ABSTRACT

Title of Thesis: **PROJECT MANAGEMENT MATURITY IN THE CONSTRUCTION INDUSTRY OF DEVELOPING COUNTRIES**

(THE CASE OF ETHIOPIAN CONTRACTORS)

Abadir H. Yimam, Master of Science, 2011

Directed By: **Professor Miroslaw J. Skibniewski (PhD), Department of Civil & Environmental Engineering**

This research has studied the maturity of PM in the construction industry of developing countries; in the course, the research has also identified two major gaps in the existing maturity models and, proposed a PM maturity model to address the gaps and adapt it to the developing countries context. Using the model, maturity assessment of contractors in Ethiopia is undertaken and, low level of PM maturity (Informal practice of the basic processes) is found. Further, the research found ISO certified contractors' PM maturity to be higher than those which are not. Similarly, the PM maturity of contractors which took part in Capacity Building Program is found to be higher than those which did not take part .Likewise, Road contractors PM maturity is found to be higher than Building contractors. Moreover, the research found higher maturity level for material, procurement, cost, financial, time, and human resource management. Risk and safety management are found to be the least matured PM areas.

PROJECT MANAGEMENT MATURITY IN THE CONSTRUCTION INDUSTRY OF DEVELOPING COUNTRIES

(THE CASE OF ETHIOPIAN CONTRACTORS)

By

Abadir H. Yimam

Thesis submitted to the Faculty of the Graduate School of the

University of Maryland, College Park, in partial fulfillment

Of the requirements for the degree of

Master of Science

2011

Advisory Committee:

Professor Miroslaw J. Skibniewski, Ph.D., Chair

John H. Cable , R.A ,PMP

Dr-Qingbin Cui ,(Ph.D)

© Copyright by

Abadir H Yimam

2011

Dedication

To

My Dear Mom- Kedija Seid

And

My Late Father- Hassen Emamu

Acknowledgements

I thank Allah for enabling me complete this work after long and stressful days and nights. My special thanks go to my advisor Professor Mirslow Skibineski for his valuable guidance and assistance throughout this research. I am also grateful to my committee members, Dr-Qingbin Cui and Mr. John H. Cable for their reviews, critiques, questions, and valuable guidance. The comments and suggestions greatly helped shape this dissertation. My special thanks also go to Dr-Ing Wubishet Jekale for his valuable comment, review and support through the courses of this research.

I also thank my wife for her understanding, assistance and endurance till I complete this research. I thank all my families, friends, peoples and organizations in US and Ethiopia who have helped me complete my study and this thesis research successfully.

I also would like to thank the Fulbright Commission and the University of Maryland for fully sponsoring my study. I thank all the Faculty and staffs of the department of civil engineering at University of Maryland. Lastly but not least, I thank Mr. Riyadh for his very warm hospitality during my stay in UAE to defend the thesis.

Table of Contents

Dedication ..... **ii**

Acknowledgements ..... **iii**

Table of Contents ..... **iv**

List of Tables ..... **ix**

List of Figures ..... **x**

PART I: RESEARCH OVERVIEW **1**

CHAPTER 1: INTRODUCTION 1

Research Background 1

Research Objectives 3

Research Motivation 4

Research Scope 4

Research Significance 5

Research Methodology 5

Research Limitations 14

Research Organization 14

PART II: RESEARCH CONTEXTUAL RAMEWORK **15**

CHAPTER 2: PROJECTS AND THEIR MANAGEMENT 15

Project and Project Management: Definition 15

Project Management vs. General Management 17

Project Management Applications 18

CHAPTER 3: CONSTRUCTION PROJECT MANAGEMENT 19

Nature and Characteristics of Construction Projects 19

The Construction Industry in the Developing Countries 20

Construction Project Management 21

CHAPTER 4: PROJECT MANAGEMENT IN THE DEVELOPING COUNTRIES. 23

Introduction 23

Nature of Projects and the Project Environment in Developing Countries 24

General Condition of Project Management in Developing countries 26

Challenges of Project Management in Developing Countries 27

CHAPTER 5: CONSTRUCTION PROJECT MANAGEMENT IN ETHIOPIA 36

PART III: RESEARCH CONCEPTUAL FRAMWORK 40

CHAPTER 6: PROJECT MANAGEMENT MATURITY 40

Introduction 40

Maturity: Concept and Definition 41

Maturity Models 44

Applications of Maturity Models 47

Maturity Assessment Process 48

CHAPTER 7: REVIEW OF MATURITY MODELS 50

Capability Maturity Model-CMM 50

Project Management Process Maturity Model-PM2 51

PM Solutions' Maturity Model 53

Kerzner's PM Maturity Model -PMMM 54

Organizational Project Management Maturity Model-OPM3 55

Maturity Models in the Construction Industry..... 58

Maturity Models in Developing Countries 61

Capability Maturity Model Integration-CMMI 63

PART IV: PROPOSED PM MATURITY MODEL..... 70

CHAPTER 8: PROPOSED PM MATURITY MODEL..... 70

Concept of Maturity Revisited..... 70

Why a New Maturity Model? 73

What does the Proposed Model look like? 80

Proposed Model's "Practice Maturity" Dimension 80

Proposed Model's "Processes Maturity" Dimension..... 84

Structure of the proposed process maturity model 88

Determination of maturity for Knowledge (process) and an organization 94

CHAPTER 9: VALIDATING PROPOSED MATURITY MODEL..... 99

Proposed Maturity model Validation Based on (Bruin, etal, 2005) Framework 99

Proposed model's Process Maturity vs. Reference Model Based Maturity..... 107

Proposed Model's Practice Maturity-Vs. Reference Model based Maturity..... 109

PART V: RESEARCH ANALYSIS 111

CHAPTER 10: RESEARCH RESULT AND DISCUSSION 111

Introduction..... 111

Practitioners interviewed 112

Maturity Assessment Result and Discussion 113

Maturity Assessment Result- Process maturity Dimension 113

Maturity Assessment Result- Practice maturity Dimension 115

CHAPTER 11: PM MATURITY ACROSS CATAEGORIES 119

ISO vs. Non-ISO Contractors' PM Maturity 119

Capacity Building Program (CBP) Vs (Non-CBP) Contractors PM Maturity 121

Road Contractors vs. Building Contractors PM Maturity 123

CHAPTER 12: MATURITY ACROSS PM KNOWLEDGE AREAS 126

Maturity of Project Scope Management 126

Maturity of Project Time management 129

Maturity of Project Cost Management 132

Maturity of Project Financial Management 134

Maturity of Project Quality Management 137

Maturity of Project Human Resource Management 140

Maturity of Project Communication Management 142

Maturity of Project Risk Management 145

Maturity of Project Procurement Management 149

Maturity of Project Equipment Management 152

Maturity of Project Materials Management 155

Maturity of Project Safety Management 157

PART VI: RESEARCH FINDINGS AND RECOMMENDATIONS..... 160

CHAPTER 13: RESEARCH MAJOR FINDINGS 160

Chapter 14: RESEARCH RECOMMENDATIONS 166

Recommendation for Action..... 166

Recommendations for Further Research..... 168

Concluding Remarks..... 170

APPENDICES 171

Appendix-A: Cover Letter sent to Contractors 171

Appendix-B: Questionnaire sent to Contractors 172

Appendix-C: Questions adopted from Reference maturity survey questionnaire 203

Appendix-D: Cover Letter sent to PM Practitioners..... 206

Appendix-E: Questionnaire for Rating of the Practices 207

Appendix-F: Questionnaire for Rating of Importance of Knowledge Areas..... 220

Appendix-G: CMMI Maturity Model Description 225

Appendix-H: Thesis Analysis result 233

Appendix-I: Hypothesis Test Result..... 251

Appendix-J: PM Solution Time Management Maturity 266

Appendix-K: Mapping of Specific Goals and Specific Practices..... 268

Appendix-L: List of Contractors that Participated on the Research 272

Bibliography 277

List of Tables

Table 1: Projects and the Project Environment in Developing and Developed countries 25

Table 2: PM2 Maturity Model's Summary..... 52

Table 3: PM solutions' five Maturity Levels and their Key attributes 53

Table 4: Summary of Kerzner's PM Maturity Model 54

Table 5: Generic Goals and generic Practices of the process Maturity Dimension..... 90

Table 6: Specific Goals and Specific Practices for Scope and Time Management 92

Table 7: Decisions made when designing a Maturity Model 100

Table 8: Summary of the demographics of participating contractors..... 111

List of Figures

Figure 1: PM functions which are sensitive to risk factor in different economies 26

Figure 2: Typical Five level Maturity Model 45

Figure 3 structure of the proposed Maturity model. 88

Figure 4: (Bruin, etal, 2005) 's maturity model development framework..... 99

Figure 5: Contractors' PM maturity: Process dimension vs. Reference Model 108

Figure 6: PM knowledge Areas maturity: Process dimension vs. Reference Model..... 108

Figure 7: Contractors PM maturity: Practice dimension vs. Reference Model 109

Figure 8: PM knowledge Areas maturity: Practice dimension vs. Reference Model.... 110

Figure 9: Construction PM Process Maturity summary of Contractors 114

Figure 10: Construction PM Knowledge Area Process Maturity 115

Figure 11: Construction PM Practice Maturity Summary of Contractors 116

Figure 12: Construction PM Practice Maturity of the Knowledge Areas..... 116

Figure 13: Process Maturity vs. Practice Maturity of Contractors 118

Figure 14: ISO vs. Non-ISO Contractors Construction PM Process Maturity 119

Figure 15: ISO vs. Non-ISO Contractors Practice Maturity..... 120

Figure 16: CBP vs. Non CBP Contractors PM Process Maturity..... 122

Figure 17: CBP vs. Non-CBP Contractors Practice Maturity..... 122

Figure 18: Road Contractors vs. Building Contractors Process Maturity 123

Figure 19: Road vs. Building Contractors Construction PM Practice Maturity 125

Figure 20: Scope Management Process Maturity 126

Figure 21: Scope Management Practice Maturity 128

Figure 22: Time Management Process Maturity 130

Figure 23: Time Management Practice Maturity Summary 131

Figure 24: Project Cost Management Process Maturity Summary..... 132

Figure 25: Project Cost Management Practice Maturity..... 134

Figure 26: Financial Management Process Maturity Summary 135

Figure 27: Financial management Practice Maturity..... 136

Figure 28: Quality Management Process Maturity..... 138

Figure 29: Quality Management Practice Maturity 139

Figure 30: Project Human Resource Management Process Maturity..... 141

Figure 31: HR Practice Maturity..... 142

Figure 32: Communication Management Process Maturity 143

Figure 33: Communication Management Practice Maturity 144

Figure 34: Risk Management Process Maturity..... 146

Figure 35: Risk Management Practice Maturity..... 147

Figure 36: Procurement Management Process Maturity 150

Figure 37: Procurement Management Practice Maturity..... 151

Figure 38: Equipment Management Process Maturity 153

Figure 39: Equipment Management Practice Maturity..... 154

Figure 40: Material Management Process Maturity 155

Figure 41: Material Management Practice Maturity..... 157

Figure 42: Safety Management Process Maturity..... 158

Figure 43: Safety Management Practice Maturity 159

PART I: RESEARCH OVERVIEW

CHAPTER 1: INTRODUCTION

Research Background

The construction industry plays significant role in the economy of developing countries. For example, in many developing countries, major construction activities account for about 80% of the total capital assets, 10 % of their GDP, and more than 50% of the wealth invested in fixed assets. In addition, the industry provides high employment opportunity, probably next after agriculture [(Ofori, 2006), (Jekale, 2004)[1]]. Despite the construction industry's significant contribution to the economy of developing countries and the critical role it plays in those countries' development, the performance of the industry still remains generally low. As (Idoko, 2008)noted, "…many projects in developing countries encounter considerable time and cost overruns, fail to realize their intended benefit or even totally terminated and abandoned before or after their completion …" Moreover, the development of the construction industry in developing countries generally lags far behind from other industries in those countries and their counter parts in developed nations. Generally, as [(Ofori, 2006) & (Jekale, 2004)] concluded, "The construction industry in developing countries failed to meet expectations of governments, clients and society as a whole".

[1] citing [(A.D. Austen and R. H. Neale, 1984), and (Lioyd Rodwin, 1987)]

Similar to the case with other developing countries, the Ethiopian construction industry shares many of the problems and challenges the industry is facing in other developing countries, perhaps with greater severity. Given the critical role the construction industry plays in Ethiopia and other developing countries, and the poor level of performance of the industry in those countries, improving the performance of the industry ought to be a priority action. As contractors are one of the key players in the industry and the makers of the final product, any development and improvement initiatives in the industry has to consider ways of improving the capacity and capability of the contractors.

Previous, research works by [(Adams, 1997), (Long, etal.2004) and others] have indicated poor managerial capability of contractors to be one of the critical problems of the construction industry in developing countries. Thus, improving the managerial capability of contractors need be one of the priority considerations for improvement of capability of contractors in developing countries. Researches by (Dlungwana & Rwelamila, 2004), and others have also strongly emphasized the importance of improving the management skills of contractors. As most of the works of contractors is managed as a project, improving the contractors' project management capability can significantly contribute to the overall improvement of contractors' capability to deliver successful projects.

Systematic and sustained improvement effort requires knowledge of where the current status of the practice is, where desired to go, and the gap between the two. In addition, systematic and sustained improvement effort demands, identifying critical and priority area, continually assessing results of improvement efforts and taking appropriate action. So far, little or no research has been done in the country in this regard. This thesis research is thus undertaken to fill the gap, primarily by doing the foundational work of determining where we are and where we need to go, leaving aside the how, for further research.

Research Objectives

The main objectives of this thesis research are to:

1. Assess whether and to what extent the processes, practices under each of PMBOK's Project Management knowledge areas are being applied by Ethiopian contractors in managing their construction projects.
2. Propose a framework (maturity model) for use in assessment of Maturity of PM in the construction industry of Ethiopia.
3. See if there is difference in Maturity of PM Practice between different categories of contractors in the country.

Research Motivation

I decided to do this thesis research on such a very broad topic (for a master's thesis) purposely and ambitiously, however, mistakenly underestimating the enormity of the effort it takes. The two main reasons that drive me to do so were:

1. My interest to use the opportunity to help me realize my aspirations in my professional development goal. Being a junior and ambitious academic staff , I was looking for a broad research topic that would enable me consolidate my PM knowledge, its practice in the context of the construction industry and developing countries , so that it can help me in the future in research ,teaching and consultancy services in the area.
2. My desire to do something that can, somehow, contribute to the development of Project Management.

Research Scope

This research on Maturity of PM in the construction industry of developing countries (Ethiopia) is limited in scope to the following:

1. The study is limited to the PM maturity in the construction industry of developing countries, specifically that of Ethiopia.
2. Only contractors' perspective is considered in the research, hence the PM maturity of the industry from the client's organization perspective could be totally different.
3. The study has covered only Ethiopian Grade -1 contractors (the highest level) in Ethiopia. Thus, the research result should be taken only as indicative of the PM maturity of Ethiopian grade-1 contractors.

Research Significance

The major contributions or significance of this research are:

1. The maturity assessment result of this research can be used as initial benchmark information in prioritizing and designing improvement action. Further the same result can also be used as a baseline to compare the success of or impact of future improvement efforts.
2. The proposed model and its questionnaires can be used in assessing maturity of construction PM. In addition, the proposed model can serve as a guide in implementing PM and designing improvement effort.
3. It has identified gaps in the existing maturity models for further refinement of those models.
4. It has assessed impact of recent PM development efforts and the impact of ISO certification in helping contractors PM maturity.
5. Revisited concept of maturity and attempted refining the concept

Research Methodology

The main purpose of this research was to assess whether and to what extent the processes, practices and tools under each of PMBOK's Project Management knowledge areas are being applied by Ethiopian contractors in managing their construction projects. Additional objectives of this research was to propose a framework (maturity model) for use in assessment of Maturity of PM practices in the construction industry of Ethiopia and to see if there is difference in maturity of PM Practice between different categories of contractors in the country.

To achieve these objectives the following steps have been followed

1. Review of literatures on PM, Construction PM, and PM in developing countries to identify areas that are peculiar to construction industry and developing countries for inclusion in assessment.
2. Literature Review of existing PM maturity models for potential use in assessment of PM maturity of contractors in Ethiopia.

The review of existing maturity models has revealed two major gaps[2] in the existing models studied. In order to address the identified gap a new maturity model was proposed. The following tasks were undertaken to develop the proposed maturity model.

1. Literature review
    a. To identify knowledge areas to be included.
    b. To identify processes and practices to be included under each knowledge area.
2. Questionnaire survey
    a. To classify the processes and practices by practitioners as Basic, Intermediate (Average) and Advanced for use in the practice dimension of proposed model.
    b. To determine the relative importance of the knowledge areas included to determine their relative weight to be used in calculation of maturity score and for use designing a prioritized improvement framework
3. Final development and Validation of the model using (Bruin, Rosemann, Freeze, & Kulkarnil, 2005) framework

---

[2] See Why a New Maturity Model? on page 82

Finally, using the developed model maturity assessment of the contractors has been undertaken by using questionnaire survey. The result of the assessment was analyzed to determine the PM maturity of the contractors and also used to further validate the proposed model.

Research Population and Sample

Only Grade-1 contractors in the country were included in this research. The decision to limit the scope of the study only to Grade-1 contractors is made for three main reasons.

1. Grade-1contractors (the highest level contractors in Ethiopia) usually undertake most of the large projects given to local contractors; hence, impact of any improvement achieved will significantly contribute to the overall improvement of the construction industry's performance.
2. Grade-1 contractors have better organizational, human and financial capability than contractors at lower level; hence they are better suited for starting efforts of PM development and improvement in the industry.
3. Contractors at lower grade (such as grade-3,4,5,6…) were excluded from the study mainly as there is a significant gap between those contractors at grade -1 and the lower grade contractors in terms of capacity and PM capability, thus, it was thought that this will create difficulty in generalizing the research result. Grade 2 contractors were excluded from the study specifically because they are very few in number (only three grade 2 contractors were registered by Ministry of Works & Urban Development when this research was conducted).

