment and experience on the system. In line with this project manager_2 commented:" *Global or common requirements for a system is identified by vender business analyst and ET design team.*" Form document analysis researcher saw separate excel documents which category requirement as submodule and global.

State of practice: "Identify volatile requirements"

In interpreting the empirical data, most of the interview there is less trend to identify volatile requirement in line with this project manager _5 commented "*when new requirement is raised, unless it is planned to be implanted in configuration base, it is considered as stable requirement. But if there is a change, it will be changed. we do not predict the requirement to be changed."*

Communication Issue

State of practice: "Deciding and using a standard language for communication"

In interpreting the empirical data, Interviewees argued that it is must to use other standard language. In this regard FRS team _4 stated:

” *English is used as a communication media between vender and Ethio Telecom but while in the meeting ET FRS team and other ET stakeholders use Amharic which then be translated for a vender in English.”*

State of practice: “Trying to find natural overlapping of working hours”

In interpreting the information TEP_1 project was high importance for the company, as much as possible vender is requested to place all their system stakeholders in ET working office.

However, in some projects there were few vender stakeholders who can not avail themselves in the physical meeting place. In this case vender business analyst coordinator is responsible to arrange meeting time with ET by setting mutual convenient time in considering various stakeholders that are scattered across different countries and times zones. In line with this project manger_3 stated:” ET *and Vender coordinators make a common plan on mutual convenient hour and vender coordinator are responsible to consider their research and development(R&D) working hour to contact developer if needed.”*

State of practice: “Facilitating direct communication among the stakeholders”

All of the interviewees commented, As TEP project is the first priority for the company as much as possible relevant stakeholders are directly communicated to explain their requirement and also stakeholder representatives permanently included in the FRS team. However, sometimes stakeholder representative many not have the requirement knowledge about the system. In this regard FRS_4 commented:

” If there is any issue which need further explanation, FRS team will invite end user to attend the meeting and explain their need and rationale.”

State of practice: “Reaching written and properly documented agreements”

Generally, Interviewees commented that all agreed functional and nonfunctional requirement is put in requirement specification document and team will sign on it. In addition, critical agreement and commitment given on the meeting is documented. In line with this FRS team_4 commented:

” *Most important agreement and task assignment is communicating for those who participate in the discussion and all concerned body in a meeting minuet via Email as for Ethio Telecom Email*

conversation is official evidence." Escalated requirement is also properly documented. In this regard project manager_1 commented:

" When there is conflict between FRS team and vender requirement analyst, the issue is escalated to both parties' higher management. After reaching in consensus the agreement document is included in sign off requirement document as an appendix."

Knowledge management and awareness issue

In this area one interviewees suggest ET must have knowledge base system which will collect requirement in different version.

State of practice: "Keeping experienced practitioners in team and those practitioners should bridge the awareness gap"

As most of the interviewees commented as much as possible experienced are kept in the group. Regarding requirement team organization, design team_1 commented: *"mostly experienced are kept in the team to share their knowledge to others. However, since there is no written policy or procedure to guide how team is formulated, sometime unexperienced person who don't fit the task are assigned."*

State of practice: "prioritizing stakeholders based on business goal"

In interpreting the empirical data, most of the interviewees commented stakeholders who come up with requirement which is critical to the business acquire higher priority. In line with this FRS team_2 commented: *"Stakeholders requirement is prioritized based on its importance to solve existing problem.*"

State of practice: "Inform the relevant stakeholder about the requirements change"

While FRS preparation stakeholder was participated, by this the change will be approved by them. But there are some internal changes which does not affect stakeholders. In line with this design team _3 commented:" *If the requirement changes impact stakeholders, as much as possible the change will be communicated, rather if the change is on the back in which the effect is not visible to stakeholders, they may not be informed."*

Management and coordination issues

State of practice: "Having clearly defined and agreed responsibilities for each individual and group"

As a group there is clearly defined responsibility on the charter. but design team _3 commented system end users do not have defined individual responsibility:" *Though, there is no clearly defined and agreed responsibility for system end user representatives, they are expected to attend meeting and explain their requirement and validate it*. For an evident researcher sawed letter send to project managers which indicate their new TEP position and read the actually responsibility on for each position but there is no written responsibility for system end user who participate in the project.

State of practice: "Establishing authoritative leadership at the level of project managers and team heads"

As all of the interviewees commented FRS Teams and projects was led by authoritative persons this means FRS Team is led by FRS team coordinator and in general projects are led by project manager.

State of practice: "Having clearly delineated and comprehended requirements engineering processes and Providing training potential team members for using appropriate processes, and supporting tools and technologies"

Almost all of the interviewees commented there in the company level RE process is not documented. In this regard design team _2 commentated: "*RE process is not documented, but requirement team use their previous experience to define requirement and include all requirements form existing system.*" design team_3 stated commonly used process:

Even if, training is not provided for using appropriate processes, and supporting tools and technologies, all of the interviewees commented training on different RE process and tools will support their job and improve requirement specification document quality.

State of practice: "Identifying all the stakeholders and considering their needs"

All of the interviewees stated even if it is not perfectly coved, most of stakeholders are identified and their need is considered.

For some of projects existing business process is referred to identify stakeholders but mostly from experience in the company project team know system end users and identify them easily. Project Manager_1 stated who is responsible to identify system stakeholders:

" Stakeholders from IS division is identified by TEP project office as a project time, however for business unit stakeholder's business unit higher management is responsible to send their experienced representative."

Even if, Ethio Telecom do not follow a single known RE process model, from qualitative study it is identified that Ethio Telecom follow a combination of Iterative and spiral RE process model. Initially requirement document structure is defined. Each spiral has basically five sections which are requirements elicitation, requirements analysis & negotiation, describing requirements or specification, system modeling and requirements validations. User knowledge and user need is used to elicit requirement.

To generalize, the current ET RE process has two phase as requirement are defined in two separate phase. First RFP prepared for the contract and then detail SRS document is prepared to be used for the remaining software development process. Below is the flow diagram of the RE process on each phase including process description.

RE process for RFP preparation

1. RFP predation team drive higher level business requirement from business concern
2. Access system feasibility to check that the technology and feature feasibility
3. Confirm if requirements are feasible. If it is not feasible, go to step 4.
4. Reject requirement
5. If confirmed, define standard template and document structure
6. Discover detail requirement form relevant stakeholders
7. Classify requirement as major and weighted
8. Describe final requirement on request for proposal document

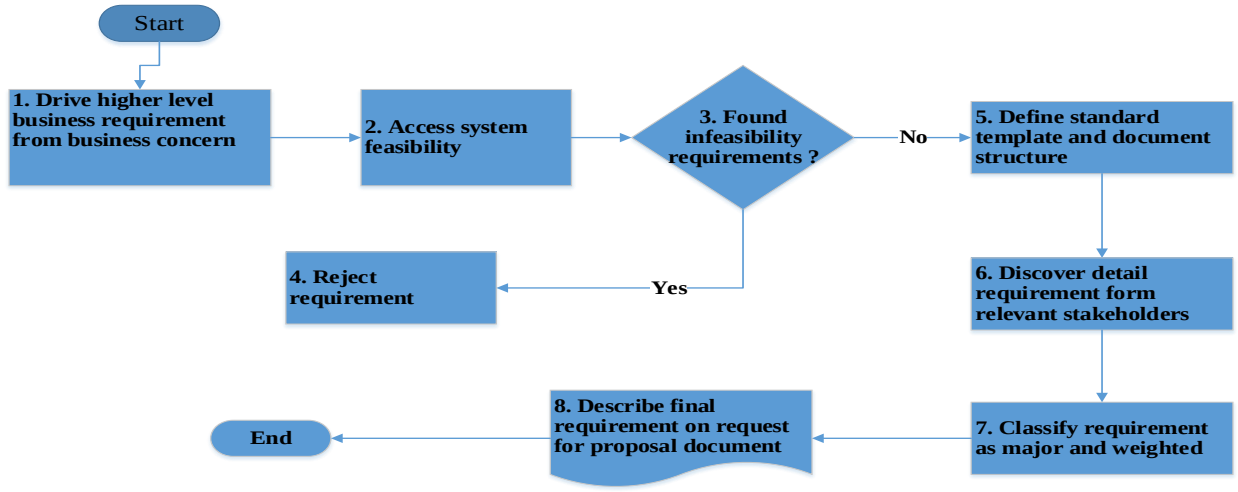

Figure 4. 6 RE Process for RFP preparation

RE process for SRS document preparation

1. Define higher level project management police
2. Select relevant stakeholders
3. Define responsibility for project managers and project team members
4. Formulate requirement team and assign team coordinator and project manger
5. Define scope of work document
6. Define standard template and document structure
7. Set mutual convenient time between both parties for meeting or workshop
8. Vender present initial requirement to ET FRS and design team
9. ET FRS and design team give feedback and use scenario to explain requirements
10. Confirm if all of the stakeholders agree on requirement. If there is disagreement go through the process from step 16

11. If confirmed, check if Further explanation required, if further explanation required, 12. check whether business process defined or not. If business process defined,

15. Refer it to understand the business.

13.If not business process is not defined, define process for the project and go to step 14

14. if further explanation required, Define functionality level boundary

16.Escalate to both parties' higher management

17.higher management Make decision

18.decision give to requirement team

19. Prioritize requirement for implementation and release in phase

20. Coordinators write discussion feedback on initial requirement and send it to vender business analysis

21. Vender business analysis supplement natural language with other notation

22. Vender business analysis update the document and send to the client for confirmation

23. Confirm if comments properly incorporated in the requirement document, if confirmed go to step 24. If not go through the process from step 9

24. Requirement validated by all stakeholders

25. If confirm if found error in validation process, if error found, go through the process from step 9, if not go to step 26.

26. ET Design team develop model for main function

27. ET Design team develop model for system environment

28. Final requirement specification document prepared

29. perform final validation

30 confirm if error found to. if error found, go through the process from step 9, if not go to step 31.

31. Responsible body sign on final SRS document

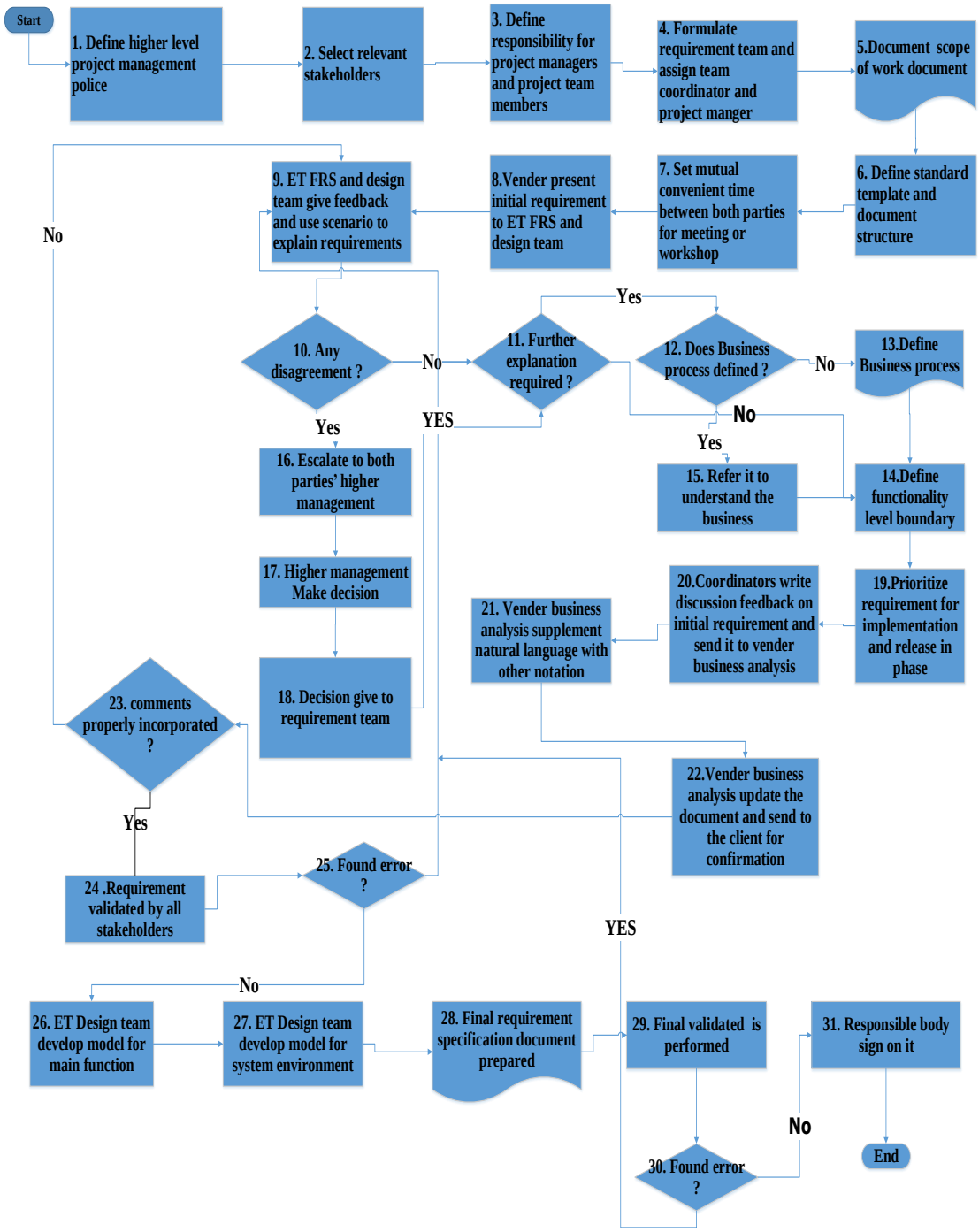

Figure 4. 7 RE process for SRS document preparation

Table 4.2 show the report of the quantitative assessment result of the thirty-seven practices under ten KPA. In this table state of the each RE practices are presented from the data gathered on the structured interview. First column is KPA's, second column is name of each practices, third column is mean usage of the practice from all respondents and the last column is the approximation of the mean usage so that it can be laid in one of the four value category of never used (0), Discretionary (1), normal (2) and standard (3).

KPA	Practices	Mean Guideline Usage	Guideline Usage By Approximation
RD	RD1B	2.43	2
	RD2B	0.66	1
RE	RE1B	2.06	2
	RE2B	2.13	2
	RE3I	1.41	1
	RE4I	1.97	2
	RE5I	2.09	2
RAN	RAN1B	2.47	2
	RAN2Bor I	1.06	1
	RAN3	2.53	3
DR	RP1B	2.49	2
	RP2B	1.96	2
	RP3	1.59	2
	RP4I or A	2.13	2
SM	SM1B	1.43	1
	SM2B	2.17	2
	SM3I	1.47	1
RV	RV1B	0.61	1
	RV2B	0.39	0
	RV3I	0.49	0
RM	RM1B	1.26	1
	RM2B or I	0.53	1
	RM3B	0.29	0
	RM4I	1.39	1
	RM5A	0.77	1
CP	CP1	2.79	3

	CP2	2.31	2
	CP3	2.27	2
	CP4	2.4	2
KMA	KMA1	1.87	2
	KMA2	2.04	2
	KMA3	2.03	2
MCP	MCP1	1.57	2
	MCP2	2.67	3
	MCP3	0.96	1
	MCP4	0.46	0
	MCP5	2.16	2

Table 4. 2: current state of ET RE process

(Source: Own Study, 2018)

The below paragraphs gives explanation about the current state of RE practices under each RE KPA. It helps to judge which practices are in used and to what extent, and to identify most critical improvement practices.

In requirement documentation area the guidelines level of usage report: as it is depicted in table 4.2 using the approximation value this KPA has one normal practice guidelines which used in many teams but in different ways and the reaming is used by individual based by their experience.

In Requirement Elicitation area the guidelines level of usage report: as it is depicted in table 4.2 using the approximation value this KPA has four normal good practice guidelines used in many teams but in different ways and the reaming is used by individual based by their experience.

In Requirement Analysis and Negotiation area the guidelines level of usage report: as it is depicted in table 4.2 using the approximation value this KPA has standardized the use of one good practice guidelines, one of them used in many teams but in different ways, the remaining is used by individual based by their experience.

In Describing Requirement area, the guidelines level of usage report: as it is depicted in table 4.2 using the approximation value all practice in this KPA are normal which is used in many teams but in different ways.

In System Modeling area the guidelines level of usage report: as it is depicted in table 4.2 using the approximation value this KPA has one normal good practice guidelines used in many teams but in different ways and the reaming two are used by individual based by their experience.

In Requirement Validation area the guidelines level of usage report: as it is depicted in table 4.2 using the approximation value this KPA has one good practice guidelines used by individual based by their experience and the reaming two guidelines almost are not used in the organization.

In Requirement Management area the guidelines level of usage report: as it is depicted in table 4.2 using the approximation value this KPA has four good practice guidelines used by individual based by their experience and the reaming one guidelines almost are not used in the organization.

In Communication area the guidelines level of usage report: as it is depicted in table 4.2 using the approximation value this KPA has standardized the use of one good practice guidelines, the remaining three of them used in many teams but in different ways.

In Knowledge Management and Awareness area the guidelines level of usage report: as it is depicted in table 4.2 using the approximation value all practice in this KPA are normal which is used in many teams but in different ways.

In Management and Coordination area the guidelines level of usage report: as it is depicted in table 4.2 using the approximation value this KPA has standardized the use of one good practice guidelines, two of them used in many teams but in different ways, one of it is used by individual based by their experience and there is one good practice guidelines almost not used in the organization.

Figure 4.8 show the report of all KPAs guidelines level of usage. State of each RE areas is calculated by making the average of each practice Mean Guideline Usage. As it is depicted in below figure three KPA's named RAN, DR, CP are normalized which used by many teams but in different ways. RE (1.93) and KMA (1.98) are almost closer to normal guidelines level of usage. RE areas RD, SM and MC are little bit pass 1.5 level of usage. RM (0.8) and RV (0.5) are the lest areas by usage of practice guidelines and this area require more attention in the improvement plan.