Contractors that took part in the research were selected based on a list obtained from Ministry of Works and Urban Development, Ethiopian Contractors Association and Ethiopian Road Authority (ERA). A total of 40 contractors of which 32 of them local and 8 of them international, were randomly selected from the above lists to take part in the research. As the sizes of the questionnaire was large (23 pages) and in orders to illicit the contractors' interest and get their commitment, the researcher has delivered the questionnaire in person to the contractor's offices and explained them the objective and importance of the research to the contractors and the construction industry in general. Further, the contractors were promised to be given the research report and a specific report that assess maturity of their organization relative to other participant organizations. The same was also included on the cover letter sent to the contractors[3]. This has helped to obtain higher response rate and complete response from the participant contractors.

For the proposed maturity model development part, the research population included professionals who have worked as Project manager in construction projects. The research sample is selected through convenience sampling (peer recommendation as to the PM knowledge and professional competency of respondents).Thus a total of 18 respondents were selected and two survey questionnaires were sent to each respondent, one questionnaire for rating the practices under each of the 12 knowledge areas as Basic, Intermediate and Advanced practice; and a second questionnaire to compare the relative importance of each knowledge areas for a successful management of construction project.

---

[3] see Appendix-A: Cover Letter sent to Contractors on page 194

Survey Design

This research is descriptive research as it tries to describe the current status of PM practice in the construction industry of Ethiopia. For this research, from different data collection method, paper survey was used primarily because of its lower cost and time and convenience to include large sample size. Even though, a case study known to give detailed information and better insight ;it was not used in this research as it takes substantial time and resources ,further difficulty of selecting representative cases and difficulty of generalizing results were also additional reasons for not using case studies.

Generally three surveys were conducted in this research; the first solicits opinion from practitioners and academicians as to the relative importance of the practices identified through literature review for the 12 construction PM knowledge areas covered in the research. The second questionnaire also solicits opinion from the practitioners as to the relative importance of the knowledge areas for prioritizing improvement efforts. The third questionnaire is used to assess the PM maturity of contractors based on the proposed model and a reference model.

The first questionnaire[4] that was distributed to the 18 practitioners has two parts. Part-I asks biographical information such as level of PM training, years worked as PM, Part-II asks respondents to rate the PM practices under each of the 12 knowledge areas as basic, intermediate and advanced based on their perceived importance to the attainment of objectives of each of the knowledge areas. The second questionnaire[5] asks to compare the 12 knowledge areas pair wise as to their relative importance to the success of a project.

---

[4] See Appendix-E: Questionnaire for Rating of the Practices on page 234

[5] See Appendix-F: Questionnaire for Rating of Importance of Knowledge Areas on page 248

The third survey questionnaire which was used to assess PM maturity of contractors has four parts. Part I asks biographic information such as the grade of contractors, category of contractor and year for which the contractor was in business. Part-II asks whether the organization is practicing or has the capability to perform PM processes or practices that have been identified through literature review. All processes in PMBOK were included in the assessment. Part –III asks how each of the knowledge area is being performed. In this part a total of 12 questions were asked for each knowledge areas to determine whether the implementation of the knowledge areas was planned, has a defined and documented process, whether the process is standard, monitored and controlled etc. Questions in Part-I, II and III give the respondent four options throughout: 'yes', 'no', 'does not apply', and 'don't know'. These types of questions were used as they help obtain clear-cut answers.

The last part (part IV) has 12 questions that are partially adapted (for 8 of the 12 knowledge areas) from a reference [6] maturity assessment survey. Each question under this part gives three descriptions of maturity for the twelve knowledge areas covered in this study from which the contractors can choose the one which is closest to their condition. These questions were included to validate the proposed model. One of the important assumptions that were made initially in the study and developing the proposed model was that Ethiopian contractors are not matured and their PM maturity will not pass

[6] See Appendix-C: Questions adopted from Reference maturity survey questionnaire on page 231

defined level (level-3 in the majorities of maturity models)[7].Thus, the questionnaire used in this research was designed to measure maturity up to defined level only. This assumption are proven to valid by the outcome of this research (the average maturity level is found to be 1.30-informal practice level; which is roughly equivalent to level-1 in the majorities of maturity models).This has helped save significant time and lower the number of questions to be asked in the survey, despite this, the size of the survey questionnaire still remains large.

All questions in the three surveys have been designed to be easily understood. Moreover, during the completion of the survey it was explicitly required to be filled by a project manager or a person who has previously worked as project manager. This ensures collection of pertinent information as the respondents chosen were people who have the knowledge and information about their organization and practice of PM.

Ensuring validity and reliability of the data obtained in survey is critical as most of the time compared with other data gathering method such as interview and case study approach; generally surveys are prone to bias and misunderstanding and thus overall the validity is doubtful. According to (Ahuja, 2001) research instrument could be validated either by testing and retesting or using independent equivalent measurement, or both. In this research both approaches were used to attain different validation objectives. The test retest approach was used to see whether the response of the respondents was bias free.

---

[7] similar studies in Croatia and Mauritius have assumed the same(see further (Sukhoo, Barnard, Eloff, & Poll, 2005)& (Supic, 2005)

For the purpose of ensuring validity, nine contractors were randomly selected from the 21 contractors that returned complete response, and the same questionnaire was administered by the researcher through scheduled interview. In the interview the respondents were required to substantiate their response with explanation of supporting practices and documentation. Analysis of the data showed 85% of agreement of the responses obtained by survey and scheduled interview. The 15% difference could be explained as a difference due to misunderstanding of the question and self-favoring tendency of the respondent during self-assessment (this is a fair degree of accuracy ,hence practically it could be estimated that the actual maturity score to be 85% of what is obtained through self-assessment) . Further, to control the impact of respondent bias, the researcher has delivered the survey in person to the contractors' offices and explained the importance of accurate data for the research and also to the participants' organization as they were promised assessment report specifically prepared for their organization that could be used for internal consumption by the organization[8] (know their strengths and weakness and know their standing with respect to their competitors).

The above effort proved to work as the high correlation in response filled by respondents and the one determined by the researcher indicate.

Equivalent testing was employed to validate the proposed model and see the ability of the assessment questionnaires to measure maturity. In this regard, summarized questions from Reference maturity assessment survey questionnaire were incorporated in the main survey and a correlation analysis was done to see whether there is strong correlation

[8] See Appendix-A: Cover Letter sent to Contractors on page 194

between the maturity as determined from the proposed model and as determined from the reference questions. The analysis shows strong correlation[9]. Moreover, pilot testing of the questioner was conducted to ensure coverage of all important aspect and clarity of the questions. Further, the requirement that the survey to be filled only by Project Managers; also has contributed to ensuring validity.

Data Analysis

The data analysis was done using both inferential (correlation analysis and hypothesis testing) and descriptive statistics. In calculating maturity of knowledge areas, all practices under the goals of each knowledge areas[10] were given equal weight. Similarly for the purpose of determining the construction PM maturity of the contractors, all the knowledge areas were considered to have equal weight, as the effort to determine a relative weight for the contribution of the different knowledge areas has failed due to absence of significant inter-rater agreement[11]. In addition, all responses other than 'yes' were construed as 'no' in the maturity calculation. The argument for this is that, what is sought to be known is whether the practice is performed or not, and as the questionnaire was filled by a competent PM, lack of awareness of a practice is assumed to be most likely due to the non-implementation of the practice. Moreover, it was assumed that the impact of lowering reported maturity due to the above assumption will to some extent be compensated by the common self-favoring bias that occurs in self-assessment.

---

[9] See pages 281 & 282 in **Appendix-I**: Hypothesis Test Result

[10] See Appendix-K: Mapping of Specific Goals and Specific Practices on page 304

[11] See Appendix-I: Hypothesis Test Result on page 296

Research Limitations

1. Due to limitation of time and resource, more reliable and informative method such as maturity assessment of organizations based on artifacts and interview, and the use of focus group in developing content of the model were not used. The research used self-administered questionnaires surveys. However, as explained in page 11 some efforts have been taken to minimize the impact.
2. Due to limitation of time the research adopted only PMI's standards.
3. The knowledge area of Environmental management is not covered by this study as there is little or no awareness and practice of the knowledge area in Ethiopia when this research was started.

Research Organization

Part I discusses the research background, goal, motivation and the research methodology. Part II discusses the research contextual framework. This section has reviewed concept of PM in general and concept of PM in developing countries and in the construction industry. Part III discusses the research Conceptual framework. In this section, review of concept of maturity and review of eight maturity models has been presented. In part IV discussion of the proposed maturity model development is presented. In this section

Concept of maturity is revisited, and discussion of the gaps identified in the existing models is presented along with discussion of the details of the proposed model and validation of the proposed maturity model. Part V presents discussion on the research analysis result across different categories of contractors and along the different knowledge areas of construction PM. The last section VI discusses the research finding and recommendations.

PART II: RESEARCH CONTEXTUAL RAMEWORK

CHAPTER 2: PROJECTS AND THEIR MANAGEMENT

Project and Project Management: Definition

Many authors and references have defined project in different ways emphasizing its different aspects. Summarizing those definitions given, this research defines a project as:

A temporary endeavor (that has definite beginning and end time)undertaken following specific cycle of Initiation, Definition, Planning, Execution and Close to create a unique product, service, or result through novel organization and coordination of human, material and financial resources.[(Project Management Institute (PMI), 2004). (Muriithi & Crawford, 2003), (Stanleigh, 2007)]

A project has a defined scope, is constrained by limited resource, involves many people with different skill and, usually progressively elaborated throughout its life cycle. [(Stanleigh, 2007), (Cleland & Ireland, 2002), (Wheatley)]

Similar to the case for project, many and different definitions were given for project management. Summarizing those definitions this research defines Project management as:

The application and integration of modern management and project management knowledge, skills, tools and techniques to the overall planning, directing , coordinating ,monitoring and control of all dimensions of a project from its inception to completion ,and the motivation of all those involved to produce the product ,service or result of the project on time, within authorized cost, and to the required quality and requirement, and to the satisfaction of participants.[(Chartered Institute of Building , 2002), (Fewings, 2005), (Carmichael, 2004)]

Project management deals mainly with coordinating resources and managing people and change. Generally "Managing a project includes: Identifying requirements, Establishing clear and achievable objectives, Balancing the competing demands for quality, scope, time and cost; Adapting specifications, plans, and approach to the different concerns and expectations of the various stakeholders" (Project Management Institute (PMI), 2004). Further, Pareto's 80-20 rule (the law of the vital few)[12], is highly applicable in managing projects, hence efforts need be focused on few and important or critical items (Carmichael, 2004).

Nine core knowledge areas of project management are identified in PMBOK. These are: scope, time, cost, risk, quality, human resources, communications, and procurement and integration management. Each knowledge area in PMBOK is composed of processes that are expected to be addressed to attain the objective of the knowledge areas. A total of 44 project management processes are identified in PMBOK for the nine knowledge areas. Management of projects is accomplished through the use of the above 44 processes. However, all the 44 process are not meant to be performed uniformly in the management of all projects. The project manager and the project teams need to decide which processes to employ, and the degree of rigor that will be applied to the execution of those processes. (Project Management Institute (PMI), 2004)

In addition to the above nine knowledge areas, there are other industry specific additional knowledge areas that the project manager should consider in managing projects. For

[12] states that, for many events, roughly 80% of the effects come from 20% of the causes

example, the construction extension to PMBOK includes four additional knowledge areas of financial, safety, environment and claim management.

Project Management vs. General Management

The fundamental difference between project management and general management stem from the difference in the type of work they manage. Project management deals with management of projects (which are temporary and unique) whereas, general management deal with management of operations (which are ongoing and repetitive). Generally project organization changes continually as the project progresses through its various phases and terminate when the mission is accomplished; whereas the ongoing organizations that manage operations sustain at least over a period of time and continue assuming a broader outlook [(Project Management Institute (PMI), 2004),(Hendrickson), (Carmichael, 2004)].

Despite the existence of fundamental difference between project management and general management; both general management and project management share many things in common. Both share the same basic philosophies, both make and implement decisions, allocate resources, manage organizational interfaces, and provide leadership for the people who are involved in performing the work. Generally, in addition to knowledge of project management, successful management of project demands knowledge of general management and working knowledge of application areas (for example for a construction project knowledge of construction)[(Cleland & Ireland, 2002), (Project Management Institute (PMI), 2004), (Hendrickson)].

Project Management Applications

Generally, Project management is used extensively in some form within many organizations. “There has been no identified profession or industry where project management practices will not work” (Cleland& Ireland, 2002).Using project management generally helps: to clarify goals and identify problem areas and risk; to isolates activities and easily monitor outcomes. (Project Management Institute (PMI)). Further, using PM enhances accountability as works can be isolated and responsibilities can be assigned; moreover, it helps focus attention on few specific and important tasks. Generally, According to (Cleland & Ireland, 2002) and others, Project management can best be applied when:

- Resources are to be shared among many units.
- Special attention or focus is to be given to important undertakings (example to focus attention on specific customers in specific market).
- Integration of systems and subsystems is sought within independent units.
- Dealing with ad hoc, complex, unfamiliar, unique, or rare; activities, problems and opportunities.
- Dealing with tasks that require pooling of many resources and capacities from diverse sources (example providing emergency response during disasters).
- It is desired to bring a wide range of experience and viewpoints into focus (example in research and product development or solving complex problems).
- Dealing with an undertaking that require massive input of capital, technology, skills, and resources.
- When it is desired to have unified management of a project-based contract in order to avoid the customer work with many different functional units.
- When there is a need to manage change.

CHAPTER 3: CONSTRUCTION PROJECT MANAGEMENT

Nature and Characteristics of Construction Projects

The management of construction project has some differences from the management of other projects. The differences mainly stems from the nature and characteristics of construction projects. The consideration of these differences is important for successful management of construction projects.

Generally construction projects:

- ✓ Are usually capital intensive, complex; and require significant management skills, involvement and coordination of a wide range of experts in various field. (Chartered Institute of Building , 2002).
- ✓ Are usually undertaken outside; hence, they are susceptible to many variables such as weather and traffic (Gould & Joyce, 2003).
- ✓ Must address the geography and conditions of the project site and the relation of the project to the environment. (Project Management Institute (PMI), 2007).
- ✓ Are subject to a variety of laws and regulations that aim to ensure public safety and minimize environmental impacts. (Bennett, 2003).
- ✓ Compared to most other industries, construction projects involve relatively intensive labor use, and consume large amount of materials and physical tools. (Jekale, 2004).

The Construction Industry in the Developing Countries

Construction is an industry that has a great impact on the economy of all countries. Almost, it is very difficult to think of any development activity that does not involve construction. All infrastructure facilities needed for development such as road , telecom ,electricity , power projects , and socioeconomic facilities such as school , hospitals ,factories etc.; and the very neighborhood we live in are all products of the construction industry. The role the construction industry plays in developing countries is quite significant. For example, in many developing countries, major construction activities account for about 80% of the total capital asset, 10 % of their GDP and; more than 50 % of the wealth invested in fixed assets. (Jekale, 2004)[13] . Despite the industry's significant contribution, its development and efficiency is relatively low compared to other industries. "High project performance and project success are not commonplace in the construction industry, especially those in developing countries" (Long etal, 2004). Moreover, in many countries, the productivity of the construction industry is one of the lowest and; its degree of high technology utilization is not comparable with that of other industries. Further, the overall management in the industry is at a low level. **"**The Construction industry's large scale scope and its use of huge capital is in sharp contrast with the low benefit (profit) and inferior management" (Guangshe etal, 2008).

The nature and characteristics of the Construction industry and construction projects in developing countries, is different from that of the developed countries in many aspects. According to (Jekale, 2004), the Construction industry in many developing countries is characterized by "too fragmented and compartmentalized; Public sector dominated

[13] citing (Lioyd Rodwin, 1987) and (A.D. Austen and R. H. Neale, 1984)

market; considerable government interventions; considerable foreign finance (dependency for public construction), and low development of indigenous technology". moreover, the construction industry in developing countries depend on imported input such as construction materials, machinery, and skilled manpower .In addition ,the industry is dominated by foreign construction firms; which execute almost exclusively all the major construction works (Adams, 1997).This is also the case in Ethiopia. Almost all major power projects and most of large road projects are constructed foreign contractors.

Construction Project Management

The management of construction projects has much in common with the management of similar types of projects in other industries (Hendrickson). "Much of the content of *PMBOK_ Guide* is also directly applicable to construction projects." (Project Management Institute (PMI), 2007). Even though, management of construction project is similar to management of other kind of project in many respects, it has also some peculiarities that differentiate it from managing other kind of projects such as software development. For example, unlike the management of many other projects, the project managers in construction project are often changed from one phase to another or some may specialize in only one phase of the construction project. (Project Management Institute (PMI), 2007).

In acknowledgment of the difference, PMI has published a supplemental guide for managing construction project (The construction extension - Guide to Project Management body of Knowledge-3rd edition). In this guide, four additional knowledge

areas of Project Safety Management, Project Environmental Management, Project Financial Management, and Project Claim Management are included.

According to (Chartered Institute of Building , 2002), the major task of project management in construction is primarily to coordinate professionals in the project team to enable them to make their best possible contribution to the project efficiently. In addition to knowledge of project management and general Management, managing construction projects requires an understanding of the design and construction process (Hendrickson). The ability to communicate and the ability to manage team are also very important for successful management of construction projects (Chen, Partington, & Qiang, 2009).

Hendrickson has summarized the functions of project management in construction as:

1. Specifying project objectives and plans including defining the scope, preparing the budget and schedule, setting performance requirements, and selecting project participants.
2. Maximization of efficient resource utilization through procurement of labor, materials and equipment according to the prescribed schedule and plan.
3. Implementation of various operations through proper coordination and control of planning, design, estimating, contracting and construction in the entire process.
4. Development of effective communications and mechanisms for resolving conflicts among the various participants.