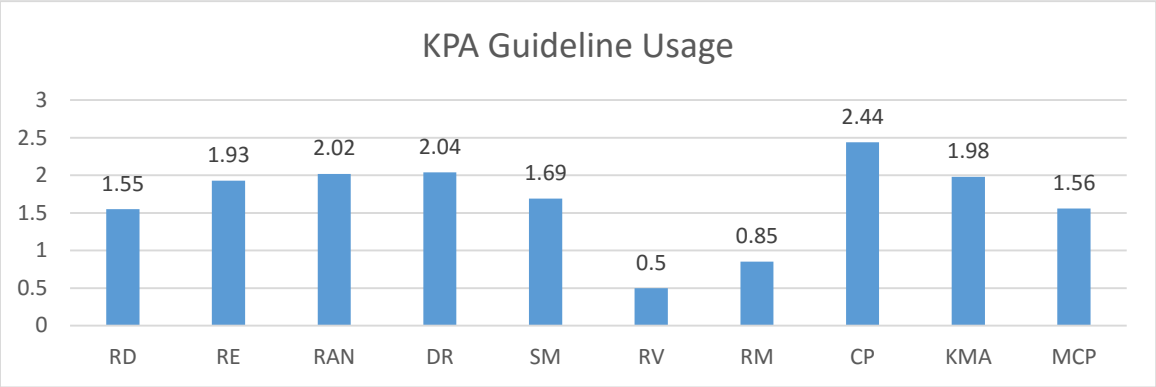

Figure 4. 8 State of the RE areas

(Source: Own Study, 2018)

4.4 Identify the weakest KPA

Research question two: Which KPA is the weakest as compare to other KPA's?

Fundamentally, this research approach is based on the notion that level of process weakness reflects the extent that good RE practices not used or not standardized in the organization. Figure 4.9 illustrate how the Ethio Telecom RE process profile was presented in the evaluation report.

In comparison of each KPA state as shown in Figure 4.9 Requirement validation and management areas categories under 50% practice usage. These areas can be considered as relatively weak areas as their actual usage lies between 0.5 to 0.83 as it is depicted in figure 4.8. As the second category Requirement Documentation, System Modeling and Management and Coordination areas are between 50%-60% and their actual usage lies between 1.55 to 1.69 as it is show in figure 4.8. Thirdly Requirement Elicitation, analysis and negotiation, Describing Requirement and Knowledge Management and Awareness areas fallen between 61-70%. This area is categorized under normal usage my approximation as their actual usage lies between 1.93 to 2.04 as it is show in figure 4.8. Lastly KPA named Communication got 81.42% of practice usage so this area can be considered as the strongest area. To generalize Communication area is relatively the strongest and requirement validation is the weakest area.

Based on the data from semi-structured interview the main reason for the weakness of requirement validation process is, management and requirement team members gave less attention for validation process as TEP projects are planned to be implemented in short time. In addition, they were not aware the importance of practices under this area. The main reason for the weakness of requirement management areas is that most of practice under this area are challenging to accomplish because some of them are intermediate and advanced practice which require further training and others require relatively moderate to high introduction cost.

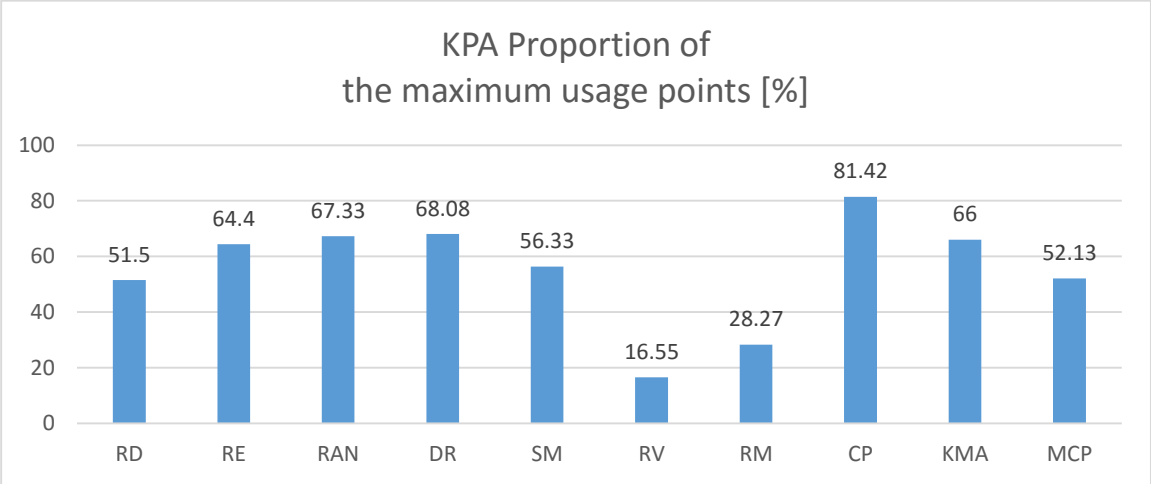

Figure 4. 9: Requirement engineering process profile

(Source: Own Study, 2018)

4.5 Identified Improvement areas

Research question three: What are improvement areas?

However, it is not mean that all practices under relatively weak RE area have low guideline usage value as the areas usage is calculated by the mean of its' guideline practices. Thus the below figure 4.10 illustrate practice wise compaction from quantities study. Sommerville explained that "REAIMS do not have numerical threshold value to identify weak practices rather he suggested researcher to discuss with organization expertise to identify relatively weak practices which require further improvement based on projects criticality "(personal communication, April 26, 2018). Thus researcher discussed with expert and decide to consider practices which the mean guideline usage value less than 1.5 as relativity weak practice. Therefore, 15 practice are identified

as relatively weak practices from seven RE areas. This means Describing requirement, communication and knowledge management and awareness areas do not contain any weak practice as all of the practice under those areas score more than 1.5 mean usage value. These areas score the first, second and fourth usage rank as it is depicted on figure 4.9. Below is analysis and interpretation on result on identified relatively weak practices in RE area base:

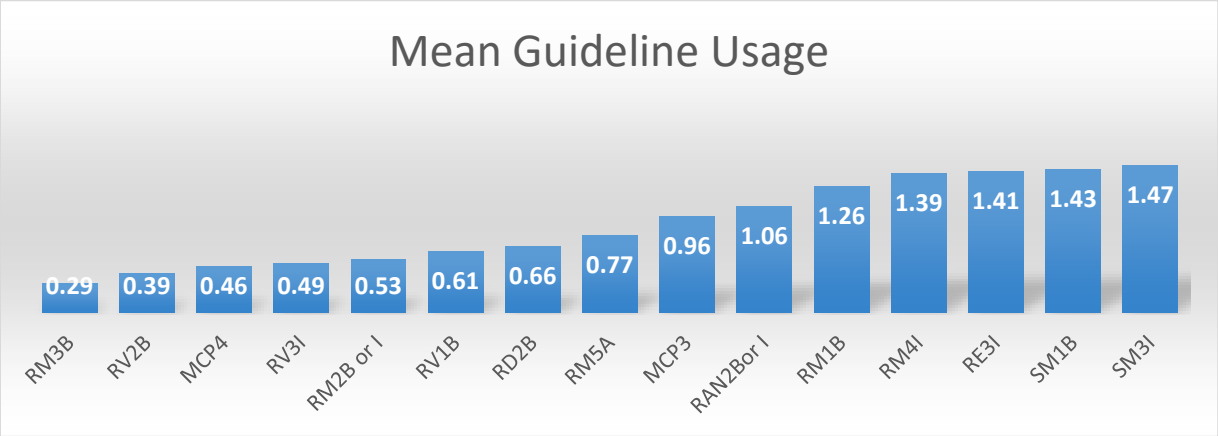

Figure 4. 10: Relatively weak practice which have Mean Guideline Usage less than 1.5

(Source: Own Study, 2018)

Though it is difficult to state this RE practice is weak using semi-structured interview and document analysis, in this section practices which have improvement issue from qualitative study result is presented. Table 4.2 and Table 4.3 depict improvement issue from semi-structured interview and document analysis respectively. All the identified improvent issue will be used for triangulation purpose in latter section.

Key process area	**Practice ID**	**Issue Descriptions**
RD	RD2B	There is no "how to use" section in the introduction part to explain how different class of readers can use the document.
RE	RE3I	Though system end user explain their challenges requirement rationale was not usually recorded.