CHAPTER 4: PROJECT MANAGEMENT IN THE DEVELOPING COUNTRIES

Introduction

Every project is implemented and managed locally, even if this is being done in accordance with some widely accepted standard. The nature of the project, its location, owner, purpose and objectives can have significant impact on the management methods to be used (Chmieliauskas). Thus, it is important to study project management practices in the context of developing countries to better understand and able to manage projects successfully in those countries. However, research works on project management in those countries has not yet received enough attention and still they are at infant stage (Jekale, 2004). In addition, the available information in the area is few and lack detail. Moreover, many of the available literatures focus on the so called "development projects" financed either by governments and/or donors. Hence, it is very difficult to find literature on the management of projects in the private sector or about project management by the private sector on the management of those development projects. Further, almost all materials in the area are written from the perspective of the client or financer, thus it is difficult to get literatures written on project management from the perspective of contractors. This seems also the case for project management in developed countries. Thus, the review presented in subsequent paragraphs is only an attempt to summarize the fragmented descriptions.

Project management methods have been extensively used by many public and private entities to solve their problems, manage scarce resources and, achieve important objectives (Andersen, 2008). For developing countries, the potential benefit of project management is extremely high and the proper application of it may even be critical; as in

those countries; resources are extremely scarce and, achievement of project objective, in most cases, is extremely important. The work of (Voropajev, 1998) also indicated that PM is much more important in developing economy (transitional economy) than it is in developed economies (as risk and change are extremely high in the developing countries). As the majority of projects in the developing countries are development related, failure of a project usually have a far reaching effect beyond financial losses; It may result in a " death", or delay of many children's hope to go to school or the hope to save many from poverty and frequent drought. Likewise, successes in projects in developing countries may mean a considerable contribution in improvement of the life of millions.

Nature of Projects and the Project Environment in Developing Countries

The nature of projects and the environment in which they are implemented in developing countries is different from that of the developed countries where PM is originated and developed [(Cusworth & Franks, 1993), (Voropajev, 1998), (Jekale, 2004)]. Most Projects in both developed and developing countries are complex and operate in a dynamic environment. However, projects in developing countries are highly uncertain, and operate in a highly unstable, unpredictable and poorly resourced environment. This poses a challenge on project manager in developing countries which is not seen by their counter parts in the developed nations. [(Cusworth & Franks, 1993), (Jekale, 2004)]. According to (Voropajev, 1998)Project management functions(processes) that are sensitive to changes such as management of risk, procurement, contracts, scope, configuration, communications, and information are more important in managing projects in developing countries than in developed countries' context (see Figure 1). The

Project management functions less exposed to change such as management of quality, time, cost, human resources become more important in the developed economies than developing countries' context. Further, according to [(Muriithi & Crawford, 2003), (Cusworth & Franks, 1993)] management of externality of projects and the political and risk management skill become very important in the context of the developing countries. Table 1presents a summary of the major difference in the nature of project and the project environment in developing and developed countries.

Table 1: Projects and the Project Environment in Developing and Developed countries

Developing countries	**Developed countries**
Most projects are public owned*	Most are private*
Infrastructure projects dominate**	More or less mix of projects*
Private projects are short time*	Medium time*
Highly sensitive to the environment**	Moderately sensitive to the environment
Complex ,uncertain ,unstable and unpredictable environment**	Complex , dynamic ,relatively stable and to some extent predictable environment***
Extreme scarcity of resources***	Resource available at cost (constrained)
Underdeveloped private sector and forces of market*	Developed private sector and forces of market*
Significant involvement of government in business*	Market economy*

* (Voropajev, 1998) ** (Jekale, 2004) *** (Cusworth & Franks, 1993)

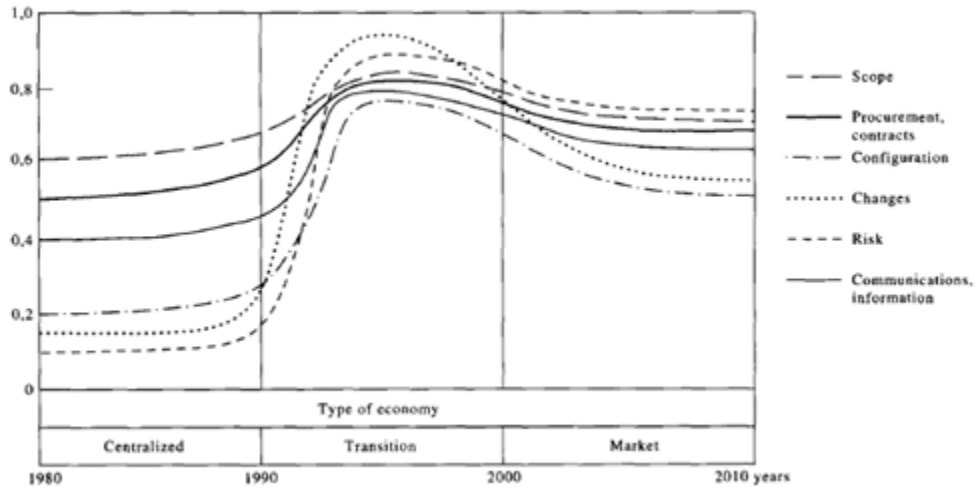

Figure 1: PM functions which are sensitive to risk factor in different economies [14]

As seen in the diagram importance of the knowledge areas shown

(Scope, procurement, change, risk and communication management) reach their peak in transition economy (the stage where most developing countries are found)

General Condition of Project Management in Developing countries

Project Management in developing countries is facing many challenging problems and non-conducive environment [(Jekale, 2004), (Abbasi & Al-Mharmah, 2000)]. Many projects in such countries end up uncompleted, abandoned or unsustainable [(Sonuga, Aliboh, & Oloke, 2002), (Andersen, 2008)]. For example, the cost of abandoned projects in Nigeria is estimated to be $12.65 billion, requiring at least twice as much additional fund for their completion [(Alutu & Udhawuve, 2009) citing Aliyu _2000].

Further, the implementation of most projects in those countries is amalgamated with normal operational undertaking in functional organizations that have low capacity

[14] Source: (Voropajev, 1998)

(Jekale, 2004). Further, corruption has become a challenge complicating project management in those countries [(Sonuga, Aliboh, & Oloke, 2002), (Andersen, 2008)]. As (Jekale, 2004) has summarized it "…. Poor support infrastructures, low level of technology, low capacity of implementing institutions, scarcity of skilled professionals and financial resources, unreliable communication ,poor and protracted documentation, high turnover of leadership and workmen, considerable political instability ,low level or absence of accountability and transparency, and long and tedious formal decision-making procedure are typical condition in Developing countries …." The majority of the above factors affect the practice of Project management, and the majority of them are either non-existent or not common in the developed countries where Project Management is developed and thrived.

Challenges of Project Management in Developing Countries

A number of factors have been identified for the poor performance of projects in developing countries. Generally factor such as government policies, insufficient funds, withdrawal by donors, shortage of foreign exchange, inappropriate contract conditions, political priorities, poverty, socio-cultural conditions, corruption , low institutional and human capacity ,and occurrence of unexpected events such as war, drought are considered to be the major factors behind the poor performance of projects in developing countries [(Idoko, 2008), (Jekale, 2004), (Andersen, 2008)]. Subsequent paragraphs provide detail discussion of the challenges.

Projects in developing countries are highly influenced by their external environment. [(Kuruoglu & E.Ergen), (Jekale, 2004)]. Moreover, the project environment in many developing countries is unstable and characterized by rapid change of markets, shift of funding sources, frequent change of government policies and the business environment [(Kuruoglu & E.Ergen)]. In addition, projects in those countries are affected by prevalence of corruption, war, drought and governments political priorities [(Alutu & Udhawuve, 2009), (Jekale, 2004)]. For example in Nigeria, the cost of construction materials was reported to have shown a 400% increase over a period of two years because of change in government policies (devaluation of its currency and inflation) (Sonuga etal,2002). Likewise, in Ethiopia inflation has increased in double digit and cost of construction has almost doubled in the last three years.

According to (Cusworth & Franks, 1993) "Most of the special problems of project management in developing countries is related to the environment, which can generally be attributed to the turbulence (the tendency of unpredictability) and rapid change in the project environment; and severe scarcity of resources in those countries". These prevailing external factors are making the planning and generally management of project extremely challenging for the poorly trained highly constrained project managers in those countries. The above generalizations are in contrast with those in the developed countries .According to the Standish Group 2004 Report: the main reason for project failure (in developed countries) is not the absence of general resources or financial resources, but the lack of Project management capability (Malan etal, 2007). Further, in the developed countries external conditions such as market & politics are less important for the success of projects (Torp, Austeng, & Jekale).

Lack of institutional capacity and trained personnel is also another main reason why projects fail in developing countries (Voropajev, 1998). Further, the lack of awareness about the benefit and application of Project Management in many developing countries' organizations combined with the presence of few trained project managers and wrong perception that sees project managers as an unnecessary expense has contributed to the low level of development of project management in those countries. [(Andersen, 2008), (Idoko, 2008)].The presence of only three PMI chapters in Africa countries attest to the value and attention given to project management in developing countries. Further, according to (Nguyen, 2007), many of the efforts to transfer Project management knowledge and technology to the developing countries were not successful mainly due to : lack of support of senior management and a perception that project management methodology is not applicable in developing countries.

In addition to lack of institutional capacity and trained PM professionals, the nature of project management in itself is a challenge for many project managers in developing countries. According to (Pant, Allinson, & Hayes, 1996) , the principles of PM are contrary to what the managers in developing countries are accustomed to do and trained for. (Muriithi & Crawford, 2003) Concluded the same based on similar study done on PM in Africa.

Conventional project structure breeches classical principles (of management-which is practiced in many developing countries); such as division of labor, organizational hierarchy and unity of command (which are adhered to in developing countries). It demands certain qualities from its members including objectivity, flexibility, and preparedness to take risks, ability to make decisions independently, low preference for conformity, low power orientation and low rule orientation (rare attributes in Developing Countries (see (Muriithi & Crawford, 2003)*)*. Individuals employed in project organizations are expected to be able to work well in teams, to have the ability to lead and to maintain close ties with other organizational members (almost none existent in developing countries). On the evidence of this …, it may be difficult for (project managers in Developing countries) …. to fulfill requirements of project management . (Pant, Allinson, & Hayes, 1996)

Another important reason for failure of projects in developing countries is the way projects are set up and implemented in those countries (Sonuga, Aliboh, & Oloke, 2002). This is mainly applicable to the so called "development projects." In such projects, it is common to see lack of involvement and consultation of users and the tendency of some donors to finance only what they wanted or perceived to be important for the recipient rather than based on need of the users (Andersen, 2008). Sometimes public projects in developing countries (both government and donor financed) fail due to lack of comprehensive planning and study .Such projects fail to consider the capacity and nature of the local support organization, economic, technological, and physical environments in the planning. Because of this, many of such projects left non-operational simply because there were no parallel work done to train staff or plan how to pay for the staff that runs them and provide the necessary support(such as spare parts, maintenance crew etc) to run them .

Most of the reasons for failure of projects and their poor management in developing countries can be associated with the failure to consider the specific context of developing countries and critically adopt the PM methodologies to the context of developing countries.[(Muriithi & Crawford, 2003), (Abbasi & Al-Mharmah, 2000), (Jekale, 2004), (Voropajev, 1998), (Pant, Allinson, & Hayes, 1996)…]. This is because the inherent assumption about people, culture, the environment and economic condition that PM methodologies (which are developed in the developed nations) consider, vary significantly in the developing countries [(Muriithi & Crawford, 2003), (Jekale, 2004)]. Unfortunately, the literature review has revealed that only few studies are done considering the above , except very few such as [(Muriithi & Crawford, 2003), (Cusworth & Franks, 1993)] the majorities of them offer little insight on how to adopt the project management methodologies , tools and techniques to the cultural and economic condition of the developing countries context.

Some researchers such as [(Muriithi & Crawford, 2003), (Cusworth & Franks, 1993)] have tried to use Hofstede's four dimensions framework in their study of PM in developing countries (in Africa) to explain application of project management in the context of developing countries. They showed how cultural variation in the developing world affects application of PM and the need to critically adopt PM to the context of the developing countries.

Hofstede's four dimensions framework for cultural study are:

- Power distance: the tendency to accept unequal distribution of power in a society.
- Uncertainty avoidance: the extent to which ambiguity is perceived as threatening and risk-taking behavior is avoided.
- Masculinity/femininity: the extent to which masculine traits such as achievement, courage and competition are valued over feminine values and behavior such as caring and sympathy.
- Individualism/collectivism: the extent to which people define themselves as individual entities or in terms of groups as the primary source of solution to their problems.

According to (Muriithi & Crawford, 2003) , the above tendencies are reflected in organizations in the way people behave in their work and structure their work .For example , tall organizational structure, unwillingness of middle managers to make decision without reference to superiors, rare open criticism and willingness to disagree with supervisors are indicative of high power distance. Low risk taking, emotional resistance to change, a preference for clearly laid out rules and heavy involvement of managers in details is indicative of high uncertainty avoidance. Many African cultures score high on Power distance and Uncertainty avoidance and Medium on Masculinity and low on Individualism [(Muriithi & Crawford, 2003) citing Kiggundu MN 1989 & Blunt P, Jones ML]. The implications of these findings to project management were discussed in detail by (Muriithi & Crawford, 2003). The high power distance in developing countries (Africa), implicate the importance of high level of commitment, follow up and fast decision making by top management in such countries. This is because middle

managers do not feel empowered to make decision and defer always to the top. Further, it emphasis the importance of having a clearly defined rules, structure, processes, methodologies, roles, responsibilities and authority. This provides clarity and minimizes uncertainty and the need to take risk by the middle managers, thus creating a better atmosphere that encourages the middle managers to make decision and take responsibility.

The above discussion shows the importance and benefit of achieving at least level -2 (formally performed level[15]) of PM maturity (which requires use of structured approach based on some guide –as practitioners will have something to guide and usually do not need to make decision). In addition, the higher power distance and uncertainty avoidance shows the need to build a culture that foster project management before trying to attain maturity above Managed Level process Maturity. Those levels are defined at higher level of generalization as guidelines and users need to tailor them to their specific needs, thus requiring higher input and frequent decision making at lower level. Further, the higher power distance implicates the need to have a method that solicits the input of subordinates in a manner that make them feel secure.

In summary, success and implementation of projects in developing countries is influenced much more by the external environment than the internal environment. Thus project management in those countries should focus more on the management of the externalities of the project environment [(Muriithi & Crawford, 2003), (Jekale, 2004)]. According to (Muriithi & Crawford, 2003)], project Managers should be skilled in politics and interpersonal relationship skills, and use it to the advantage of the project.

---

[15] See Processes maturity on page 79

This has been found to be the crucial factor behind the success of Kenyan managers. In addition, continuous planning, risk management, resource planning and management should be given special consideration in the management of projects in developing countries. Further, the PM should work to continuously involve top management to get easily the necessary resources and facilitations, which otherwise would be very difficult [(Muriithi & Crawford, 2003)and others].

In addition, procurement and contract administration should be given special attention as it has significant impact on the cost and time of projects and is an area that is highly susceptible to risk and corruption. Further, the integrating function of project management is difficult in developing countries because top management is slow to delegate and the external environment is overpowering [(Muriithi & Crawford, 2003)]. Hence, PM's should work on relationship with the top management to get fast decision and the necessary power to get the support of others.

As discussed in the above paragraphs the environment in developing countries does not foster the application of project management. Thus, in the past, the efforts to promote development of PM in developing countries mainly dealt with how the environment in those countries should be changed to make it conducive and more favorable to PM (Cusworth & Franks, 1993). Now the tendency has shifted to the importance of critical works to adapt PM to the developing counties' environment rather than the other way around. The later one was advocated by many of the recent researchers in the area such as [(Jekale, 2004), (Voropajev, 1998), (Muriithi & Crawford, 2003) , etc]. However, any sound approach for the development of PM in developing countries should combine both

approaches; as some times it may be easier and more valuable to change the PM environment to adapt it to the need of PM rather than to adapt PM to the environment. Hence, there should be a planned effort to bring both, changes in the project environment to make it more favorable to the need of PM, as well as, critical adaptation of PM concepts and tools to the developing countries' project environment.

CHAPTER 5: CONSTRUCTION PROJECT MANAGEMENT IN ETHIOPIA

"A detailed literature on the management practices of construction projects in Ethiopia is difficult to find. As a result research works in such an industry is difficult or mystified" (Jekale, 2004).Despite this, this research has tried to summarize existing literature on the area, most of which are result of Master's thesis done at Addis Ababa University(Ethiopia) and a doctoral dissertation done abroad.

Like any developing country the construction industry plays major role and contributes highly to the development of the economy of the country. Next to agriculture, the industry provides one of the largest employment opportunities.

Developing countries like Ethiopia , spend substantial amount of their budgets in infrastructure development that involve significant construction works in projects such as construction of roads, buildings, water works, telecom civil works, etc. This is also the case in Ethiopia. For example, the Ethiopian government has spent about 50% of its total budget in fiscal year 2007/2008 for capital projects out of which road construction accounts about 33 %. (Ministry of Finance and Economic Development (MoFED), 2008). From project expenses in other sectors, the construction part accounts for the major part as most socio economic projects such as school and healthcare involve significant construction component. Even though significantly large amount of money is being poured in to infrastructure development, the infrastructure of the country is still considered to be very poor, even when seen by the standards of the Sub-Saharan countries. For example, the country's passengers and freight traffic, road density is one of the lowest compared to other Sub-Saharan Countries. From the huge hydropower

potential the country has, only less than 10% of it has been put in use (Ministry of Finance and Economic Development (MoFED), 2006). These all mean, enormous volume of infrastructure (construction) works is coming to the industry. Nevertheless, the construction industry of the country looks unprepared for these huge volumes of works to come. The industry is still in the infancy stage, growing unfortunately, slowly both technically and financially.