RAN	RAN2BorI	Ethio Telecom do not have checklist questionaries' as organization level for analysis purpose.
DR	RP2B	Describing the requirement in simple, consistent and concise manner depends on individual English writing skill, thus few project may have poor wordings.
	RP3	Using additional natation is not that much well matured practice.
SM	SM1B	Occasionally several system model is developed for main functions which have to be implemented in different ways.
	SM3I	There is less trend to document the association between stakeholder requirements and system models.
RV	RV1B	Except document structure standard, there is no other defined standard for requirements contents in the company level.
	RV2B	There were no organized inspection group for validation purpose.
	RV3I	Test case is not proposed to validate the requirement
RM	RM1B	There are high level change control polices which state who is responsible for a change management. However, there is no formally defined police about change request process.
	RM2B or I	No defined requirements traceability policies.
	RM3B	No traceability manual.
	RM5A	Sometimes when system end user mention that the system environment will be changed, the requirement is considered as volatile. Otherwise requirement are consider as stable.
KM	KMA1	There is no written policy or procedure to guide how team is formulated because of it sometime unexperienced system

		end user representatives who does not fit the for the task may be assigned.
MC	MCP1	Though system end users are permanent FRS team members they do not have defined and agreed responsibilities as other members have.
	MCP3	As company level there is no formal or structured requirement engineering process which state what practice have to be performed on each key process areas.
	MCP4	Training is not provided for using appropriate processes, and supporting tools and technologies.

Table 4. 3: Improvement issue from semi-structured interview (Source: Own Study, 2018)

Key process area	**Practice ID**	**Issue Descriptions**
RD	RD2B	There is no "how to use" section in the introduction part to explain how different class of readers can use the document.
RE	RE3I	Only few projects record the challenge, why the requirement is raised using separate excel document.
RAN	RAN2Bor I	No checklists for requirement analysis purpose is documented.
DR	RP2B	Few FRS document are not simple to understand.
	RP3	There are few requirement documents which supplement natural language with other natation.
SM	SM1B	Few documents are found which contain complementary system models
RV	RV1B	Document structure standard is documented but no checklist as quality standard is documented.

	RV3I	No test case developed for validation purpose is documented
RM	RM1B	High level change control polices which state who is responsible for a change management is documented in the TEP project charted. However, all expected police regarding requirement management is not stated e.g there is no formally defined police about change request process.
	RM2B or I	No defined requirements traceability policies
	RM3B	No traceability manual.
	RM5A	No document found which identify requirements as stable, may change and most likely to change or volatile.
MC	MCP1	There is no responsibility letter given for system end user representative though they are permanent FRS team members.
	MCP3	There is no formal document contains company level RE process so that all team will follow as a higher level guidance.
	MCP4	There is no training manual prepared on RE process and tools.

Table 4. 4: Improvement issue from document analysis (Source: Own Study, 2018)

4.5.1 Triangulation of Improvement Areas

Table 4.4 depicted an overview of identified practices which have improvement issue from qualitative study and relatively weak practice from quantitative study. In addition, information about substantiation from different data sources are presented. Seventeen out of nineteen practices

are substantiation by two or three data source as improvement areas. Thus seventeen practice are considered to be triangulated. Practice named KMA1 got a total triangulation value of one because the prove of issue in this practice cannot be identified in quantitative study and document analysis. Therefore, issue in practice KMA1and RM4I are not triangulated.

KPA	Practice ID	Relatively weak practice form structured interview or practice Require improvement	Issue from semi-structured interview	Issue from document analysis	Total
RD	RD2B	☑	☑	☑	**3**
RE	RE3I	☑	☑	☑	**3**
RAN	RAN2Bor I	☑	☑	☑	**3**
DR	RP2B		☑	☑	**2**
	RP3		☑	☑	**2**
SM	SM1B	☑	☑	☑	**3**
	SM3I	☑	☑		**2**
RV	RV1B	☑	☑	☑	**3**
	RV2B	☑	☑		**2**
	RV3I	☑	☑	☑	**3**
RM	RM1B	☑	☑	☑	**3**
	RM2B or I	☑	☑	☑	**3**
	RM3B	☑	☑	☑	**3**
	RM4I	☑			**1**
	RM5A	☑	☑	☑	**3**
KM	KMA1		☑		**1**

	MCP1		☑	☑	**2**
	MCP3	☑	☑	☑	**3**
CM	MCP4	☑	☑	☑	**3**

Table 4. 5: Triangulation of improvement areas

(Source: Own Study, 2018)

4.6 How Ethio Telecom RE practices can be improved

Research question four: How Ethio Telecom RE practices can be improved?

Though the process improvement benefit is widely accepted, implementing process improvement in real scenario is difficult task. Because the improvent strategy have to consider skills, experience of the staffs involved in requirement definition process and the time available (Sommerville & Ransom 2005). This research goal is to give improvement recommendation to improve RE process. To do so researcher used the below mentioned reasonable approached:

(1) Focus improvements on RE practice guidelines where the Ethio Telecom is weak as suggested in table 4.8.

(2) Consolidate and standardize practices that are already in use in Ethio Telecom.

(3) Introduce new practices which was not used before by discussion with expertise on the company.

The first step in process improvement was to identify the practice guidelines or areas where a company is relatively weak as these practice guidelines requires improvement. Thus, improvement strategy was to focus on introducing or standardizing the use of good RE practices guideline which are identify as improvement areas. All the recommendation given on basic RE practice are taken from Sommerville REAIMS model.

Recommending Improvements

1. **In requirement documentation, practice "Explain how to use the document"**

Cost of introduction =low and Cost of application =low

Implementation: This section can be named "how to use the document" and include this section in the introduction part of requirement specification document. At least the following points have to be included in this section.

1. Intended class of readers that the document is prepared for
2. Technical knowledge required to understand document in general and specific section
3. Sections of the document which are intended for a specific class of reader
4. Section dependency in order to explain the order that the section have to read. Also mention independent section.

Costs and problems: Almost there is no significant cost required to introduce this practice. Principal problem for introducing this practice is that requirement team may have it difficult to identify technical knowledge required for each section and set the best order for reading.

2. **In requirement Elicitation, practice "Record requirements rationale"**

Cost of introduction =low and Cost of application =low –moderate

Implementation: Requirement rationale can be easily recorder by adding one filed on requirement collection format to record rationale in natural language.

Costs and problems: If the organization want to implement this practice in a simple way like record it in database or excel format, the implementation cost will be the time required to elicit the rationale and understand and write it. There may be two problems while applying this practice. First requirement source may not be willing to tell their true rationale and one requirement may be requested by different source from different reason, so the rationale will be conflicting.

3. **In Requirement Analysis and Negotiation practice, "use checklists for requirement analysis"**

Cost of introduction = low – moderate and Cost of application =low

Implementation: Requirement problems based on BA experience are used to develop checklist of question. Thus the analyst will check items while reading requirement document. Checklist can simply have prepared by excel format in which the rows are labelled with the requirements identifier and column contain list of item. Checklist question have to be updated based on analyst experience. Below figure 4. 11 can be used as initial checklist.

Costs and problems: Introducing this guideline is slightly expensive as compare to informal approach. It requires to develop agreed checklist item in organization level as it is organization resource should not be updated or changed without organization awareness. Also this practice requires checklist management as item have to updated when new problem emerged. Potential problem on this kind of analysis is that the checklist may be inappropriate and analyst may focus on problem only listed on checklist and ignore other problems.

Checklist item	Description
Premature design	Does the requirement include premature design or implementation information?
Combined requirements	Does the description of a requirement describe a single requirement or could it be broken down into several different requirements?
Unnecessary requirements	Is the requirement 'gold plating'? That is, is the requirement a cosmetic addition to the system which is not really necessary.
Conformance with business goals	Is the requirement consistent with the business goals defined in the introduction to the requirements document?
Requirements ambiguity	Is the requirement ambiguous i.e. could it be read in different ways by different people? What are the possible interpretations of the requirement? Ambiguity is not necessarily a bad thing as it allows system designers some freedom. However, it has to be removed at some stage in the development process.
Requirements realism	Is the requirement realistic given the technology which will be used to implement the system?
Requirements testability	Is the requirement testable, that is, is it stated in such a way that test engineers can derive a test which can show if the system meets that requirement?

Figure 4. 11: Analysis checklist items

4. **In Describing Requirements, practice use simple, consistent and concise language to describe requirements**

Cost of introduction = fairly low and Cost of application = low – moderate

Implementation: In order to make the document easy to understand, writer have to keep sentence and paragraph sort, use terminology consistently, avoid usage of jargon word, use active voice sentence and have to use other notation like table to express complex requirement.

Costs and problems: Training on style guide may be taken as the cost of this guideline introduction. Introducing this guideline may face problem in the beginning as most of technical person face a challenge on writing concisely.

5. **In Describing Requirements, practice supplement natural language expiation with other descriptions of requirements.**

Cost of introduction = very low and Cost of application = low

Implementation: Natural language can be supplanted by other notation to address the interest of different class of readers. Below are few notations can be supplanted on natural language description:

- ✓ Use decision tables rather than writhing text having many conditional close.
- ✓ Use algebra for numerical computation,
- ✓ Use data follow diagram for defining sequence of changes and use system model

Costs and problems: Cost of this guideline is very low as BA already know about natation, so the main thing is to replace textual description on notation when appropriate. The principal problem with this guideline is that if unfamiliar natation is used, reader specially system end user by be uncomfortable. So to overcome this problem it is better to use different type of natation in different section which is specified for different class of readers.