Like the industry in other developing countries, the construction industry in Ethiopia is plagued by many problems .The description of the current state of the industry given in various studies is summarized here under:

Generally the current state of the industry is characterized by:

- An inadequate capital base.
- Old and limited numbers of equipment and low levels of availability and utilization.
- Severe shortage of construction materials, most notably cement
- Low level of management, especially project management knowledge and practice (Low level of Contract administration, Project planning and Project monitoring capabilities).
- Deficiencies in technical, financial management and entrepreneurial skills.
- Small-scale local contractors which lack experience in construction management.
- Limited experience and participation of the private sector in large construction project or the provision of related consulting services.

- Outdated technology (insufficient and ineffective labor-based construction technology).
- Inadequate and inappropriate project organization structures, which lead to problems of authority, responsibility, communication and coordination, etc.

Generally speaking, according to (Jekale, 2004), there is not enough construction and management capacity in the country. The practitioners (in Ethiopia) are less experienced in project management. The management of construction project is highly influenced by the utilization of scarce financial and physical resource with controlling activities limited to cost and time monitoring dimensions only. Contractors cannot properly administer contract, most of them are not properly trained to prepare cost and schedule reports, quality records, safety reports, change order records, claims records, progress reports, payment requisition, etc. Most local contractors even don't have claim management knowledge or are not interested to pursue legitimate claim for fear of damaging working relationships and their reputation in the industry as they will be dealing usually with few public institutions (Dessa, 2003).

Many studies in the area have indicated the need to improve the capacity of contractors in areas such as financial management, project estimating and costing, total quality management, change management ,claim management, business planning , personnel and general management skill, etc which almost all can be included under the 12 PMI's knowledge areas of construction project management. This shows that improving the

project management capacity of contractors can significantly improve the current status of the construction industry in the country.

The need for the improvement and development initiative has already been acknowledged by the government of Ethiopian, and University Capacity Building Program (UCBP) has been initiated with the assistance of the German government to support the capacity of local contractors by providing managerial and entrepreneurial training and coaching that prepare contractors for ISO 9001certification. Contractors under the program were given training in areas such as modern contract and project management, modern financial and construction equipment management systems, general management and leadership, marketing, project and quality management.

PART III: RESEARCH CONCEPTUAL FRAMWORK

CHAPTER 6: PROJECT MANAGEMENT MATURITY

Introduction

Project management is being embraced, to some extent, by most organizations as the best way to develop and deliver new or improved products, services, and organizational process changes (Cleland & Ireland, 2002). It has been a continuous effort of researchers and practitioners to look for ways to develop and improve organizations' PM capability so that organizations may be able to benefit from project management. The improvement of PM capability of an organization can be realized in many different ways (training, mentoring, benchmarking, the use of new tools and techniques and use of maturity model, etc). Project Management Maturity models are just one such means that organizations can use in their pursuit of improving their Project Management capability.[(Cooke-Davies, 2005), (Cleland & Ireland, 2002), (Skulmoski, 2001)].According to (Cooke-Davies, 2005),the use of maturity models provides a frame work for purposeful and progressive development of project management capability of repeatedly delivering successful projects. Generally maturity models help an organization know how mature its project management practice is; that is, it helps the organization measure the degree to which it is executing Project management against the practice of its peers in the industry in general or best practice in the industry (Man, 2007).In addition, maturity models help frame improvement efforts by identifying priority area and suggesting improvement subjects.

Maturity: Concept and Definition

Maturity is defined by many writers differently in closely related way. Some of the definitions given are presented here under.

"Maturity is the extent to which a specific process is explicitly defined, managed, measured, controlled, and effective. Maturity implies a potential for growth in capability and indicates both the richness of an organization's (Project Management) process and the consistency with which it is applied in projects throughout the organization." (Paulk, Curtis, Chrissis, & Weber, 1993)

Organizational Maturity is "the extent to which an organization has explicitly and consistently deployed processes that are documented, managed, measured, controlled, and continually improved." [(CMMI Product Team, 2002, p. 582).cited by (Cooke-Davies, 2005)]

"….. (Maturity) is a comparative level of advancement an organization has achieved with regard to any given process or set of activities. Organizations with more fully defined and actively used policies, standards, and practices are considered more mature". (PM Solutions, 2008)

"Maturity is the level of sophistication that indicates organization's current project management practices and processes".

"The degree to which an organization practices project management measured by the ability of an organization to successfully initiate, plan, execute, monitor and control individual projects." (Project Management Institute (PMI), 2003).

What is common in most of the above definitions is the idea of consistent and repeated practice, measurement and improvement or advancement. According to (Paulk etal, 1993) ,as an organization matures, the predictability, effectiveness, and control of an organization's processes are expected to improve. "Maturity in project management is a never-ending journey, with a never-ending cycle of bench- marking and continuous improvement (Kerzner, 2001). "As an organization gains in (project management) process maturity, it institutionalizes its project management process via policies, standards, and organizational structures. Institutionalization (demands) building infrastructure and a corporate culture that supports the methods, practices, and procedures of the organization so that they endure after those who originally defined them have gone" (Paulk etal,1993).The more mature an organization's practices are, the more likely the organization meets its project goals successfully." (PM Solutions, 2008).

According to (Chrissis, Konrad, & Shrum, 2003) , a matured process is well understood throughout a mature organization; usually through documentation and training, and the process is continually being monitored and improved by its users. The capability of a mature process is known. Process maturity implies that the productivity and quality resulting from an organization's use of the process can be improved over time through consistent gains in the discipline achieved by using its process .A mature organization has an organization-wide ability for managing initiatives based on standardized and defined management processes. In such organizations, activities are carried out according to defined processes and plans. Roles and responsibilities are well defined and understood. Such organizations have also an objective way of measuring performance and quality;

and the necessary information and database for doing that [(Office of Government Commerce (OGC)) (Supic, 2005)]. “In general, in a matured organization, a disciplined process is consistently followed because all of the participants understand the value of doing so, and the necessary infrastructure exists to support the process” (Sarshar, et al., 2000).

An immature organization on the other hand is an organization that does not have or use consistent and defined processes in management of its projects (Sarshar, et al., 2000). “An organization that is immature in project management may occasionally deliver individual (projects) that produce excellent results. However, in such cases managers are more likely to be working reactively, focusing on solving immediate issues, rather than proactively acting. In addition, schedules and budgets are likely to be exceeded and if deadlines are imposed, the quality of deliverables is likely to be compromised in order to meet the schedule. In an immature organization, repeatable processes and results depend entirely on the availability of specific individuals with a proven track record.” (Office of Government Commerce (OGC)).

“As maturity increases, the variability of actual results around targeted results decreases. For instance, in an immature organization delivery dates for projects of similar size are unpredictable and vary widely. However, similar projects in a matured organization are expected to be delivered within a much smaller range. This narrowed variation occurs at the highest maturity levels because virtually all projects are performing within controlled parameters approaching the organization's process capability” (Paulk etal,1993).

Attaining maturity would not necessarily guarantee that a project would be successful. However, it could increase a project's chances of being successful. It should be noted that the processes of attaining maturity is not a one-time event that is accomplished by declaring a methodology and structure, nor it is a quick fix for immediate tactical problems rather, it is a consciously planned and properly managed continuous improvement effort **[** (Supic, 2005)**,** (Kaya & Iyigun, 2001)**,** (Saiedia & Kuzara, 1995)**].**

Maturity Models

Maturity Models are process models (measurement tools) that are developed to assess the maturity of organization's (can also be business unit, or department) processes and practices to identify opportunities for improvement and point out strengths and weaknesses. Maturity models are also used as a framework to guide improvement efforts [(Jugdev & Thomas, 2002)**,** (Cleland & Ireland, 2002)]. Most of the current Maturity models have their origin in the field of total quality management. The concept is built on the Deming, Juran, and Crosby quality paradigm: "Quality products are a result of quality processes" [(Chrissis, Konrad, & Shrum, 2003), (Paulk etal, 1993)]. Further, Maturity models differ from one another in the concepts they embody and the suggestions they make as to how the path to maturity looks like. Moreover, different maturity models for PM may define maturity differently and measure different things to determine maturity (Man, 2007).As (Paulk etal, 1993) puts clearly "(Maturity models) are not silver bullets and do not address all of the issues that are important for successful projects. The models are developed only to provide an orderly and disciplined framework within which to address (certain) management and engineering process issues".

The majority of maturity models generally consist of description of maturity levels, model of Processes to be assessed, Assessment tools and a model that guides the improvement path to the next level of maturity. Maturity models contain behaviors or best practices that successful projects have demonstrated. Hence, they generally, show what organizations need to do without mentioning the how or who. As (Supic, 2005) puts, "A generic goal of project management maturity models is to create strategic plan for moving project management forward"

The majority of maturity models have adapted the CMM's five levels of maturity stage beginning from lower level of maturity, initial (Level 1), to the highest level of maturity, continuous improvement(level-5). According to (Chrissis, Konrad, & Shrum, 2003) the commonly used concept of five stages or maturity levels goes back to Crosby in Quality Is Free, which described a five-level scale with "world-class" as level 5.

Figure 2: shows a typical five level PM maturity Model

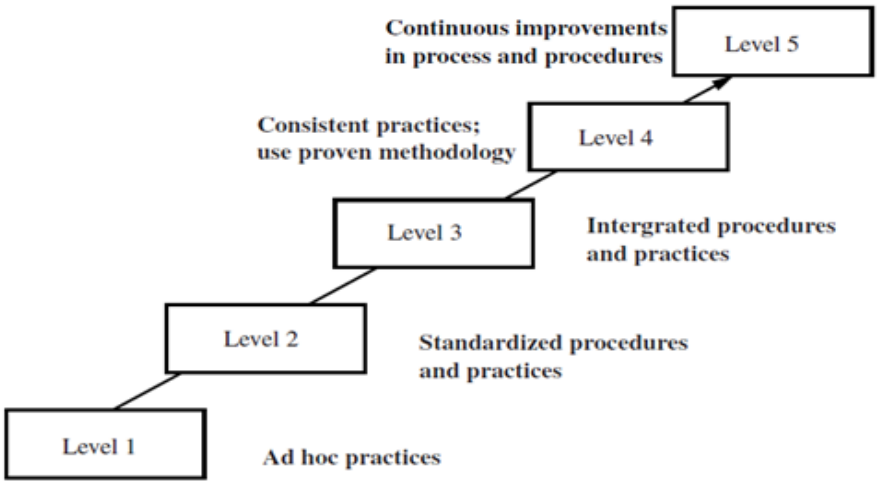

Figure 2: Typical Five level Maturity Model

Attaining a higher level of maturity is an effort that requires significant investment and the commitment of senior management. Not every organization is expected to reach the highest maturity level; rather each organization should decide a level that would be optimal for its context and aim for attaining that **[** (Office of Government Commerce (OGC))**,** (Crawford, 2002)**].** According to (Crawford, 2002) , striving to increase maturity level just for the sake of reaching a higher level is unwise (investment) and use of a tool. Maturity assessment should be done to help the business- not for its own sake. Generally, to derive the benefits of maturity , organizations should: exert continuous and consistent effort , have strong executive management support for the process ,emphasis on project management best practices ,set reasonable goals, implement changes step by step, conduct project management training , create opportunity for sharing knowledge across the organization and always target incremental improvement. According to (Crawford, 2002), many organizations can achieve significant benefits by reaching (level-2) repeatable/ managed level maturity. It should be noted that, achieving a higher maturity level does not mean that the organization should always use sophisticated tools and methodologies. Rather, the organization can and should still be able to use tools and methods that are typical of lower level depending on the complexity and nature of each project. A higher maturity level mean only the organization has the capability to selectively choose and apply the proper PM processes, practices and tools (Kwak & Ibbs, 2002)**.**

Applications of Maturity Models

Maturity models are not meant to provide a quick fix for projects in trouble. Rather, they are primarily used internally by organizations to guide their effort of improving their project management capability [(Office of Government Commerce (OGC)), (Supic, 2005), (Saiedia & Kuzara, 1995)].This is achieved through assessment of the organization's PM processes to find out strengths, weaknesses and gaps. Later the result of the assessment is used to guide continuous improvement efforts .In addition, the result of the assessment can serve as quantitative metric (baseline) against which progress in improvement and its effectiveness is compared (Kawak, Young Hoon, 1997). Maturity models can also be used by external procuring organizations as an evaluation tool to assess the capability of providers (contractors) and their risk profile (Saiedia & Kuzara, 1995). The use of maturity model helps organizations gain competitive edge by enabling them delivers predictable results and quality products [(Jugdev & Thomas, 2002)]. Successful use and the resulting benefit from the use of such models have been reported by many researchers in the field. For example, (Sarshar, et al., 2000) reported[16] an average of 35% productivity improvements and a return on investment (ROI) from 5:1 to 7.7:1.

[16] citing (Herbsleb *et al*. 1994)

Like many other management tools the use of maturity models have some drawbacks. (Saiedia & Kuzara, 1995) has cited that in those models such as CMM that adopt Key process areas (KPA) ,adoptions of such KPA delays useful process improvement activities which are not part of a given Maturity level; as they cannot account for parallel, interdependent, and continuous improvement of all KPA activities. Further, the use of standard methodologies and adherence to process may affect the manner in which a company interacts with its customers and affect its flexibility. Generally, as well summarized by [(Crawford, 2002)] and others "Maturity models are used in setting direction, prioritizing actions, and beginning cultural change rather than mare understanding (or determination of) the current level at which an organization is performing. maturity models provide baseline for measuring improvement, documents the need for change, provide common language, shared vision, fosters a culture of excellence, and sets the stage for organizational change, provide frame work for prioritizing improvement action".

Maturity Assessment Process

Maturity assessment generally can be conducted either by the organization's internal staff with assistance by a licensed assessor or could be done by an external assessment vendor [(Saiedia & Kuzara, 1995), (Crawford, 2002)]. Any thorough assessment of PM maturity includes a minimum personal and/or group interviews, artifact collection and evaluation, survey, and benchmark comparison to established standards (Crawford, 2002).Typically; organizations start the assessment with a baseline assessment of their current situation. The baseline assessment enables an organization to identify areas that need immediate

actions and areas that will have an impact and provide greatest return on investment (Crawford, 2002). This helps the organization prioritize its improvement actions and plan for continuous improvement.

PM maturity assessments are typically divided into two key assessment processes: audit and self- assessment. Audits collect and compare data against a reference standard, evaluating the degree to which the criteria have been fulfilled, whereas self-assessments are designed to evaluate the strengths, weaknesses, and opportunities for improvement against a number of dimensions. Audits are primarily designed to support an external driver of compliance, whereas self-assessments are typically more internally focused on improvement" (Mullay, 2006).

CHAPTER 7: REVIEW OF MATURITY MODELS

A number of maturity models are available. The following subsections provide description of some of the prominent maturity models.

Capability Maturity Model-CMM

Capability maturity model is the first maturity model to be developed. The model was developed by the software Engineering Institute at Carnegie Mellon University. The model was initially developed for use in improvement of software development processes. Later it was extended for use in other areas of systems, and software engineering and procurement. The model was primarily developed to evaluate software contractor's capability for contract award and administration purpose. Later the model has been used by software developers as a guide for the improvement of their processes (Sarshar, Finnemore, Haigh, & Goulding, 1999). This model has served as a basis for the development of a number of maturity models in different fields including project management .Unlike Project Management maturity models; this model assesses the entire software development process including the PM part and technical parts of software development. The CMM model has five maturity levels beginning from the initial stage (level 1) to the most matured level of optimizing (Level-5). Each maturity level has key processes areas (KPA) that identify it. In addition to the model has a prioritized improvement path for achievement of a higher level capability. However, as the model is descriptive in nature, it does not tell an organization how to improve; rather it describes essential attributes that would be expected to characterize an organization at a particular maturity level (Paulk etal, 1993).

Following is given characterizations of the five maturity levels as given by(Paulk etal,1993).

1- Initial: The software process is characterized as ad hoc, and occasionally even chaotic. Few processes are defined, and success depends on individual effort.

2- Repeatable: Basic project management processes are established to track cost, schedule, and functionality. The necessary process discipline is in place to repeat earlier successes on projects with similar applications.

3- Defined: The software process for both management and engineering activities is documented, standardized, and integrated into a standard software process for the organization. All projects use an approved, tailored version of the organization's standard software process for developing and maintaining software.

4- Managed: Detailed measures of the software process and product quality are collected. Both the software process and products are quantitatively understood and controlled.

5- Optimizing: Continuous process improvement is enabled by quantitative feedback from the process and from piloting innovative ideas and technologies.

Project Management Process Maturity Model-PM2

The PM2 model is one of the pioneer PM maturity models developed. The model was developed by (William C. Ibbs and Kwak in 1997). Like the CMM model, the PM2 model has five levels of maturity with slight difference in its use of terminologies. The model divides PM processes and practices into eight PM knowledge areas and six phases

of PM processes adopting PMBOK's division. The model evaluates organization's PM maturity through the assessment of these knowledge areas and phases.

The description of the five maturity levels, key project management processes in each level, their organizational characteristics and the focus areas at each level of PM2's Model given by (Kwak & Ibbs, 2002) is summarized in Table 2.

Table 2: PM2 Maturity Model's Summary

Maturity Level	Key PM Processes	Major Organizational Characteristics	Key Focus Area
Level-1 (Ad-hoc Level)	No PM processes or practices are consistently available. No PM data are consistently collected or analyzed.	Functionally isolated. Lack of senior management support. Project success depends on individual efforts.	Understand and establish basic PM processes.
Level-2 (planned Level)	Informal PM processes are defined. Informal PM problems are identified. Informal PM data are collected.	Level-2 (planned Level)	Informal PM processes are defined. Informal PM problems are identified. Informal PM data are collected.
(managed at project Level)	Formal project planning and control system are managed. Formal PM data are managed.	Team oriented (medium). Informal training of PM skills and practices.	Systematic and structure planning and control for individual project.
Level-4 (Managed at corporate level)	Multiple PM (program Management). PM data and processes are integrated. PM processes data are quantitatively analyzed, measured and stored.	Strong team work Formal PM training for project team	Planning and controlling Multiple projects in a professional manner
Level-5 (Continuous learning)	PM processes are continuously improved PM processes are fully understood PM data are optimized and sustained	Project driven organization Dynamic energetic ,and fluid organization Continuous improvement of PM processes and practices	Innovative ideas to improve PM processes and practices

PM Solutions' Maturity Model

Similar to the PM2 model; this model is developed by mirroring PMBOK's knowledge areas with that of CMM's five level maturity stage. The model examines an organization's PM implementation across the nine PM knowledge areas, which are in turn broken down in to components (Crawford, 2002). In their book[17], the model's developers have given a detailed description of the characteristics of the knowledge area at each maturity level. Table 3 presents a summary description of the five maturity level given by (Crawford, 2002)

Table 3: PM solutions' five Maturity Levels and their Key attributes

Maturity Level	Key attributes
Level 1 **Initial Process**	Ad hoc processes. Management awareness.
Level 2 **Structured Process and Standards**	Basic processes; not standard on all projects; used on large and highly visible projects. Management supports and encourages use of processes. Mix of intermediate and summary-level information. Estimates and schedules are based on expert knowledge and generic tools. Mostly a project-centric focus.
Level 3 **Organizational Standards and Institutionalized Process**	All processes are standard for all projects and are repeatable Institutionalized processes. Summary and detailed information. Informal collection of actual data. Estimates and schedules based on industry standards More of an organizational focus. Informal analysis of project performance.
Level 4 **Managed Processes**	Processes are integrated with corporate processes. Management mandates compliance. Management takes an organizational entity view. Solid analysis of project performance. Estimates and schedules are normally based on organization. Management uses data to make decisions.
Level 5 **Optimizing Process**	Use of Processes to measure project effectiveness and efficiency. Processes in place to improve project performance. Management focus on continuous improvement.

[17] see: (Crawford, 2002)

Kerzner's PM Maturity Model -PMMM

Like most of the other maturity models this model has also five levels of maturity; however, the naming and the attributes of the levels slightly differ from the others. Unlike the other models, this model emphasis benchmarking and make benchmarking the forth level on its maturity model.

Kerzner has described the characteristics of each level of maturity in detail in his book[18]. In this book, the author has described the characteristic at each maturity level ,the 'roadblocks', 'risks' and actions required to complete at each level. In addition, an 'assessment instrument' is included in the book for each maturity level. Table 4 below provides the summary of the model.

Table 4: Summary of Kerzner's PM Maturity Model

Levels	General descriptions	Main characteristics
Level 1 **Common** **Language**	Organizations recognize the importance of project management and the need for a good understanding of the basic knowledge of PM and its language/terminology.	➢ None or sporadic use of project management. ➢ No Executive-level support. ➢ No investment or support for project management training.
Level 2 **Common** **Processes**	Organizations recognize the need for common processes and they make a concerted effort to use project management and develop processes and methodologies to support its effective use.	➢ Recognition of benefits of PM. ➢ Organizational support at all levels. ➢ Recognition of need for processes/methodologies. ➢ Recognition of the need for cost control. ➢ Development of a project management Training Curriculum.

[18] Strategic Planning for Project Management using a Project Management Maturity Model: (Kerzner, 2001)

Level 3 **Singular** **Methodology**	Organizations develop singular methodologies (rather than using multiple methodologies) to best achieve synergy and process control.	➢ Total commitment to the concept of PM. ➢ Integrated processes: Example integrated PM and TQM. ➢ Cooperative culture. ➢ Visible management support at all level. ➢ Informal project management based upon guidelines and checklists with little paper work, rather than rigid policies and procedures. ➢ Training and education.
Level 4 **Benchmarking**	Organizations perform benchmarking on a continuous basis against those practiced in similar and non-similar industries. Few selected critical success factors are benchmarked.	➢ Establishment of project office (PO) or a center of excellence (COE) that is dedicated to the project management improvement process ➢ Performance of both quantitative and qualitative benchmarking
Level 5 **Continuous** **improvement**	Organizations evaluate the information learned during benchmarking and implement the changes necessary to improve the PM process. Especially on existing Process Improvements, Integrated Process Improvements, and Behavioral, Benchmarking and Managerial Issues.	➢ Creation of lessons learned files and transfer of knowledge to other projects and teams ➢ Recognition of the need for and implementation of a mentorship program for future project managers ➢ A corporate-wide understanding that strategic planning for project management is a continuous, ongoing process.

Organizational Project Management Maturity Model-OPM3

The OPM3 maturity model is a PM maturity model developed by PMI through worldwide volunteer contribution of PM practitioners and consultants in diverse industries. The model defines knowledge, assessment, and improvement processes for organization's project, program and portfolio management practices. The OPM3 maturity model consists of two main complementary parts: The Foundation and the Product Suite. The Foundation (The OPM3 book) describes in general terms organizational project management and OPM3 maturity models contents and applications. The Product Suite, on the other hand, describes how the OPM3 model is applied and what steps are taken

during a maturity assessment. Further, the model contains list of capabilities and best practices for use in improvement steps design.

Generally, the OPM3 model is organized in:

- Three domains of project, program and portfolio management domains.
- Three interrelated components of (1) Best practices (2) Capabilities and (3) Outcomes in all three domains.
- Three general elements of: Knowledge, Assessment and Improvement.
- Four stages of improvement: Standardize Measure, Control and Continuously Improve (SMCI).

OPM3 can assess organizational PM maturity along the three domains and the four stages of improvement. In OPM3, maturity is measured by assessing the existence of best practices within the OPM domains. The existence of best practices in turn is verified by using key performance indicators (KPI).Unlike many of maturity models, OPM3 does not explicitly assign a maturity level for organization; in OPM3, maturity is assessed and reported as percentages of best practice in the entire three dimensions.

OPM3's Best practices, Capabilities and Outcomes

In OPM3 a Best Practice is defined as a currently recognized optimal method of achieving a stated goal or objective .OPM3's best practices are grouped in to two categories: (1) SMCI best practices [those that are related to stage of process improvement of standardize, measure, control and continuously improve] (2) Organizational Enabler (OB) best practices [those best practices that facilitate the implementation of SMCI best practices and help make organizational improvement sustainable]. OPM3 best practices are further categorized across domains.

In the context of OPM3, a best practice is considered to be achieved when an organization demonstrates consistent organizational PM processes evidenced by its aggregated capabilities and successful outcomes. Generally a best practice can be considered to exist when all its listed capabilities exist.

Capability is defined in OPM3 as a specific competency that must exist in an organization in order for it to execute project management processes. Capabilities are incremental steps that lead to achievement of one or more best practices. The presence of specific capability is used as a criterion in OPM3 for assessing organizational maturity. In general, capability can be said to exist when all of the outcomes under the capability have been observed.

An Outcome is defined in OPM3 as tangible result of applying a capability. In the model, achievement of an outcome can be demonstrated through observation, documentation, or any other method that demonstrates that the outcome is achieved. Key Performance Indicators (KPIs) are usually used to determine the existence of an outcome and or the degree to which it exists.

The OPM3 framework provides flexibility to focus assessment and improvement efforts in specific domains (project, program and portfolio management), and across domains at various degree of SMCI (standardize, measure, control and continuously improve).This provides the flexibility to best suit the improvement effort to organizational needs and goals. Development of OPM3 capabilities and the adoption of the resulting best practice is thought to help an organization deliver the desired strategic outcomes in predictable, controllable, and reliable manner.

Maturity Models in the Construction Industry

Many Researchers and practitioners in construction industry have been endeavoring to find ways of measuring and improving performance. Description of two major attempts to develop maturity model for construction industry is presented below**.**

The SPICE Framework

SPICE (Standardized Process Improvement for Construction Enterprises) is a research project that attempts to develop a incremental process improvement framework for the construction industry. The model is developed by adapting CMM's five maturity levels for project management in the construction industry. (Sarshar, et al., 2000).The general description of the Five Maturity levels was provided by (Finnemore, etal, 2000) and is summarized and presented below.

Level-1, (Initial) - The processes at this level are characterized as ad hoc, and occasionally even chaotic. Few processes are defined, and success depends on isolated effort. The construction process capability of level-1 organization is unpredictable because the process is not specified and is constantly changed or modified as the work progresses. Performance and success depend entirely on the capabilities of the individuals or teams, rather than that of the organization.

Level 2, (Repeatable) - At this level the focus is on establishing effective management processes within each construction project. At this level, basic project management processes are established and are repeatable. The necessary process discipline is in place. At this level there is a degree of project predictability. Policies and procedures for managing the major project are established. Managers track quality and functionality as

well as time and costs. Problems in meeting commitments are identified as they arise. Standards are defined and organizations ensure that they are faithfully followed.

Level 3, Defined- At this level the processes for all activities are documented, standardized, and integrated into the organization. All projects use an approved, tailored version of the organization's standard process. At level 3, both management and engineering activities are documented, standardized and integrated into the organization.

Level 4, Managed- At this level detailed measurement of the processes and product quality are collected. Both processes and products are quantitatively understood and controlled. Productivity and quality are measured for important construction process activities across all projects as part of an organizational measurement program. Projects gain control by narrowing the variations in their process performance.

Level 5, Optimizing- At this level, continuous process improvement is enabled by using feedback from the processes to pilot innovative ideas and technologies

Like CMM, each maturity level in the SPICE model has a set of key processes to be performed at each level. To achieve each level of maturity an organization must perform all these key processes adequately. The key processes are developed based on CMM's key processes areas. Like CMM, SPICE's Level 1 has no key processes and organizations at this level have little process focus. Level 1 organization must focus on implementing level 2 key processes. Level 2 key processes are: Brief and Scope of Work Management, Project Planning, Project Tracking and Monitoring, Sub-contract Management, Project Change Management, Risk Management, Project Team Co-ordination. The key process areas for the other maturity level are yet to be developed.

The development of SPICE's process improvement for level 2 have already been completed and tested in real life projects. The result of a number of real life case studies showed that SPICE is effective and beneficial in identifying organizational improvements .Similar work was also done to adopt six key processes from CMM for level 3. However, unlike that of level 2 processes the test on field projects could not validate level 3 processes (Sarshar, et al., 2000)**.**Thus, the characteristics of levels 3, 4 and 5 in the SPICE model presented above were based on solely adaptation of CMM (Sarshar, et al., 2000)**.**

Frame Work for Construction Project Management Maturity Model -CMP3

Similar to the majority of maturity models; this model too is developed adopting CMM's maturity model .This model is developed in China considering the Chinese construction industry context.

The model defines a total of six processes groups - : tendering, planning, executing, controlling, closing and integration as the Key processes of construction project management.

The model's description of the maturity levels is very close to that of CMM.

To measure the maturity, the model identified a total of 30 key processes for the six process group .The key processes/practices are identified through literature review and interviewing professionals. In the model, the key process areas are considered to be critical for the success of construction project.

The model appears to be primarily designed to help determination of the overall level of maturity of construction project management by establishing relationship between maturity of each key practice and the score of each practice (i.e. its weight) as determined

by perceived contribution to success of construction project . The model employs statistical methods to determine the score (weight) of each key practice. Once the score is determined and fixed then for a given project or company the level of maturity of each of the key practice is determined through expert judgment and the overall maturity level determined using multivariable regression analysis.

Maturity Models in Developing Countries

Evolutionary Software Project Management Maturity Model -ESPM3

Even though this model is not one of the commonly known, it is included in this research due to its relevance to the research topic (that fact that it is developed in a context of a developing country). This model is the result of an attempt to develop a simple maturity model for Mauritius software /IT industry. The model adopts the concepts of Key Processes Areas (KPA) similar to that of CMM, and categorizes the KPA's in to two maturity levels and a continuous process improvement group. Unlike most of maturity model this model has only three level of maturity.

(Sukhoo, etal, 2005)'s description of the maturity levels is summarized below**.**

Level-1 - At level -1 no KPAs are defined. The software development process is carried out in an ad-hoc (Chaotic) manner. Project success depends on heroic effort of the project team. This is a typical definition adopted by many models that are based on the CMM framework.

Level -2- (Basic Project Management Level), provides basic project management focus to the software development.

Three KPAs are identified to achieve this level. These are: Time management, Cost management and Quality management. At this level the focus is on triple constraints (cost, time and quality).

Level -3- (The highest maturity level in the model). This level provides an organizational focus. The KPA identified for improvement at this level are: Human Resource management, Risk management and Contract management.

In addition to the six processes at level 2 and level three, the model has five additional KPAs under continuous process improvement group. These are: Soft skills management, Change management, Software specific focus, Integration management, and Environmental management [social, cultural, political and economic].These are meant to be continuously improved at every stage beginning from the initial stage.

Unlike most maturity models, in this model, KPAs at a given maturity level are considered to have evolved fully and do not require further development at any of the higher levels except for continuous process improvement where improvement is required for the process to adapt to the dynamic environment in which organizations evolve. (Sukhoo, etal, 2005)

The main idea of the model is that organizations need to focus first in developing their capability to manage the triple constraints of (time, cost and scope) while continuously working to improve the processes in the continuous processes improvement group (which are thought to be necessary at every stage-to adapt to the dynamic environment) before they consider improving the other processes-of Human Resource management, Risk management and Contract management.

Capability Maturity Model Integration-CMMI

CMMI is a successor of the CMM model that is built combining the best components of individual disciplines of CMM (Software CMM, People CMM etc). The model consists of best practices that address product development from its conception through delivery and maintenance. Moreover, the model provides an extensible framework for new bodies of knowledge. (Chrissis, Konrad, & Shrum, 2003)

An excellent and a detailed description of the model is given by (Chrissis, Konrad, & Shrum, 2003) and (Ahern, Clouse, & Turner, 2008) in their two books. The subsequent discussions are direct summary from the two books with minor rephrasing and some additional discussion points provided by the researcher. Because of its high relevance for this research (the maturity assessment was done based on an adopted CMMI model) relatively broader description of the model is provided.

Organization of CMMI model

The CMMI model has two representation .These are staged and continuous representation.

The Staged representation is an approach that uses predefined sets of process areas to define an improvement path for an organization. In this representation, process areas are organized by maturity levels from the initial level to the optimizing level. The staged representation defines the improvement path for an organization by prescribing the order for implementing each process area at different maturity levels.

The continuous representation, on the other hand, offers a flexible approach to process improvement. It allows an organization to select the specific process areas to be improved. This allows an organization to improve different processes at different rates. In

continuous representation, capability levels from an unperformed process to an optimizing process levels are used to measure the improvement path through each process area.

This thesis has chosen to adapt the continuous representation of CMMI, thus subsequent description of the model are given for the continuous representation. However, most of the descriptions are also equally applicable for the case of staged representation.

Concept of maturity in CMMI is built in the concept of institutionalization. In the CMMI's context, institutionalization implies that the process is ingrained in the way the work is performed and there is commitment and consistency to performing the process. The generic practices[19] in CMMI describe activities that address these dimensions of institutionalization. The degree of institutionalization is captured in the generic goals[20] and expressed in the names of the processes associated with each goal.

The CMMI continuous representation model has six capability levels that are defined and organized by Generic Goals which are intern organized by Generic Practice. All of the process areas in CMMI are also defined and organized by Specific Goals[21] and Specific Practices[22]. In CMMI, for a process area to attain a given capability level, it has to attain all the specific goals of the process area and the generic goals of the capability level it is

---

[19] A generic practice is the description of an activity that is considered important in achieving the associated generic goal. A set of generic practices represent the "expected" means of achieving a generic goal.

[20] A generic goal describes the characteristics that must be present to institutionalize processes that implement a process area. A generic goal is a required model component and is used in appraisals to determine whether a process area is satisfied

[21] A specific goal describes the unique characteristics that must be present to satisfy the process area. A specific goal is a required model component and is used in appraisals to help determine whether a process area is satisfied

[22] A specific practice is the description of an activity that is considered important in achieving the associated specific goal. A set of practices represent the "expected" means of achieving a goal

aiming for. The capability levels of process areas are achieved through the application of generic practices or suitable alternatives.

Except the first, each of the six capability level has one generic goal that defines the level. The generic goals evolve so that each goal provides a foundation for the next. Thus, applied sequentially and in order, the generic goals describe a process that is increasingly institutionalized, from a performed process to an optimizing process.

CMMI's six capability levels are Incomplete, Performed, Managed, Defined, Quantitatively Managed and, Optimizing process.

A summary description of the six capability levels and the generic goal at each level is provided here under. A more detailed description of the model is also provided in Appendix-A.

Capability Level 0: Incomplete Process

An "incomplete process" is a process that is either not performed or partially performed. This is when one or more of the specific goals of the process area are not satisfied.

Generic Goal: There is no generic goal for this area.

Capability Level 1: Performed Process

A performed process is a process that accomplishes the work necessary to produce work products. For a performed process the specific goals of the process area are satisfied. Achieving generic goal for a process area at this level is equivalent to saying the specific goals of the process area are achieved.

Generic Goal-1: Achieve Specific Goals of the processes area.

Capability Level 2: Managed Process

A managed process is a performed (capability level 1) process that has the basic infrastructure in place to support the process. It is planned and executed in accordance with policy; employs skilled people who have adequate resources to produce controlled outputs; involves relevant stakeholders; is monitored, controlled, and reviewed; and is evaluated for adherence to its process description.

A critical distinction between a performed process and a managed process is the extent to which the process is managed. A managed process is planned and the performance of the process is managed against the plan. Corrective actions are taken when the actual results and performance deviate significantly from the plan. A managed process achieves the objectives of the plan and is institutionalized for consistent performance.

Achieving the generic goal at this level for a process area is equivalent to saying the performance of processes associated with the process area is managed. That means, there is a policy that indicates the process will performed, there is a plan for performing it ,resources are provided, responsibilities are assigned, training is provided on how to perform it, selected work products from performing the process are controlled, and so on. In other words, the process is planned and monitored just like any project or support activity.