6. **In system modeling, practice develop complementary system models**

Cost of introduction = low to moderate and Cost of application = moderate

Implementation: Below are some of commonly recommended model developed on analysis process.

Data-processing model, Entity-relation diagrams, stimulus-response model and process model. Since there is no best model, set of system model best suite your project depends on the type of information that is required to specify, on the type of readers, skill of individual who develop model.

Costs and problems: Cost of this guideline is depend on the type model used. If the model is used in more structured method by supported tools, training cost will be involved. Common problem regarding this guideline introduction is that non specialist may have a problem to understand some advanced models. So to overcome this problem it is better to use different type of model in different section which is specified for different class of readers.

7. **In system modeling, practice document the association between stakeholder requirements and system models**

Ethio Telecom technical FRS team themselves have to develop the system model as this improve the FRS team understanding about the requirement and solution. In addition, association between requirement and model can be efficiently logged and updated when there is a change on the requirement or vice versa.

Cost of introduction = low and Cost of application = moderate

Implementation: In order to refer each system model and requirement, it is must those to have unique level. In addition, system model has to be annotated with the identifiers of requirements which have been specified. The best way to document the association between requirement and model on the mapping between them. Thus commonly there are four possible mapping.

1.If there is a 1:1 relationship between single requirement and a model. Add reference in the statement of the requirement.

2.If there is a 1:m relationship between a requirement and a number of models. In this case association can be documented by including list of system model identifiers in the requirement itself.

3. If there is a m:1 relationship between requirements and a model. In this case association can be maintain by including reference in each requirement and descriptive text with the model to describe how the parts of the model relate to the requirements.

4. If there is a m: n relationship between requirements and number of models. In this case association can be maintain by describing what aspects of each requirement are specified in each system model. With each system model, you should add references to the requirements which it specifies and an associated explanation of what parts of these requirements are covered.

Costs and problems: Cost of this guideline is time required to create and maintain the association. The Principal problem with this guideline may be as the benefit of it is not in short term, BA may give it less priority

8. **In Requirements Validation, practice to check that the requirements document meets your standard**

Cost of introduction = low and Cost of application = low

Implementation: Initially ET have to define quality standard Experienced. BA who were not involved in requirement definition process shall be the responsible to check the requirement document against the standard. It is not expected checker to understand requirement. Checker will compare requirement with defined quality standard and highlight if problem or deviation found. If there is enough time return deviation to requirement team, if not send the deviation information to document reviewers.

Costs and problems: Once quality standard is defined, the only implementation cost is if checker is not familiar with standard, it will take some time to understand.

9. **In Requirements Validation, practice organize formal requirement inspection**

Cost of introduction = low and Cost of application = moderate

Implementation: Requirement Inspection is formal meeting which is chaired by person not involved in requirement definition session for requirement which is going to be validated. BA present requirement for inspectors or inspector read the document and identify problem so that it can be fixed.

Costs and problems: Training have to be given for inspector how to do the inspection. Inspection group may need inspector having different skill and responsibility. Inspectors may come from different organization or same organization but from different project so it requires additional time in RE process.

10. **In Requirements Validation, practice to propose requirement test cases**

Cost of introduction = low and Cost of application = moderate

Implementation: In requirement definition stage it is not important to develop real detail test case which will be applied for final system validation. In order to define test cases, it is important to ask some question like what are prerequisites for the test, does the requirement have all information required to propose test case, how many test case is required to define the functionalities. So this question will help to identify problem.

Costs and problems: The cost of this guideline is low. It requires only time to propose test case actually this time will be compensated by minimizing final test case plan. As the problem BA may refuse to do this as they may consider this task will be others responsibility.

11. In Requirements management practice, define polices for requirement management

Cost of introduction = moderate and Cost of application = low

Implementation: The first step in defining requirement management policy is to study existing Ethio Telecom requirement management process in order to identify areas which have a problem so that it can be improved. This police are the base for quality management. In general, there must be one general requirement management police, but each project manager has to amend or select policy best suite specific project. So the general requirement management police have to include set of objectives and their rationale for requirement management, define standards for requirement documentation, change management and control, traceability and validation polices. In addition, exception handling mechanism have to be defined so that the police have to be flexible.

Costs and problems: It may take several months to define the police as it requires to consult individual involved in previous RE process. In addition, Ethio Telecom are expected to deliver the training to create awareness about the policy and how to apply. If requirement team is not consulted while the police defined, at last they may refuse to use it.

12. In Requirements management practice to define traceability polices

Cost of introduction = moderate and Cost of application = moderate to high

Implementation: Traceability policy is written policy in company level. Policy have to mention about the techniques used to maintain traceability, when to maintain traceability information and by whom and policy exception. Ethio Telecom can use traceability table, traceability list and automated traceability link techniques to maintain selected traceability information. Some of commonly known traceability information are shown in the below figure.12. Since recording all traceability is not important, policy have to be realistic about which traceability information is maintained.

Traceability type	Description
Requirements–sources traceability	Links the requirement and the people or documents which specified the requirement. See **Guideline 4.4**, *Record requirements sources*.
Requirements-rationale traceability	Links the requirement with a description of why that requirement has been specified. See **Guideline 4.7**, *Record requirements rationale*.
Requirements-requirements traceability	Links requirements with other requirements which are, in some way, dependent on them. You should always try to maintain this type of information.
Requirements-architecture traceability	Links requirements with the sub-systems where these requirements are implemented. This is particularly important where sub-systems are being developed by different sub-contractors.
Requirements-design traceability	Links requirements with specific components in the system which are used to implement the requirement. These may be hardware or software components. It is particularly important to maintain this type of information for critical systems.
Requirements-interface traceability	Links requirements with the interfaces of external systems which are used in the provision of the requirements. Should be maintained where there is a high dependency on other systems.

Figure 4. 12: Types of traceability information

Costs and problems: As guideline implementation cost it require significant effort to guarantee that high-quality policies are defined. Addition this guideline requires policy maintenance cost for any policy change. As guideline implementation problem, Analyst may have got challenge on managing large volume of requirement.

13. In Requirements management practice maintain traceability manual

Cost of introduction = low and Cost of application = moderate to high

Implementation: Traceability manual is central record of project specific traceability policy and traceability information used for the project. Project specific traceability policy is used by considering size or number of requirement, estimating project life time, size of project and type of system. This manual it better to be developed incrementally as according to system development process. Manual have to be updated according to system version change. To do so Ethio Telecom

have to assign traceability manager who work with FRS team, design team and developers so that all change can be recorder.

Costs and problems: Cost to maintain traceably manual is depend on the traceability policy complexity and number of requirement. The main problem of this guideline is keeping the manual up to date.

14. In Requirements management practice identify volatile requirement

Cost of introduction = low and Cost of application = low

Implementation: In order to implement this guideline, requirements have to be examined by requirement expertise so that to identify requirement which are most likely to change. In addition, involving domain expertise will help to identify domains which mostly experience unexpected change. In order to identify volatile requirement which is recorder in DB or excel document, it is important to add field to estimate volatility. Volatility scale can be named like fairly stable, medium term change and most likely to change.

Costs and problems: This guideline does not require any cost, if Ethio Telecom have experienced individual who can judge requirement volatility while requirement validation process. The main problem is volatility information have to be updated whenever there is a requirement change.

15.In Requirements management practice having clearly defined and agreed responsibilities for each individual and group

Implementation: All individual involved in requirement team including system end user should have clearly defined responsibility in individual and as group.

16. In Requirements management practice providing training potential team members for using appropriate processes, and supporting tools and technologies

Implementation: Among supportive RE tools such as survey, interview, questionnaires, observations, prototyping and class responsibility collaboration(CRC) cards Ethio Telecom have to select appropriate one and give training potential team requirement members. In addition, RE process can be automate by using modern technology such as Neural Impulse Actuator this

technology reads the human mind or indicate what stakeholders are thinking about. It is used in conjunction with interview, brainstorming other RE tools. Web-based mobile technology delivers the internet service for stakeholder communication and its graphical user interface is easy to use RE tools such as CRC cards (Shams-ul-Arif et al., 2009).

17.In Requirements management practice having clearly delineated and comprehended requirements engineering processes

Implementation: Based on Gorschek & Wohlin (2003) recommendation for an organization to define RE process the main task is to identify the practice which are necessary to achieve organization goals. So as the initial step the Ethio Telecom can begin to define RE process by use practices or actions which is validated by expertise to be useful for the organization under study.