Generic Goal-2 Institutionalize a Managed Process.

Capability Level 3: Defined Process

A defined process is a managed process that is tailored from the organization's set of standard processes according to the organization's tailoring guidelines; has maintained process description; and contributes work products, measures, and other process improvement information to the organizational process assets. Standard processes describe the fundamental process elements that are expected in the defined processes. A defined process clearly states the Purpose, Inputs, Entry criteria, Activities, Roles, Measures, Verification steps, Outputs, and Exit criteria.

A critical distinction between a managed process and a defined process is the scope of application of the process descriptions, standards, and procedures. For a managed process, the process descriptions, standards, and procedures are applicable to a particular project, group, or organizational function. As a result, the managed processes of two projects in one organization may be different.

Another critical distinction is that a defined process is described in more detail and performed more rigorously than a managed process. With a defined process, variability in how the processes are performed across the organization is reduced and process assets, data, and learning can be effectively shared.

Achieving generic goal for a process area at this level assumes that an organizational standard process or processes exist associated with that process area that can be tailored to the needs of the projects. The processes in the organization are now more consistently defined and applied because they are based on organizational standard processes. In this regard, tailoring might result in making no changes to the standard process.

Generic Goal- 3 Institutionalize a Defined Process.

Capability Level 4: Quantitatively Managed Process

A quantitatively managed process is a defined process that is controlled using statistical and other quantitative techniques. The product quality, service quality, and process performance attributes are measurable and controlled throughout the project. The sub processes that are significant contributors to overall process performance are statistically managed.

A critical distinction between a defined process and a quantitatively managed process is the predictability of the process performance. Quantitatively managed processes provide quantitative predictability, whereas, a defined process provides only qualitative predictability.

Generic Goal-4 Institutionalize a quantitatively managed process.

Capability Level 5: Optimizing Process

An optimizing process is a quantitatively managed process that is changed and adapted to meet relevant current and projected business objectives. An optimizing process focuses on continually improving process performance through both incremental and innovative improvements. Process improvements that address common causes of process variation, root causes of defects and other problems, and those that would measurably improve the organization's processes are identified, evaluated, and deployed as appropriate. These improvements are selected based on a quantitative understanding of their expected contribution to achieving the organization's process improvement objectives versus the cost and impact to the organization.

A critical distinction between a quantitatively managed process and an optimizing process is that the optimizing process is continuously improved by addressing common causes of process variation. A quantitatively managed process is concerned with addressing special causes of process variation and providing statistical predictability of the results. Although the process may produce predictable results, the results may be insufficient to achieve the organization's process improvement objectives.

Reaching capability level 5 for a process area assumes that the selected sub processes has been stabilized and that reduction of the common causes of variation within that process is sought. Although it is conceptually feasible to improve all processes, it would not be economical to improve all processes to level 5. Hence, Organizations should concentrate on those processes that would help meet their business objectives.

Generic Goal-5 Institutionalize an optimizing Process.

PART IV: PROPOSED PM MATURITY MODEL

CHAPTER 8: PROPOSED PM MATURITY MODEL

"All models are wrong, but some are useful." - George Box

Concept of Maturity Revisited

According to (Cooke-Davies, 2005), there is neither a common understanding nor definition of the concept of maturity or the route to gain in maturity in most of PM maturity models. Thus, an analogy of maturity in a practice of profession is used here to get better understanding of the concept. Maturity in practice of a profession is generally developed in two dimensions ; one is through acquiring the capability of using different, more advanced and effective processes, practices, methods ,tools, techniques , and procedures; the other is through systematizing ,standardizing , and continuously refining and improving the overall practice from deeper understanding of the relationships and functionalities of the practices . The analogy shows two aspects of maturity, one which is gained through gains in more knowledge and skills through learning and use of new or more advanced way of doing things; the other is gain in maturity through standardizing, systematizing and refining the process, practices ,methods and tools. The former one will help us improve our effectiveness as our capability of using different and advanced method is improved, thus, we can select the appropriate method and employ it. Whereas; the later one impacts more the efficiency of attaining a goal as the standardization and systemization help complete the work fast and help avoid most of rework and ensure consideration of every aspects. The same concept seems, also applied in defining organizational maturity. "As an organization increases in its maturity, so it will

implement additional process areas and, improve the capability level of each of them" (Cooke-Davies, 2005). That means, there is a gain in capability of performing additional process areas and at the same time there is improvement on the capability of those process areas which have been being performed. The same analogy can be extended in defining maturity of a knowledge area[23] . In organizations too, the improvement of existing processes/practices can be achieved either by improving the existing process by managing ,defining ,standardizing, quantitatively managing and continuously improving it (like in CMMI) ;or it can also be achieved by gaining the capability of using more advanced practices, methods ,tools, techniques and procedures. Development of maturity of a knowledge area can also be achieved in two dimensions that resemble development of maturity of a profession. One is through development of capability of employing more advanced and effective practices, techniques, methods and tools as appropriate; the other is by systematizing and refining the process, that is, by explicitly, defining and documenting, managing, standardizing, measuring and controlling, and continuously improving the process/practice of the knowledge area. This research has termed the two dimensions of development of maturity as **"practice maturity"** and **"processes maturity"** dimensions respectively. The formal definition of maturity in both CMM and CMMI emphasizes the second dimension. Maturity of a process is "the extent to which a specific process is **explicitly defined, managed, measured, controlled, and effective**" (Paulk, Curtis, Chrissis, & Weber, 1993).

Practice Maturity

---

[23] PMBOK's equivalent of processes area in CMMI(Example risk management knowledge(process) area)

“Practice maturity” shows the aspect of an organization’s capability of using more advanced and effective practices, methods, techniques, tools and procedures that are recognized in an industry to enhance attainment of process or knowledge area goals. It also shows to what extent an organization’s practices are refined or detailed. Generally, practice maturity is concerned with more about assessing **what** the organization is doing to perform a given process and achieve the objective of a given knowledge area rather than **how** the organization is performing the process or knowledge area. For example, in performing assessment of time management processes of an organization; the practice maturity dimension sees to what extent the practices ,methods, tools, techniques and procedures used in managing time are more advanced and effective or whether it is limited to performing only the basic(the minimum required) practices. For instance, in time management process; it sees, whether a simple bar chart or a network schedule is prepared, whether the activity definition was detailed or simple listing of major deliverable, whether the duration estimate is crude approximation, or based on organizational or commercial or industry methods, and standards; or whether the organization has a capability of using advanced practices such as earned value method, resource leveling, simulation techniques, probabilistic PERT, etc. In short, “Practice maturity “dimension tells whether the organization has the capability of using more advanced and effective practices, tools, methods, techniques and procedures that enhance chance of attainment of objective and control over the process.

Processes maturity

“Processes maturity” on the other hand shows the degree of institutionalization of the processes that are being performed (i.e. whether the processes that are being performed

were defined and documented, managed, standardized, measured and controlled and, continuously improved). In other words, "Process maturity" addresses whether the organization is performing the processes informally or formally, whether the processes are defined or not ,standardized or not, integrated with other processes or not , quantitatively managed or not ,and whether the process is being continually improved or not. Generally, Process maturity focuses on **how** the organization is using the practices, tools, techniques and methods it chose to perform a knowledge area. This is very close to definition of maturity in models like CMMI.

Why a New Maturity Model?

The primary objective of this thesis research was to assess the extent of use (maturity) of Project Management methodologies in the Ethiopian Construction Industry. One way of performing the assessment is through use of maturity model. Thus, review of existing maturity model was done to select appropriate maturity model that could be used for the assessment purpose. This review, however, has revealed two major gaps that were not sufficiently addressed by the reviewed existing models. These were

1. The tendency of clustering PM "Practice Maturity" with PM "Process maturity" by the majority of PM maturity models that were developed based on the concept of CMM's staged maturity representation[24].

[24] See Capability Maturity Model Integration-CMMI on page 64

2. Lack of consideration or paying little attention to "Practice maturity" dimension by models that were developed on a concept similar to that of CMMI's continuous maturity representation.

From his study on maturity model (Cooke-Davies, 2005) also concluded that " Maturity models are not an adequate way of measuring organizational project management maturity, at least as these now stand"

A desire to address these identified gaps lead the research to a direction that was not initially planned. Thus ,through the course of the research , the initial idea of selecting an appropriate maturity model that serve as a tool to assess the PM maturity of contractors in Ethiopia ,has evolved and grown to an attempt to develop /propose a maturity model. This "scope creep" has resulted in a delay of completion of this thesis research.

Subsequent paragraph in following subsections discuss the above identified major gaps in the models that were reviewed in this research.

Many of PM maturity models that define maturity based on CMM's staged representation, such as PM2 and PM solution maturity models consider partially both dimensions of "practice maturity" and "process maturity". The description of maturity in such models shows improvement in both "practice maturity" as well as "process maturity" dimensions. However, the way these models addressed the two dimensions of maturity has its own problem. These models cluster the two dimensions of maturity in a way that constrain flexibility and sometimes give unintended wrong implications. The following example of progression of time management maturity in the PM solution method, explains the case[25].

---

[25] See detail in

In the PM solution's maturity model, the time management maturity progresses generally from a level of preparing milestone schedule at ad-hoc level (level-1), to preparing detailed network schedule at defined level (level-3). In the model, the "process maturity" is improving initially from ad hoc process (level-1) to basic and non-standard process (level-2), and then to a more matured level of defined and standard process at (level-3). Parallel to this progression in "process maturity", there is also a progression in "practice maturity". That is preparation of milestone schedule at level-1, summary level schedule at level -2 and detailed network schedule at level-3. In the model, the two dimensions of maturity are clustered together and defined at each level in such a way that may constrain flexibility and implicate unintended suggestions. For example, in the model, preparing a detailed schedule is an attribute of Level-3 (Organizational Standards and Institutionalized Process) maturity level. However, if an organization at Level-1(initial process) maturity level wants to improve its time management capability and wants to prepare a detailed schedule, it gives unintended implication that the organization first need to have a basic process in place, or first it need to develop a capability of developing summary level schedule (which are attributes of level-2) before thinking jumping to developing a detailed level schedule (which is a level-3 attribute). This will most likely occur as the organization will not want to skip levels as advised by many maturity models. However, the need to prepare detailed schedule has nothing to do with whether the process is a basic process (level-2) or a define process level-3. It may be sufficient to have a level-2 Process in place and prepare and use detailed schedule for the organization

---

Appendix-J: PM Solution Time Management Maturity on page 291

to improve its time management capability. Similarly, the use of simulation and historical data base are also considered to be attributes of level -3 in the model. These also could be used at level-2 depending on the specific context of each organization. Depending on specific context of each organization, it could be more important and useful to start using advanced practices at level -2 and not improve their processes further. Thus, the drawback of such models is that they fix the relationship between "practice maturity" and "process maturity". In addition, clustering of the two dimensions of maturity can unintentionally mislead improvement effort and unnecessarily deprive flexibility and result in missing effective and less costly improvement opportunities (options). It might be argued that models such as CMMI are not prescriptive and do not prevent the organization from seeing the other aspect; as to how to improve is already left for the organization. However, as the models have framed the improvement, the organization would implicitly be constrained if it uses the framework to chart its improvement initiatives. The problem with the multitude of PM maturity model is that they have already decided that the two maturity dimensions be combined, thus, unnecessarily constraining the organization by limiting flexibility, as sometimes it may be sufficient improving either the "process maturity" or the "practice maturity" instead of both.

Thus, as explained in the above paragraph , clustering of "Practice maturity" and "Process maturity" at the same level by prescribing practices for a given process maturity level, can lead to misleading, unnecessarily and unintended implications that constrain or eliminate flexibility of improvement approaches and may result in distorted priority of improvement efforts and missing more effective and less costly improvement

opportunities (options).This is the major gap of models that were built on maturity concept similar to that of CMM 's staged maturity representation. This is one of the major gaps this thesis research has tried to address in the proposed maturity model.

Unlike models that were developed based on CMM's staged maturity representation, some models that were developed based on maturity concept similar to CMMI's continuous maturity representation mainly consider "process maturity" dimension and give little or no consideration for the "practice maturity" dimension. For example the CMMI model treats "practice maturity" at performed level only, and it does not provide a framework (guide) for incremental improvement of the "practice maturity" dimension as it does for the "process maturity" dimension (the older version of CMMI V1.1 has tried to address this to some extent on few of the process areas by using base practice and advanced practice for practices at level 1, and those at level-2 and above respectively, however this idea was no longer used in the later versions). The lack of consideration for a frame work for the development of the "practice maturity dimension" in the CMMI model and its likes; has many unintended implications for organization that seeks to use the model to guide their maturity self-assessment and improvement effort.

One implication for organization that uses the model is that , once an organization has achieved Performed level (level-1) in the model, the focus becomes improving the "process Maturity" perhaps , until it reaches level-5 (level –of continuous improvement); this is because, all the remaining stages focus on improvement of "Process Maturity". This could happen despite the fact the organization has achieved performed level

maturity by performing the practices informally or at an elementary or average level, because in CMMI model and its likes, it does not matter whether the practices are performed formally or informally to achieve performed level of maturity, or whether advanced and more effective practices are used or not. What matters in those models is attainment of the process area goal, irrespective of how it is achieved .Thus, improvement of "Practice maturity" dimension can unnecessarily be delayed or totally ignored. Without parallel improvement of the "practice maturity", the benefit that could be gained from improvement of the process maturity dimension could be severely limited.

The other unintended implication of treating "practice maturity" at performed level only is that, it may lead organizations that use the model to think that, they have to make sure first that, they have performed all the practices (or their equivalents), probably to the degree of detail as provided in the model before starting to improve its "process maturity", as according to CMMI, organizations should reach performed level before thinking advancing to the next level. This may unnecessarily delay the improvement of "process maturity" (i.e. it delays starting to perform the process in a planned, defined, documented, monitored and controlled manner).This tendency has already been observed "Although CMMI is becoming well established, its application is limited by its overall invasiveness. To fully apply the CMMI model… requires significant amount of resource and integration..." (Bourne, 2008)

Like the process maturity dimension, organizations should also have incremental stages of improving their practice maturity dimension. The lack of attention or consideration for incremental improvement of the "practice maturity" dimension by models that are developed based on continuous process maturity was the other major gap that this research has tried to address in the proposed maturity model.

In order to reap the full benefit of concept of maturity, the models to be used for assessment should be able to help capture both dimensions of maturity and provide framework for improvement in both maturity dimensions. In addition, the models should offer a flexible approach as to which maturity dimension to improve at a given instant or whether to consider both. As shown in earlier paragraphs, the approach of the two families of maturity model discussed is either incomplete or not flexible enough to address the above two important issues. Thus, one of objectives of the proposed model was to address these issues. Accordingly, this research has proposed a maturity model that addresses these issues so that organizations would be able to measure maturity of their practice as well as their processes, and at same time be able to chart their improvement efforts flexibly in both dimensions. For this, extensive research is needed to identify industry best practices from time to time. However, due to limitation of time and resource, this master's thesis research was limited in this regard, to the coverage of practices in PMBOK and some reference books that were available to the researcher. The main objective of the research was to emphasis the importance of improving both dimensions of maturity and, to perform some foundational work that demonstrate the application of the concept, and serve as a basis for further refinement.

What does the Proposed Model look like?

The proposed maturity model has two dimensions for assessment and development of maturity. These are "Process Maturity" dimension and "Practice Maturity" dimension. Like most of the PM maturity models, the proposed maturity model's process maturity dimension was developed mainly by adapting the concepts and frame works of maturity definition of CMMI's continuous maturity representation. However, the model's practice maturity dimension (classifying practices under a knowledge area in to three progressing levels of basic, average and advanced practice, and measuring maturity in the practice dimension separately) is an original contribution of this research.

The proposed model differentiates the two dimensions of maturity, and provides clear and flexible option for developing maturity depending on the organization's specific need and circumstances.

Proposed Model's "Practice Maturity" Dimension

The practice maturity dimension applies concept that is very close to the concept of best practice in defining its maturity. However, the contribution, importance and the required infrastructure and capability for performing different practices is expected to be different. Hence, the model categorizes practices identified for a knowledge (process) area in to three main categories of: Basic practice, Intermediate (average) practice and advanced practice. The idea of categorizing practices has been used by some models, for example older version of CMMI continuous representation (version CMMI V1.1) has categorized

some practices in process areas such as requirement management as base[26] practice and advanced practices.[27] (Chrissis, Konrad, & Shrum, 2003).

In the proposed model the practices under each knowledge area were identified from PMBOK and other references. The practices were categorized (rated) by PM practitioners in Ethiopia as basic, intermediate (average) and, advanced practice using the following criteria[28].

A basic (a must) Practice

A practice is considered to be a Basic Practice if the practice is believed to be critical for the attainment of the goals of a knowledge area, and, if it is impossible or very difficult to achieve a meaningful management of the knowledge area in the absence of the practice. Such practice is expected to be performed in the management of almost any project to achieve the objective of the process area, and is considered to be **a must practice.**

An Intermediate (Average) practice

A practice is considered to be an Intermediate or Average Practice if the practice is believed to be useful, important and enhance the attainment of the goals of the knowledge area. However, such practice can be skipped in management of small or less important projects without significantly affecting attainment of the objective of the knowledge area.

---

[26] Practices at CMMI's capability level-1

[27] Practices at CMMI's capability level 2 and above

[28] See Appendix-G for complete listing of practices under each category for the 12 Construction PM knowledge areas

Generally, such practice is expected to be performed in the management of the majority of projects, and is considered to be an **Important and highly recommended practice.**

An Advanced Practice

A practice is considered to be an Advanced Practice if the practice is believed to be important and useful, and enhances the attainment of the goals of the knowledge area with a high degree of reliability. However, unless the project is large or complex, such practice can be skipped in management of the majorities of projects.

Generally, such practice is considered to be best suited for use in large or complex projects, or when the company desires to have a very high level of project management capability. This practice is considered to be a **recommended Practice –** for large or complex project.