Key process area	**Action or practice**
Requirements Documentation	Define and follow a standard document structure
	Include a section in the introduction part of the document to explain how to use it
requirements elicitation	Assess system feasibility
	Use business concerns to drive requirements elicitation
	Records requirements rationale
	Use scenarios to elicit requirements
	Define operational processes
	Define operational Business rule
Requirement Analysis and Negotiation	Define system boundaries
	Use checklists for requirements analysis
	Prioritize requirements
Describing Requirements	Define and use standard templates for requirements description
	Use simple, consistent and concise language to describe requirements
	Supplement natural language with other descriptions of requirements where appropriate.
	Specify requirements quantitatively where appropriate
System Modelling	Develop complementary system models
	Model the system's environment
	Document the association between stakeholder requirements and system models.
Requirements Validation	Check that the requirements document meets your standard
	Organize requirements inspection

	Propose requirements test cases
Requirements Management	2.Define policies for requirements management
	3.Define requirements traceability policies
	Maintain traceability manual
	Identify global system requirements
	Identify volatile requirements
Communication	Deciding and using a standard language for communication
	Trying to find natural overlapping of working hours
	Facilitating direct communication among the stakeholders
	Reaching written and properly documented agreements
Knowledge management and awareness	8.Keeping experienced practitioners in team and those practitioners should bridge the awareness gap
	prioritizing stakeholders based on business goal
	Inform the relevant stakeholder about the requirements change
	Develop requirement knowledge base system
Management and coordination	5Having clearly defined and agreed responsibilities for each individual and group.
	6.Establishing authoritative leadership at the level of project managers and team heads.
	1.Having clearly delineated and comprehended requirements engineering processes.
	7.Providing training potential team members for using appropriate processes, and supporting tools and technologies
	4.Identifying all the stakeholders and considering their need

Table 4. 6: Recommended initial RE process for Ethio Telecom

Figure 4. 13: Recommended RE process for Ethio Telecom SRS document preparation

4.7 Evaluation of the proposed RE practice

4.7.1.1 Evaluation Approach

Proposed practice have to be evaluated in order to be sure that it will improve organization RE process and solve real world business problem. Initially each practice applicability in ET context is proved form the information gain by semi-structured interview and structured interview. In addition, in order to elevate the confidence level on each practice that going to be proposed, further evaluation is performed.

Secondly, researcher make discussion with expert, so that improvement recommendation will be check for its sufficiently accurate in order to improve the process or whether improvement recommendation fit in ET requirement definition process (Beecham et al., 2005).

Finally, the proposed practice has been evaluated using the evaluation framework developed by solemon. This framework has been developed using five main criteria :1) completeness, 2) consistency, 3) practicality, 4) usefulness, and 5) verifiability. Thus evaluation questioner are prepared by fallowing the evaluation general rules (Solemon, 2013). The Proposed practice are explained or send via Email for respondents before data collection begin.

Among 17 invited respondents, 10 participants completed the survey. Thus the response rate of the framework evaluation survey is 100%. Using SPPS descriptive analysis method is used to analyze the data. Next section describes the evaluation result.

4.7.1.2 Evaluation result of the proposed RE practice

Table 4.5 depict the computation of evaluation survey result using descriptive analysis method. The overall rating of the proposed practice is 4.2 which indicate the respondents agree on the fitness of the proposed practice in Ethio Telecom context. Also most of the evaluation permanents is found to be greater than 4 which indicate that most of the respondent agree on the consistency, practicality, usefulness, verifiability and completeness of the proposed practice.

Descriptive Statistics				
	N	Minimum	Maximum	Mean
RE Practices are complete and recognizable as adaptation of existing standards, models and methods.	15	4	5	4.20
RE Practices are provided with sufficient level of detail for initial guide to RE process improvement.	15	4	5	4.20
RE Practices should be recognizable as a derivative of the CMMI-DEV – both in structure and concept	15	3	5	4.60
RE practices should require little or no training to be used	15	1	5	3.27
RE practices should be simple to understand with the practices are clearly defined	15	3	5	4.40
The RE practice guidelines are general improvement method require minimum resources	15	2	5	3.80
The RE practices are flexible, tailorable and adaptable	15	3	5	4.07
The RE practices are likely to be useful in improving RE processes	15	3	5	4.67
The RE practices meets their development objectives	15	4	5	4.47
Valid N (list wise)	15			

Table 4. 7 Evaluation of the proposed RE practice using framework

Evaluation parameter "RE practices should require little or no training to be used" scored the lowest mean value 3.3, because there are some practices which are categorized under intermediate and advanced which require additional training for implementation (Sommerville and Sawyer,1997). Again the implementation of this those practice require additional time and resource. This situation

makes the sixth evaluation parameters "The RE practice guidelines are general improvement method require minimum resources "to score low value of 3.8.

The evaluation result indicated evaluation parameters "The RE practices are likely to be useful in improving RE" score the higher mean value of 4.7. This parameter is the most critical parameter which directly decide the importance of all parameter, thus survey result revealed that respondents strongly agreed on that the suggested RE practice are useful to improve Ethio Telecom RE process.

Generally, evaluation survey result shown that suggested RE practice are fit to Ethio Telecom context, valuable to improve RE process and to produce quality SRS document.

4.8 Discussion

Quality requirement specification document is related to the usage extent of best practice in organization RE process (Sommerville & Ransom, 2005). However, based on study finding in Ethio Telecom RE process there are areas which require improvent as their good practice usage extent is relatively weak and have improvement issues, thus eight RE areas are found as an area which require an improvement. These eight RE areas are discussed in the following section. However, Knowledge management and awareness and communication areas perform relatedly well.

1. **Requirements Documentation**

Almost all of the participant noted that each project requirement team define standard document structure by cooperation with vender's business analyst and most of the requirement team scriber follow it while writing the requirement. However, almost there is no trend to include how to use the document section in the introduction part. This means all class of requirement readers will read the whole document so that they can figure out which section will interest them. if readers identify section that interest them form table of content, they may not know which section have to be read first before the identified section so that reader can acquire the complete idea. The finding is consistent with results of Gorschek et al. (2003)) who argued the company under study seems often forgotten to document usage description in order to assist them to use and navigate via document.

2. **Requirements Elicitation**

Regarding requirement elicitation, finding of this study suggest that though there is no separate phase for feasibility study, requirement feasibility is check by technical requirement team members so that it will be checked against the applicability on existing technology and the cost. System end user involvement while RFP preparation is very low. Once RFP is defined user requirement cannot be out of it anymore, so there is a challenge to drive all lower level requirement form business concern. As most of the participant noted business process is defined by external team and requirement team will refer it while requirement elicited so that team can understand the working process and occasionally this process is used to identify stakeholder. While requirement become challenging to understand by vender or Ethio Telecom requirement team scenarios such as video demonstration and storytelling will be used. Requirement may originated from different point of views so rationale have to be properly identified and recorder (Kumar, Sreenu, Kumar, & Ambedkar, 2012). However, study result identified few individual record requirements rationale and this practice is not well known in company level. Because of this when requirement move from one business analyst to other each time stakeholders are going to explain reason why requirement is defined. In addition, when requirement changed identifying the impact of its change are challenging. In line with this Bruegge, Gall, & Berenbach (2006) sated that mostly the rationale behind the requirements is not recorded or may be recorded and is not available for the developers so that they can refer it for decision making while there is requirement change.

3. Requirement Analysis and Negotiation

Regarding requirement analysis and negotiation, finding of this study revealed that initial or higher level system bounders is defined in scope of work document. After this while requirement specified in detail, system bounders is defined in negotiation with vender for requirement which are not stated as major on scope of work document. All of the participated noted when there is resource shortage requirement is prioritized for implementation and release in phase. However, in company wise there is no define checklist for requirement analysis purpose but few individual develop and use their own checklist. This means requirement is analyzed by reading the whole requirement and check all points raised in the discussion included or not. This kind of analysis take too much time; analyst cannot know the analysis is complete or not. In addition, this practice

has possibility of committing error while analysis process. In line with this Suleiman, Adepetu, Arnautovic, & Svetinovic (2013) noted research on checklist development is not matured and there is few "unified and integrated checklists from research and industry resulting in significant disparities"

4. Describing Requirements

Regarding describing requirement, finding of this study revealed that for each project requirement team in cooperation with vender define standard templates for requirements description and most of teams use it. It is globally accepted that requirements have to be described in concise, understandable and unambiguous way (Bhardwaj, 2016). However, English which is used to describe requirement is the second language for both venders and Ethio Telecom staffs, describing requirement is depend on individual writing skill so that there are requirement specification documents which are easily understandable and also there are few documents which are not concise and difficult to understand. In this regard Firesmith (2003) commented "many requirements are ambiguous, incomplete, inconsistent, incorrect, infeasible and unusable." Furthermore, there are few individual made some effort to use diagram and supplement natural language with other descriptions of requirements. Because of this mostly information's on requirement document do not meet the conflicting objectives of different class readers especially designer and end users so this practice need improvement. In line with this Niazi, Cox, & Verner (2008) noted that though among many one of organization under study start use diagrams, but pratice is weak and require improvement.