Based on the three categories of practices, the model defines four levels for practice maturity dimension of a process (knowledge) area. These are:

Level-0-Incomplete level Practice maturity

This level indicates that the assessed organization is performing (or have the capability of employing) none or only some of the Basic Practices of the process (knowledge) area that are expected to be employed to meet the goals of a process (knowledge) area. That is there are some basic practices which the organization is not performing.

Level- 1-Basic Level Practice Maturity

This level indicates that the organization is performing (or has the capability to employ) all of the Basic Practices-(or their equivalent practices) that are expected to be employed to meet the goals of a knowledge (process) area under consideration.

Level-2-Intermediate or Average Level Practice Maturity

This level indicates that the organization is performing (or has the capability to employ) all of the Basic Practices and Intermediate (Average) practices (or their equivalent practices) that are expected to be employed to meet the goals of a knowledge (process) area under consideration.

Level-3-Advanced Level Practice Maturity

This level indicates that the organization is performing (or has the capability to employ) all of the Basic and Intermediate (Average) Practices, and it has performed (or have the capability to perform) most of the advanced practices (or their equivalent practices) that are expected to be employed to meet the goals of the knowledge (process) area under consideration.

In other word, it means the organization has achieved Intermediate (Average) Practice maturity and has the capability of performing most of the Advanced Practices that are used in the performing of a knowledge area.

Like most maturity model this model also has adopted concept of incremental and progressive maturity definition. That is achieving a higher level of practice maturity means the practices at lower level have already been achieved. Thus, for example, if an organization reached advanced level of practice maturity, it means automatically it has already has a capability of performing all the practices at lower level. Thus during assessment, an organization is assessed for the level that the organization sought and for all lower levels.

Proposed Model's "Processes Maturity" Dimension

Like most of the PM maturity models, the proposed model for process maturity dimension was developed mainly (with some modifications) by adapting the concepts and frame works of maturity definition of CMMI's continuous maturity representation. Hence, the definitions, the concepts and terms used in this model are the same as those provided in CMMI unless it is explicitly redefined. Description of the CMMI model and its concepts is provided in (Appendix-G: CMMI Maturity Model Description)

The Proposed process maturity model has five maturity levels for the process maturity dimension of organizations' PM processes. These levels are: Incomplete Process, Informally Performed Process, Formally Performed Process, Managed Process, and Defined Process.

Informally performed and formally performed process maturity levels are treated together at CMMI's level-1 performed process level. However, in the proposed model, this level is divided in to two levels as, attaining managed level maturity (level-2 in CMMI& level-3 in the proposed model) requires significant resource, commitment for defining and institutionalizing of the process, in such case, as the gap from informal management to managed process level could be so wide it may delay benefits which can easily be obtained by first formalizing the processes till the organization achieved managed level of process maturity. Instead, by achieving a formally managed process maturity level (that is employing structured approach based on existing guides such PMBOK or any source available to the project management team) in the meantime the organization can enhance the benefit gained from maturity; as formalization enhance chance of performing a process at the right time and consideration of all relevant aspect

which could be easily missed or overlooked in informal practice. Further, the use of guide as in formal process maturity level could also serve as a basis in defining the process for managed level. Thus, in the proposed model formally performed level is included as additional level in the process maturity dimension.

Also CMMI's level -4 and level-5 are not included in the maturity model proposed for process maturity dimension, as the purpose of the development of this model was for use in assessing contractors in Ethiopia and, it was assumed that the maturity of the contractors will not reach these levels. The result of the research has also validated this assumption. The same assumption was made in similar studies like in assessment of maturity of PM in Croatian organizations and the maturity model for Mauritius IT industry. PRINCE-2[29] maturity model also do not include CMMI's level-4 and Level-5 maturity. Following is provided the descriptions of the five levels of the process maturity dimension of the proposed model.

Level-0 Incomplete Process

There is no or little awareness on the need to perform the process area; sometimes there might be informal attempt to perform some of the processes or practices under a process/ knowledge area; however, such practices are not complete enough to meet the goal of the process/ knowledge area .Hence, the process is considered to be incomplete.

---

[29] A Maturity model developed by the Office of Government Commerce (UK)

Level-1-Informally Performed Process

Informally Performed Process is a process that met all the specific goals of the Process (knowledge) area. However, unlike that of formally performed process the implementation of the process is not disciplined. That is, the process is not performed following an established or prescribed structured approach. In other words, the process is done without following a documented approach.

Such process is performed in a way that the PM knows and chose based on his experience, training, and judgment with little or no use of guidelines or industry standards. There is little and informal planning and control of the process implementation.

Level-2 Formally Performed Process

A formally performed Process is a process that meets all the specific goals of the process (knowledge) area and which is performed following a disciplined approach. That is, the process is performed following an established or prescribed structured approach (For example based on guides such as PMBOK, CMMI, etc or any relevant guide or reference source).

For a process at this maturity level, even though there might not exist organizational guide and standard, usually there will be organizational (or project level) understanding or expectation of the need to perform the process (knowledge) area. Further, there will be some sort of monitoring and control of the process at least during project review and reporting.

Level-3 Managed process

A managed process is a formally performed process that employee's skillful persons, and whose implementation is organizationally mandated, formally planned and documented, and formally monitored and controlled as to the adherence to the process description. Further, for a process at this level there will be clear understanding of the processes, practices and the sequences of the activities to be performed.

At this level, the process and implementation of the practices in the process is organizationally required. In addition, implementation of the practices in the process and the process itself are managed as any activity or project (by planning and documenting the processes, performing the process and monitoring and controlling the process as any activity or project)

Level-4 Defined Process

A defined process is a managed process that is defined and documented by tailoring from the organization's standard process, and contributes measurements and other process improvement information for future use in planning the implementation of the process or improvement of the process. The main difference between managed level and defined level maturity is that at a defined level there is a documented standard organizational process and all projects tailor their specific process from the organizational standard process; whereas, at a managed level there is no documented organizational process, hence each project prepares its own documented process.

Structure of the proposed process maturity model

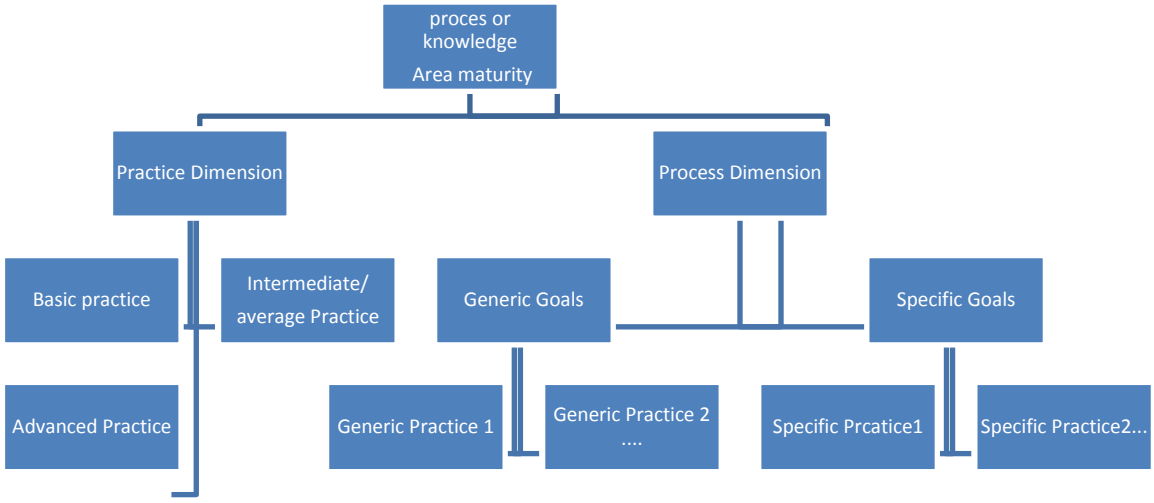

Figure 3 structure of the proposed Maturity model.

Like the CMMI model, this model also has two components, a Required Component[30] and an Expected Component[31]. The generic goals and specific goals are the required component of the model; whereas, the generic and specific practices are the expected components of the model. Goals generally represent a desirable end state and reflect the minimum requirements for satisfying a process area (specific goal) or a maturity level (generic goal). On the other hand, practices generally represent the "expected" means of

[30] Those which must be present to demonstrate attainment of maturity

[31] Those which are expected to be present to demonstrate attainment of maturity

achieving a goal, in other words, they are typical activities necessary to implement a goal. As practices are not a required component, they can be substituted by appropriate alternative practices if the alternatives are also effective in implementing the goal. Generally, generic goals and generic practices are associated with the levels of maturity in the model and they are used with all the knowledge areas. Generic goals describe the goals that have to be achieved to attain a given maturity level and the generic practices indicate the expected means of achieving that goal. Specific goals and specific practices are associated implementation of knowledge (process) area. Specific goals describe the goals that have to be achieved to perform a knowledge (process) area and the specific practices indicate the expected means of achieving that goal.

Similar to CMMI, in this Proposed model, a given level of maturity is said to be achieved for a knowledge (process) area, if it has demonstrated that all the specific goals of the knowledge area are attained and if it has demonstrated that all the generic goals of the level for which the organization is assessed and the levels below are met. During maturity assessment, the implementation of the generic and specific practice at a given level is assessed to determine whether the goals at that level are achieved or not. In addition, the generic and specific practices can be used as a frame work to guide improvement efforts towards a desired level of maturity. In the model, attainment of higher level of maturity also means attainment of lower level maturity. Thus, for example if an organization has reached a defined process level maturity it means automatically it satisfies all the requirements of levels below it; that is, it means, it also satisfies requirements of managed process and formally performed process level process maturity.

Table 5 below presents the generic goals and generic practices associated with each process maturity level.

Table 5: Generic Goals and generic Practices of the process Maturity Dimension

Maturity level	**Generic Goal**	**Generic Practice**
Level-0 Incomplete Process	No generic Goal.	No generic Practice.
Level-1 Informally Performed Process	GG1- Perform the Practices of the knowledge area.	GP1.1-1 Implement the practices of the knowledge area to produce a product or a result of the knowledge area.
Level-2 Formally Performed Process	GG2- Formally Perform the Practices of the knowledge area.	GP2.1-1**Formally** implement the practices of the knowledge area to produce a product or a result of the knowledge area.
Level-3 Managed Process	GG3-Institutionalize a Managed Process.	GP3.1-1 Establish and maintain visible organizational policy or expectations for planning and performing the process. GP3.1-2 plan for performing the process by determining and documenting what is needed (resources, documents, standards etc) to perform the processes. GP3.1-3 Monitor and control the process against the plan for performing the process and take appropriate corrective action. GP3.1-4 Train the people performing or supporting the

		process to equip them with the skill and expertise needed to perform or provide support to the implementation of the process.
Level-4 Defined Process	GG 4- Institutionalize a Defined Process.	GP 4.1-1 Establish and maintain the description of a defined process that is tailored from the organization's standard process. GP4.1-2 Collect measurements and improvement information derived from planning and performing the process.

CMMI model has ten generic practices for managed level, however, unlike that of CMMI, the proposed model's generic practices at managed level are limited to four, as the fulfillment of the generic goals at this level is thought to sufficiently be realized with the implementation of the four generic practices. Similar idea was also raised in CMMI to limit the practices at this level to even three (Konrad, Young, & Hayes, 2009).

Specific Goals and Specific Practices of Knowledge areas

For ten of the twelve constructions PM knowledge areas considered in the model, the mapping of goals and practices is done considering only the processes in PMBOK (and its construction extension). For the remaining two knowledge areas other sources have also been consulted to determine the processes under those knowledge areas and map the relationship of goals and practices.

The goals and specific practices of each knowledge area are defined and mapped based on Respondents (Project Managers) rating of the PM processes as basic ,intermediate

and advanced as defined in the practice maturity dimension in the proposed model , and the researcher's judgment based on the following questions.

1. What is the objective that we want to achieve by performing the knowledge area?

2. Which (PMBOK) processes must necessarily be performed to achieve the objective of the knowledge area?

The above two questions were used to define the goals from the PMBOK processes under each knowledge area. The rest of the processes were mapped to one of the goals as practices in the knowledge area based on the question.

3. With which goal the process under consideration is more related- and helps more to attain which goal?

Table 6 presents examples for Specific Goals and Specific Practices for project time management knowledge area.

Table 6: Specific Goals and Specific Practices for Scope and Time Management [32]

Question	**Answer**
1. What is the objective that we want to achieve by performing **project time management**?	Complete the project on schedule or (within intended time)

[32] Complete listing of Specific Goals and Specific practices for all the twelve knowledge areas considered in this research is given in appendix-I- on page 162

2. Which (PMBOK's) project time management processes must necessarily be performed to achieve objective of project time management?	1.Preparing schedule 2.Control of the schedule
Thus the specific goals of the project time management will be 1. Prepare project schedule 2. Control project schedule Now each of the PMBOKs process will be grouped under one of the two goals by asking the third question for each PMBOK time management process	
With which goal **Define Activity** process is more related- and helps more to attain which goal?	Prepare project schedule
With which goal **Sequence Activity** process is more related- and helps more to attain which goal?	Prepare project schedule
With which goal **Estimate Activity Resource** process is more related- and helps more to attain which goal?	Prepare project schedule
With which goal **Estimate Activity Duration** process is more related- and helps more to attain which goal?	Prepare project schedule
With which goal **Develop Schedule** process is more related- and helps more to attain which goal?	Prepare project schedule
With which goal **Monitor and Control Schedule** process is more related- and helps more to attain which goal?	Monitor and Control Schedule
Thus follows the mapping of the Specific Goals and Specific Practices for project time management knowledge area	
Specific Goal	**Specific Practice(process)**
SG1.Prepare Project Schedule.	SP1.1 Define Activity. SP1.2 Sequence Activity. SP1.3 Estimate Activity Resource. SP1.4 Estimate Activity Duration. SP1.5 Develop Schedule.
SG2. Control Project Schedule.	SP2.1Monitor and Control Schedule

SG= Specific Goal SP= Specific Practice

Determination of maturity for Knowledge (process) and an organization

Determination of Practice Dimension of maturity for Knowledge (process) Area

In determining the practice maturity level of a process (knowledge area) the following sequential assessment is performed partially or fully depending on the outcome of each step as explained below.

1. Assessment for implementation of the Basic Practices: The organization is first assessed to see if it is implementing all basic practices identified under the knowledge area or their equivalents. If the organization is found to implement only some of the basic practices (partial implementation) then a score between 0 and 1 (proportional to the number of basic practices implemented would be assigned). If the assessed organization is found to implement all the basic practices then the organization would be assessed for the implementation of the intermediate (average) practices identified for the knowledge area.
2. Assessment for implementation of the Intermediate (Average) Practices. If the assessment showed that the organization is implementing only some of the average practices or their equivalents (partial implementation) then a score between 1 and 2 (a score above 1 proportional to the number of additional intermediate (average) practices implemented) would be assigned. If the assessed organization is found to implement all the intermediate (average) practices then the organization would be assessed again for the implementation of the advanced practices identified for the knowledge area.
3. Assessment for implementation of the Advanced Practices. If the assessment showed that the organization is implementing only some of the advanced

practices or their equivalents (partial implementation) then a score between 2 and 3 (a score above 2 proportional to the number of additional advanced practices implemented) would be assigned. If the assessed organization is found to implement all the advanced practices then the organization would be assigned a score of 3.

Determination of Practice Dimension of maturity for an Organization

The overall construction PM practice maturity is determined by calculating the average maturity score determined for the 12 knowledge areas. In determining the overall maturity the weight (contribution) of the 12 knowledge areas is assumed to be equal. This research has hypothesized that the relative contribution of the knowledge area to be different and to determine their relative weight; judgment of practitioners and academician was collected through questionnaire survey –III, however the analysis has showed that there is no significant agreement between the professional as to the relative weight of the knowledge areas (see page263 in Appendix-I: Hypothesis Test Result), hence the weights determined were not used, and instead equal contribution is assumed. The average result obtained is interpreted as shown below.

1. Average maturity score less than 0.5 : Little or no Practice of PM
2. Average maturity score between 0.5 and 1 incomplete Level of construction PM practice
3. Average maturity score between 1 and 2 basic practice of basic level of construction PM maturity
4. Average maturity score between 2 and 3 Intermediate (average)level of construction PM maturity

5. Average maturity score of 3 advanced level of construction PM maturity

Determination of Process Dimension of maturity for Knowledge (process) Area

In determining the process maturity level of a process (knowledge area) the following sequential assessment is performed partially or fully depending on the outcome of each step as explained below.

1. Assessment for the achievement of the goals of the knowledge area: The organization is first assessed to see if it has implemented the practices identified for a knowledge area or their equivalent and achieved the specific goals of the knowledge areas. (See Appendix-K: Mapping of Specific Goals and Specific Practices for the goals and practices of the construction PM knowledge areas) If the organization is found to achieve only some of the specific goals (partial implementation) of the knowledge area, then a score between 0 and 1 (proportional to the number of goals achieved would be assigned). If the assessed organization is found to achieve all the specific goals then the organization would be assessed whether the goals are achieved by implementing the specific practices formally or informally. If it is found that the organization has achieved the goal by implementing the specific practices informally, then a maturity score of 1 is assigned and if it is found that to be formally then the assessment in 2 follows
2. Assessment for the achievement of the generic goal of the managed level[33]: The organization is assessed to see if it has achieved the generic goals of the managed level process maturity. If the assessment showed that the organization has

[33] :see Table 5: Generic Goals and generic Practices of the process Maturity Dimension on page 54

achieved only some of the goals (partial achievement) then a score between 2 and 3 (a score above 2 proportional to the number of generic goals achieved) would be assigned. If the assessed organization is found to achieve none of the generic goals of the managed level then a score of 2 is assigned and, if is found to achieve all the generic goals of the managed level then the assessment in 3 below follows.