5. System Modelling

Regarding system modeling, finding of this study indicated that Ethio Telecom have relatively good practice in modeling system environment to documents the external systems whose interfaces must be specified. However, few individual develop complementary system models or create several system models to illustrate different aspects of the system specification. Because of this there are many requirements which is model in one implantation aspect though in reality it have to be implemented in different aspects. This in turn lead to have many requirements which is well design in one aspect and poorly designed in other aspect. Furthermore, few individuals document the association between stakeholder requirements and system models. Because of this problem,

when there is a requirement change it is very challenging for business analysts to identify which requirements and models are affected by change. This means Ethio Telecom is poor in requirement traceability. In line with this Niazi, et al., (2008) noted that among many one of organization under study do not document the association between stakeholder requirements and system models.

6. Requirements Validation

Regarding requirement validation, finding of this study noted that generally Ethio Telecom do not give emphasis on for validation process in requirement definition phase as higher management believe system will be exhaustively validated on testing phase. Because of this, this area is the weakest RE area which require major improvement. Requirement is validated by checking whether all points mentioned in discussion session are included in the document or not. Out of this on the company level there is no defined quality standard checklist except the document structure standard. This mean in validation process quality of requirement specification is not examined and validators cannot be sure all points are considered in validation process. However, using quality checklist of question for validation is recommended practice (Firesmith , 2003). In addition, Ethio Telecom do not organize requirement inspection groups which will find out problem in requirement by fresh eyes. Moreover, almost there is no trend to propose test case for validation purpose. Form researcher experience because of this when test case developer finds it hard to acquire all information from requirement document, they may refer vender web site to get missed steps from commercial system. but the requirement on vender site may not be applicable for Ethio Telecom. In line with this Niazi, et al., (2008) noted that two of organization under study are weak genrally in requirment validation process as most of the pratice under this areas is weak and this resercher recommend that as managemnt need for vliadtion process inclrease practice awarness, mangemnt have to be more convienved on the value of this process.

7. Requirements Management

Regarding requirement management, finding of this study revealed that generally this KPA require major improvement. Though there are high level defined polices on project charter to be used for requirements management, this police have to include other polices regarding to validation, change control and other issues. This means requirement from different project is managed inconsistent

way also requirement is managed depending on project managers experience. In addition, Ethio Telecom as company level do not have a defined requirements traceability policies and not maintain traceability manual. This caused recording traceability information depend on individual team experience. This situation brought requirement not to trace easily, not to identify which requirement is affected by the change. The findings are consistent with Ramesh & Jarke (2001 statement that many organizations do not have clear understanding about the principle of traceability and are struggling to implement traceability practice. And Gorschek et al. (2003) noted that because of poor tractability management many organizations are not update requirement specification document if there is a change of design and implementation.

On top of this there are few individual who have adequate skill to predict which requirement is most likely to be volatile. Because of this when there is a change, its management will be challenging for project managers also its implementation may be difficult when the change may require global deign change. In line with this Niazi, et al., (2008) noted that one of organization under study do not made any effort to introduce managemnt practice thus all of the practice under it got zero score. However Ethio Telecom made better effort to identify global requiremetns.

8. Management and coordination

Regarding to management coordination, finding of this study noted that each project has lead by project manager and team leader. Even though all of technical team members and project manager taken clearly defined and agreed responsibilities for individual or as a group, for system end user there is no defined responsivity and some of user interviewees noted that they were not informed they join FRS team. In line with this Gorschek & Wohlin (2003) identify issue regarding to defining role and responsibility for all project members including system end user. The researcher recommends that as all person involved in RE process including system end user are the members of a project team, their role and responsibility have to be clearly stated.

In addition, surprisingly as the company level RE process is not documented. Because of this each requirement team will follow their own RE process depending on project manager and vender business analyst experience. This situation cause company to produce requirement specification document different quality which are the result of divers processes. In line with this again Gorschek

& Wohlin (2003) identify issue regarding RE process/methods and stated as “there is a lack of a formalized and/or structured RE process, or methods supporting certain tasks performed during RE process “and this researcher noted this issue is “un umbrella issue under which the rest improvement issue can be sorted”. This is also in line with this with argument of Kotonya and Somerville (as cited in Aurum and Wohlin, n.d, p.06) that many organizations not have a standard RE process as some of the project use explicitly defined RE process and the other is not.

One of the main element in RE is the utilization of tools for requirements elicitation (Shams-ul-Arif et al., 2009). Thus it is important to train potential team members for RE process if there is any defined process and on the usage of supporting tools and software. However almost there is no training delivered on tools and software for requirement team members. The findings are consistent with results of Shakeel, Shafi, Ghani & Jehan (2014) who argued that most of the employee’s knowledge about RE is come from higher university courses not form the training received from the organization as most of the time software project have tight schedule and training require additional cost.

4.9 Chapter Summary

This chapter present and triangulate the finding of both qualitative and quantitative cases studies and the finding of cases study is discussed. Drawing on the data collected from both case studies, Ethio Telecom made comparatively better effort on communication and knowledge and awareness KPAs. The remaining eight KPA’s are identified as KPAs which require additional improvement effort. Form these KPAs validation is the weakest one. One of the main reason is that management have less awareness about validation practices values. Again from evident on the case study it can be generalized Ethio Telecom made less efforts on requirement management specially on traceability practices on defining traceability police and maintaining tractability manual. Finally, exhaustive improvement recommendation is given on each improvement areas.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Most outsourced software projects fail because of Requirement Engineering (RE) process. Thus it is important to improve RE process so that the requirement specification document will be a valuables input for further software development process. For instance, these days, organizations have begun to show interest towards improving their requirements engineering processes. While process improvement is a continuing process with a number of steps, identifying what to improve is initial step.

To this end, the main purpose of this study is to evaluate the current state of Ethio Telecom RE process for outsourced projects and identify improvement areas. The literature review made for this study revealed that such kind of holistic conceptualization for RE process improvement in outsourced projects is performed by considering basic RE practices and other set of RE practices to overcome challenges faced by outsourced projects, thus this research used REAIMS model for basic RE practices and REP model for outsourced issues.

On KPA basis comparison, Communication is relatively the strongest and Requirement Validation is the weakest KPA.

Project and TEP higher management give less attention for validation process as they think the final system acceptance test will replace this phase. However, this approach leads an error which can be identified in the early stage of development process move to the end of implementation. When error identified in the test phase, system feature will be corrected with extra money. Even though it is good practice to validate the requirement by requirement team members as Ethio Telecom already did, validating requirement using standard checklist and by other expertise not involved in requirement definition process will reveal many more problem. Thus the Ethio Telecom higher management have to start to plan to incorporate validation practices in the company RE process.

Though Ethio Telecom define higher level RE management police to indicate project management responsibility and to define template used for requirement change requires, Ethio Telecom seems

to ignore the importance of traceability polices. In the company there is no defined traceability police and no manual developed to maintain treatability information. As changes are common in software development process Ethio Telecom higher managements have to plan to defined detail change management police including traceability information to simplify change management process.

Next to this, it is identified that system modeling practice are not matured specialty on developing several system models to illustrate different aspect of the system to satisfy different class of readers. Lastly, it is identified that Ethio Telecom have no clearly defined RE process. Each project team will define requirement based on their experience. This situation brought the organization not to produce requirement specification document in consistent quality and made the quality to be dependent on individual experience. Ethio Telecom have to select appropriate RE activities from different frameworks including the frameworks used in this research and define initial set of RE process which have to be updated according to the organization experience. In order to use defined process there are a lot of tools and technologies. Training on tools and technology will support the success of RE process implementation.

5.2 Recommendation for Future Research

Even though this study provides new insights and draws valuable lessons with regard to Ethio Telecom RE process for outsourced projects, there are some limitations which are worth noting as they open up paths for future research.

Firstly, evaluate organization RE process by practice base will cause critical issue or weak areas to be missed. Conducting the research by exhaustive investigation over all activates that are used to define requirement will reveal many issue or improvement areas than the approach followed in this study.

Secondly, in considering resource limitation, improving all improvement areas at the same time is infeasible. Thus It is important to support higher management on their improvement planning activity. So further research has to be performed to identify dependency between improvent areas so that higher management will decide on priority of improvement proposals.

Thirdly, further research can be conducted by analyzing and modeling critical success factors for RE process improvement for outsourced projects.

Fourthly, while Ethio Telecom software requirement is defined together with vender business analyst. For this study only one vender business analysis was participated in the structured interview as others left the organization. Research which participate both vender and Ethio Telecom responsible bodies will provide more complete information.

Finally, if the organization under study introduce the recommended improvement practice, further evaluation study is necessary to compare the second evaluation result with the initial assessment to quantify the actual RE process improvements made.

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APPENDIX

Appendix A: Semi-structured Interview Guideline

1. While being on the requirement documentation process, does your company "Define and follow a standard document structure"? if yes, which standard do you follow? If no, why not?

2. For requirement documentation process, does your company include a section in the introduction part of the document to explain how to use it? if yes, what are the contents included? If no, why not?

3. do you assess system feasibility? if yes, which criteria is assessed? If no, why not?

4. Do you have a practice to use business concerns to drive requirements elicitation? if yes, who is responsible to know the business concern and how do you know it? If no, why not?

5. In requirement elicitation stage, do you record requirements rationale? if yes, how do you associate with each requirement? If no, why not?

6. In requirement elicitation stage, do you use scenarios to elicit requirements? if yes, how do you make the scenarios? If no, why not?.

7. Do you define operational or business processes in while elicitation process? if yes, how do you define operational or business processes? If no, why not?

8. Do you define system boundaries in the analysis and negotiation process to identify the scope of the system? if yes, how do you define system boundaries? If no, why not?

9. Do you use checklists for requirement analysis? If yes, how do you develop checklist question? If no, why not?

10. Do you prioritize requirements for implementation and release in phase? if yes, what are the criteria for prioritization? If no, why not?

11. Do you define and use standard templates for requirements description? if yes, how do you define template do use? If no, why not?

12. Do you use simple, consistent and concise language to describe requirements? if yes, which natural language is used? If no, why not?

13. Do you supplement natural language expiation with other descriptions of requirements where appropriate in order to describe requirements? If no, why not?

14. Do you specify requirements quantitatively where appropriate? if yes, for which requirement s specified in quantity? If no, why not?

15. Do you develop complementary system models or create several system models to illustrate different aspects of the system specification? if yes, which system model do you use? If no, why not?

16. Do you model the system's environment to documents the external systems whose interfaces must be specified? if yes, which system model do you use? If no, why not?

17. Do you document the association between stakeholder requirements and system models? if yes, what kind of requirement are associated to system model? If no, why not?

18. In order to validate the requirement, do you check that the requirements document meets your standard? if yes, what are defined standards to check. If no, why not?

19. Do you organize requirements inspection group or meeting to discuss problems with the requirements and to fix? If no, why not?

20. Do you propose requirements test cases to check if the system meets that requirement? If no, why not?

21. Do you define policies or the procedures which should be followed and the standards which should be used for requirements management? if yes, what kind of policy you have, who is responsible for version change control, making traceability, record change history and validity? If no, why not?

22. Do you define requirements traceability policies to define what traceability information should be maintained and how this should be represented? if yes, what is policy you have, in which representation form the information presented? If no, why not?

23. Do you maintain traceability manual which includes the specific traceability policies used in a project and all requirements traceability information? if yes, what are requirements traceability information? If no, why not?

24. Do you identify global system requirement, which set out essential properties of the system as a whole? If no, why not?

25. Do you identify volatile requirements, which are most likely to change? If no, why not?

26. As the communication plays important role, do you give importance for deciding and using a standard language for communication? if yes, what is the standard language? If no, why not?

27. Since working with international vendors is exposed to overlapping working hours, do you manage to set mutual convenient hours? if yes, which time is taken as a convent time? If no, why not?

28. As the communication demands all points to be taken, do you facilitate direct communication among the stakeholders? If no, why not?

29. Most agreements tend to be made orally but are not as much reliable, thus, do you reach to make properly written and documented agreements? if yes, what point is considered in the agreement t ? If no, why not?

30. Did you Keep experienced practitioners in team and make those practitioners to bridge the awareness gap? If no, why not?

31. Do you value and give attention for stakeholders based on business goal priorities? if yes, which business goal is taken as high priority? If no, why not?

32. Do you Inform the relevant stakeholder about the requirements change? If no, why not?

33. How carefully is taken having clearly defined and agreed responsibilities for each individual and group? if yes, what are the commonly defined responsibility in TEP software project? If no, why not?

34. As most responsibilities lack ownership, do you give emphasis for establishing authoritative leadership at the level of project managers and team heads? If no, why not?

35. Do you have clearly delineated and comprehended requirements engineering processes? if yes, what the defined process? If no, why not?

36. Have you considered providing training potential team members for using appropriate processes, and supporting tools and technologies? if yes, what kind of RE training delivered? If no, why not?

37. Do you identify all the stakeholders and considering their needs? If no, why not?

Appendix B: Structured Interview and Document Analysis Guideline

However, only checklists than can be analyzed by document is used for document analysis

No	Practice guideline	Never used	Discretionary	Normal	Standardized
RD1B	While being on the requirement documentation process, does your company "Define and follow a standard document structure"? **Comments:**				
RD2B	For requirement documentation process, does your company include a section in the introduction part of the document to explain how to use it? **Comments:**				
RE1B	do you assess system feasibility? **Comments:**				
RE2B	Do you have a practice to use business concerns to drive requirements elicitation? **Comments:**				
RE3I	In requirement elicitation stage, do you record requirements rationale? **Comments:**				
RE4I	In requirement elicitation stage, do you use scenarios to elicit requirements? **Comments:**				
RE5I	Do you define operational or business processes in while elicitation process? **Comments:**				

RAN 1B	Do you define system boundaries in the analysis and negotiation process to identify the scope of the system? **Comments:**				
RAN 2Bor I	Do you use checklists for requirement analysis? **Comments:**				
RAN 3	Do you prioritize requirements for implementation and release in phase? **Comments:**				
DR1B	Do you define and use standard templates for requirements description? **Comments:**				
DR2B	Do you use simple, consistent and concise language to describe requirements? **Comments:**				
DR3B	Do you Supplement natural language with other descriptions of requirements where appropriate in order to describe requirements? **Comments:**				
DR4I-A	Do you specify requirements quantitatively where appropriate? **Comments:**				
SM1 B	Do you develop complementary system models or create several system models to illustrate different aspects of the system specification? **Comments:**				

SM2 B	Do you model the system's environment to documents the external systems whose interfaces must be specified? **Comments:**				
SM3I	Do you document the association between stakeholder requirements and system models? **Comments:**				
RV1B	In order to validate the requirement, do you check that the requirements document meets your standard by person not been involved on requirement specification? **Comments:**				
RV2B	Do you organize requirements inspection group, which include persons not involved in producing requirement in order to discuss problems on requirements with requirement team representatives and to fix it? **Comments:**				
RV3I	Do you propose requirements test cases to check if the system meets that requirement? **Comments:**				
RM1 B	Do you define policies or the procedures which should be followed and the standards which should be used for requirements management? **Comments:**				

RM2 B-I	Do you define requirements traceability policies to define what traceability information should be maintained and how this should be represented? **Comments:**				
RM3 B	Do you maintain traceability manual which includes the specific traceability policies used in a project and all requirements traceability information? **Comments:**				
RM4I	Do you identify global system requirement, which set out essential properties of the system as a whole? **Comments:**				
RM5 A	Do you identify volatile requirements, which are most likely to change? **Comments:**				
CP1	As the communication plays important role, do you give importance for deciding and using a standard language for communication? **Comments:**				
CP2	Since working with international vendors is exposed to overlapping working hours, do you manage to set mutual convenient hours? **Comments:**				
CP3	As the communication demands all points to be taken, do you facilitate direct communication among the stakeholders? **Comments:**				
CP4	Most agreements tend to be made orally but are not as much reliable, thus, do				

	you reach to make properly written and documented agreements? **Comments:**				
KMA P1	Did you Keep experienced practitioners in team and make those practitioners to bridge the awareness gap? **Comments:**				
KMA P2	Do you value and give attention for stakeholders based on business goal priorities? **Comments:**				
KMA P3	Do you Inform the relevant stakeholder about the requirements change? **Comments:**				
MCP 1	How carefully is taken having clearly defined and agreed responsibilities for each individual and group? **Comments:**				
MCP P2	As most responsibilities lack ownership, do you give emphasis for establishing authoritative leadership at the level of project managers and team heads? **Comments:**				
MCP P3	Do you have clearly defined and comprehended requirements engineering processes? **Comments:**				
MCP P4	Have you considered providing training potential team members for using appropriate processes, and supporting tools and technologies? **Comments:**				

MCP 5	Do you identify all the stakeholders and consider their needs? **Comments:**				

Source: Adopted from Sommerville and Sawyer (1997) and Iqbal (2016)

Appendix C: The Proposed RE Practices Evaluation Survey

Criterion	Evaluation parameters	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Completeness	RE Practices are complete and recognizable as adaptation of existing standards, models and methods.					
	RE Practices are provided with sufficient level of detail for initial guide to RE process improvement.					
Consistency	RE Practices should be recognizable as a derivative of the CMMI-DEV – both in structure and concept					
Practicality	RE practices should require little or no training to be used					
	RE practices should be simple to understand with the practices are clearly defined					
	The RE practice guidelines are general improvement method require minimum resources					
	The RE practices are flexible, tailorable and adaptable					
Usefulness	The RE practices are likely to be useful in improving RE processes					
Verifiability	The RE practices meets their development objectives					

Appendix D: Letter of Request

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ADDIS ABABA UNIVERSITY
College of Natural Science
School of Information Science

Date March 27, 2018
Ref:-SIS/16 /2010

To: Ethio Telecom
Addis Ababa

Dear Sir / Madam

Student Eden Getachew (ID. No. GSE/0368/08) is a graduate student at the School of Information Science, Addis Ababa University. She is currently conducting a MSc. thesis research under the title "Requirement Engineering process Improvement for outsourced Project at Ethio Telecom".

I would like to thank you in advance for all the assistance that you would provide to the student.

With Regards,

Martha Yifiru (PhD)
Head, School of Information Science

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