3. Assessment for the achievement of the generic goal of the defined level: The organization is assessed to see if it has achieved the generic goals of the defined level process maturity. If the assessment showed that the organization has achieved only some of the goals (partial achievement) then a score between 3 and 4 (a score above 3 proportional to the number of generic goals achieved) would be assigned. If the assessed organization is found to achieve none of the generic goals of the defined level then a score of 3 is assigned and, if is found to achieve all the generic goals of the defined level then a score of 4 would be assigned.

Determination of Process Dimension of maturity for an Organization

The overall construction PM process maturity is determined by calculating the average maturity score determined for the 12 knowledge areas. Similar to the case with practice maturity dimension; the weight (contribution) of the 12 knowledge areas is assumed to be equal. The average result obtained is interpreted as shown below.

1. Average maturity score less than 0.5 : Little or no Practice of PM
2. Average maturity score between 0.5 and 1 incomplete Level PM process maturity
3. Average maturity score between 1 and 2 informal level PM process maturity
4. Average maturity score between 2 and 3 formal level PM process maturity
5. Average maturity score between 3 and 4 managed level of construction PM process maturity
6. Average maturity score of 4 advanced level of PM process maturity

Note that, this proposed model is industry specific (Construction industry) ,reflects only contractors perspective, and mainly the Ethiopian context .However ,as the concept used is global ,the framework of the model can be used for assessing and framing improvement of project management maturity of any organization anywhere .The model can be extended to any industry and stakeholder perspective or it can be framed in such a way that it could be used in any industry and context and reflects perspective of major stakeholders. The researcher has limited the scope of the model purposely for two main reasons. These were

1. Limitation of time and resource, and
2. The scope was sufficient for the initial purpose the model was sought (i.e. to have appropriate maturity model that could be used to assess maturity of PM of contractors in Ethiopia).

CHAPTER 9: VALIDATING PROPOSED MATURITY MODEL

Proposed Maturity model Validation Based on (Bruin, etal, 2005) Framework

(Bruin, etal, 2005) have proposed a frame work for development of maturity model. The model proposed by this research has been developed following the framework proposed by the above authors. Their proposed frame work for developing a maturity model consists of six major steps of Scope, Design, Populate, Test, Deploy and Maintain.

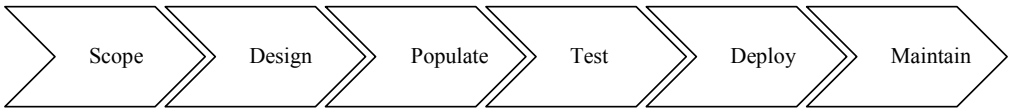

Figure 4: (Bruin, etal, 2005) 's maturity model development framework

According to the authors their proposed frame work forms a sound basis to guide the development of a model through first the descriptive phase, and then to enable the evolution of the model through both the prescriptive and comparative phases within a given domain. The maturity model proposed by this research is limited to the descriptive phase.

Phase 1 - Scope

According to (Bruin, etal, 2005), the first phase in developing a maturity model is to determine the scope of the desired model. The major decisions to be addressed at this phase are focus of the model (domain specific or general) and development stakeholders (Academician, Practitioners, Government or combination).The maturity model proposed by this research is domain specific(to the Construction PM in developing countries) and the development stakeholders were both Academicians and Practitioners.

The proposed model was developed specifically to assess the construction PM maturity of contractors in developing countries. In the development process of the model both academicians and practitioners were involved in developing the practice maturity dimension of the proposed model mainly in categorizing the practices identified during literature survey as basic , average and advanced practices. The input of these two groups was obtained using survey.

Phase 2 - Design

The second phase in the framework is to determine the architecture for the model.

Table 7 shows major decision to be made at this stage.

Table 7: Decisions made when designing a Maturity Model[34]

Criterion	**Characteristic**		
Audience	Internal	External	
	Executives, Management	Auditors, Partners	
Method of Application	Self-Assessment	Third Party Assisted	Certified Practitioner
Driver of Application	Internal Requirement	External Requirement	Both
Respondents	Management	Staff	Business Partners
Application	1 entity / 1 region	Multiple entities / single region	Multiple entities / multiple region

As the main goal of the proposed model was to assess the status of PM maturity of contractors for improvement purpose the targeted audience were internal-(executives and management).The chosen method of application was self-assessment and the driver of application is considered to be for the organization's internal improvement need. For the

[34] :Directly reproduced from the authors paper titled: Understanding the Main Phases of Developing a Maturity Assessment Model

assessment, the respondents were decided to be Project Managers or peoples who worked as Project Manager in their organizations so that all relevant information could easily be obtained. The application is considered to be for multiple entities in single region (contractors in Ethiopia/Developing Countries).

According to (Bruin, etal, 2005), model design has to strike an appropriate balance between complex reality and model simplicity. In addition, the authors indicated that most maturity models represent maturity as five cumulative stages where higher stages build on the requirements of lower stages with the fifth stage representing high maturity and the first stage representing low maturity. The authors have emphasized the need for the final stages to be distinct and well-defined, moreover, according to the authors there need to be a logical progression through the stages and, the stages should be named with short labels that give a clear indication of the intent of the stage. The proposed maturity model, in this regard, totally responds to the requirement posed by the authors. For example, the process dimension of maturity has five levels of maturity with the higher stages building on the requirements of lower stages. For instance, Intermediate level of maturity in the practice dimension means the organization has already performed all the practices that are considered to be basic (has already attained basic level practice maturity); in addition, it means it has the capability of using practices that are considered to be of intermediate importance. Similarly, Advanced level of practice maturity builds up on the intermediate practice maturity (that is the organization has the capability to use all the basic, intermediate and advanced practices). In addition, the naming in both the practice and process dimensions of the proposed maturity model clearly indicates the intent of the stages. For instance ,the basic level practice maturity indicates that the

organization should have the capability to perform all the practices that are considered to be basic , similarly, advanced level practice maturity indicates that the organization should have the capability to use advanced practices. The same is true for process maturity dimension. For example, formal level of process maturity shows that the organization is performing the processes formally.

The authors have also discussed generally two approaches for reporting maturity. The first approach is reporting an 'average' maturity stage. This is the most commonly used method. This form provides a simple means of comparing maturity stages, however, it does not adequately represent maturity within complex domains; providing little guidance to an organization wishing to improve its 'as-is' position. The second approach for reporting maturity provides additional layers of detail that enable separate maturity assessments for a number of discrete areas in addition to an overall assessment of maturity for the entity. The results obtained from a layered model (second approach) enable an organization to gain a deeper understanding of their relative strengths and weaknesses in the domain and to target specific improvement strategies; in addition, such an approach enables model assessment reports to be tailored to varying needs of multiple audiences. The proposed maturity model in this regard follows an approach similar to the second one. In the proposed model, maturity is assessed in different components that have different layers; for example, the process dimension maturity is assessed in 12 knowledge areas (component) each organized by goals and practices (subcomponents). A single average value is reported for the overall maturity of construction PM and for each knowledge area; further, a value indicating level of achievement of each goal can also be reported.

Phase 3 - Populate

According to (Bruin, etal, 2005), "At this phase the content of the model is decided. Identification is made as to what to be measured in the maturity assessment and how to measure. Identification of domain components and sub-components that are mutually exclusive and collectively exhaustive is made at this phase. This additional layer of detail assists in the development of assessment questions, enables richer analysis of maturity results and improves the ability to present maturity results in a manner that meets the needs of the target audience".

In the proposed model, components and subcomponents were identified through literature review mainly using PMBOK guide and its construction extension as a basis. Thus, 12 knowledge areas were identified with their goals and practices. The decomposition of each knowledge area in to goals and their subsequent practices (components and sub components) is done following PMBOK's organization. In the model the implementation of the practices is measured (what to be measured) through survey (how to be measured) to determine whether the goals of the knowledge (process) areas are met and a given maturity is attained. According to (Bruin, Rosemann, Freeze, & Kulkarnil, 2005), " When selecting an instrument for conducting an assessment consideration needs to be given to the model generalizability together with resources available for conducting assessments. Moreover, it is important that questions and responses are valid i.e. they measure what they are intended to measure. In addition, a balance in the number of questions is important. Sufficient questions are required to ensure complete measurement but too many questions may reduce reliability of data by resulting in a reduction in total survey responses or an increase in incomplete surveys. "

In this regard, the proposed model has used paper survey for the assessment as online survey is infeasible given the low level of internet availability in Ethiopia. Other method of assessment such as assessment by external assessor were also were not considered due to limitation of time and the resource it needs; further, as the main objective of the model is for internal use by the organization, it is assumed that comparatively honest information would be obtained from the survey. To ensure validity of the information obtained from the contractors, this research has taken a number of measures. In order to ensure model generalizability and validity sufficient number of question were included in the maturity assessment (a total of 322 yes/No question and 12 multiple choice questions). This might seem large; however this is not new in surveys that aim detailed maturity assessment. For example, in his book (Wysocki, 2004) has used more than 800 questions for the PM maturity assessment of the PMBOK's nine knowledge areas. (Kawak, Young Hoon, 1997) also have used 156 multiple choice questions (each questions providing about four or five choices) for their maturity assessment based on PM2 model. In addition, a pilot test survey was conducted and the feedback obtained was used to improve the survey. To improve response rate and get complete response the researcher has delivered the survey questionnaire personally to each contractor's office and briefed all the persons that fill the questioners about the relevance of the research and the need to provide complete and accurate information. Moreover, the participants were promised both delivery of individual report about maturity of their organization and the overall report of the research upon completion of the research; these efforts by the researcher have helped to get relatively higher response rate and more or less complete

survey despite the length of the survey questionnaires. Further, frequent reminder calls were made to participants and this has also helped to increase response rate.

Phase 4 - Test

According to (Bruin, Rosemann, Freeze, & Kulkarnil, 2005) "once a model is populated, it must be tested for relevance and rigor. To ensure these, it is important to test both the construct of the model and the model instruments for validity, reliability and generalizability.Construct validity is represented by both face and content validity. Face validity is assessed during the population of the model using such tools as focus groups and interviews. The maturity model should be considered complete and accurate with respect to the identified scope of the model. Selecting complementary methods for populating the model can also assist in achieving face validity. Content validity on the other is ensured by assessing how completely the domain has been represented. The extent of the literature review and breadth of the domain covered provide a measure of content validity."

As discussed in the Populate phase, in order to ensure validity and reliability a number of measures have been taken in this research. These include Pilot testing of the survey questionnaire (to insure the understandability and relevance of the questions) and the use of highly established references as a basis for the development of the model (PMBOK and CMMI). In addition, Content validity is achieved for the majority part of the model as it was prepared based on established references PMBOK and CMMI – coverage of all the knowledge areas under PMBOK has been ensured and CMMI was used as a reference model. In addition, extensive literature survey has been conducted and additional contents were added (equipment management and material management

knowledge areas).Moreover, from those who returned the survey, nine contractors were randomly selected and the same questionnaire was administered by the researcher through structured interview. In the processes the contractors were required to substantiate their answer with examples and explanations. Analysis of the data showed 85% of agreement between survey response and the responses obtained through scheduled interview conducted by the researcher. Moreover, a parallel assessment of maturity based on modified existing model (Reference questionnaire)[35] has been done and the results were compared with maturity result obtained based on the proposed model. The correlation analysis showed strong correlation).The paragraphs on page 107 and 109provide detail discussion of the correlation analysis of maturity based on proposed model and that of the reference model.

Phase 5 – Deploy

According to (Bruin, Rosemann, Freeze, & Kulkarnil, 2005),"Following population and testing, the model must be made available for use and to verify the extent of the model's generalizability... Until the model has been deployed to entities independent of the development and testing activities, generalizability will continue to be an open issue irrespective of whether the model has been developed for a specific domain or for general application.... Depending on the original scope of model application, selection of a range of entities on the basis of industry, region, sector, financial resources and employee numbers will assist in improving the generalizability of the model. Deployment involves generally two steps, first the application of the model on those stakeholders that were

[35] : (a survey instrument very close in content to PM solution's maturity model)see Appendix-B for the questions adapted from the questionnaire

involved in the development and second the application of the model to those which are independent of the development of the model." In this regard, the proposed model was used to assess maturity of contractors which were independent of the model development. Further the model was deployed to contractors at different categories: Building contractors, Road contractors, ISO certified contractors and Non-ISO certified contractors. In all cases correlation analysis on the result obtained based on the proposed model and the result obtained based on reference model has shown strong correlation. This shows to some extent the generalizability of the model. To ensure generalizability reliably the model need be deployed to contractors at different categories and regions (for example, contractors at lower grade (such as grade-3 contractors) and contractors in other developing countries, however, due to limitation of time and resource this further work is left for future research.

Phase 6 – Maintain

This has to do with the continued refinement and updating of the model and the assessment instrument with the model's growth and use. (Bruin, Rosemann, Freeze, & Kulkarnil, 2005). This part is outside the scope of this research as it deals with the continued use of the model in the future.

Proposed model's Process Maturity vs. Reference Model Based Maturity

The result of the analysis shows that the proposed model's prediction of process maturity is strongly correlated to that of the Reference model's prediction (see Figure 5). A spearman correlation coefficient of 0.777 is found for the relationship between PM Process maturity of the contractors based on the proposed model and based on the reference model. Similarly spearman correlation coefficient of 0.845 is found for the

relationship between Process maturity of knowledge areas based on the proposed model and based on the reference model (see Figure). Moreover hypothesis test of significance has been undertaken and it was found that there is significant correlation between the prediction between the proposed process maturity model and the prediction of the reference model. (See pages 251 & 252 in **Appendix-I**: Hypothesis Test Result)

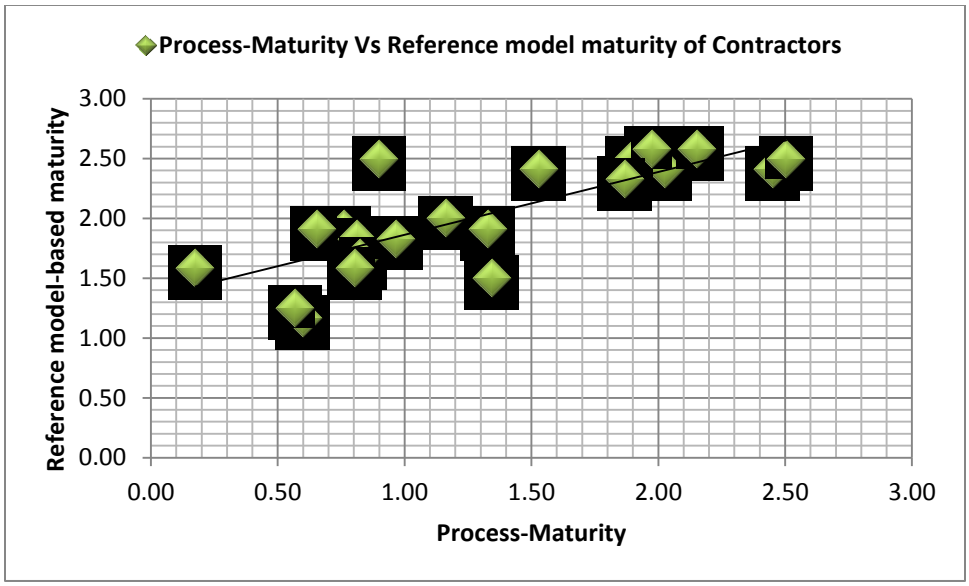

Figure 5: Contractors' PM maturity: Process dimension vs. Reference Model

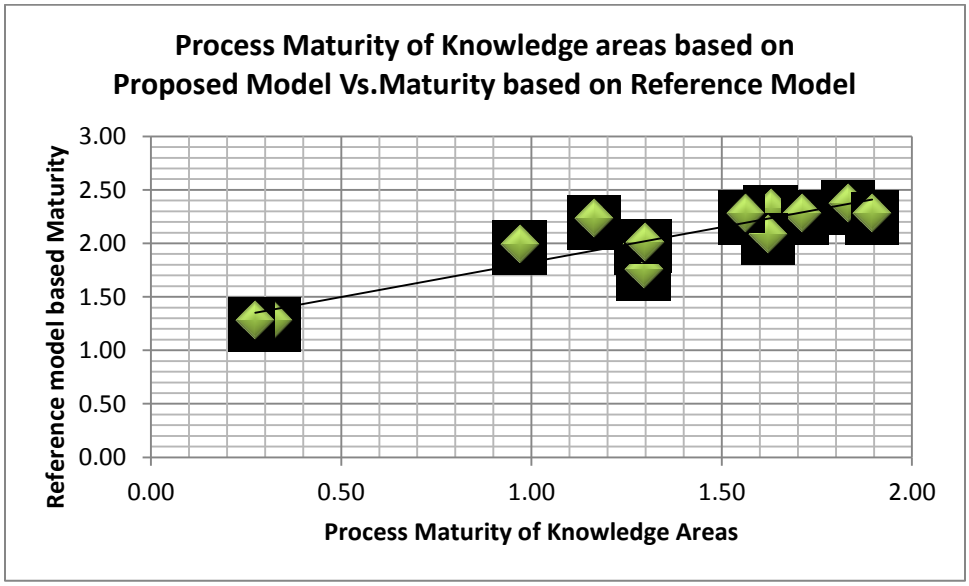

Figure 6: PM knowledge Areas maturity: Process dimension vs. Reference Model

Proposed Model's Practice Maturity-Vs. Reference Model based Maturity

Similar to the relationship between Process Maturity vs. Reference Model based Maturity, result of the analysis shows that the proposed model's prediction of Practice maturity is strongly correlated to that of the Reference model's prediction of maturity. A correlation coefficient of 0.739 is found for the relationship between the practice maturity of the contractors based on the proposed model and based on the reference model (see Figure 7). Similarly, a coefficient of correlation of 0.762 is found for the relationship between Practice maturity of knowledge areas based on the Proposed Model and based on the Reference Model (

Figure 8). Moreover hypothesis test of significance has been undertaken and it was found that there is significant correlation between the prediction between the proposed Practice Maturity model and the prediction of the reference model. (See pages 253 & 255 in Appendix-I: Hypothesis Test Result)

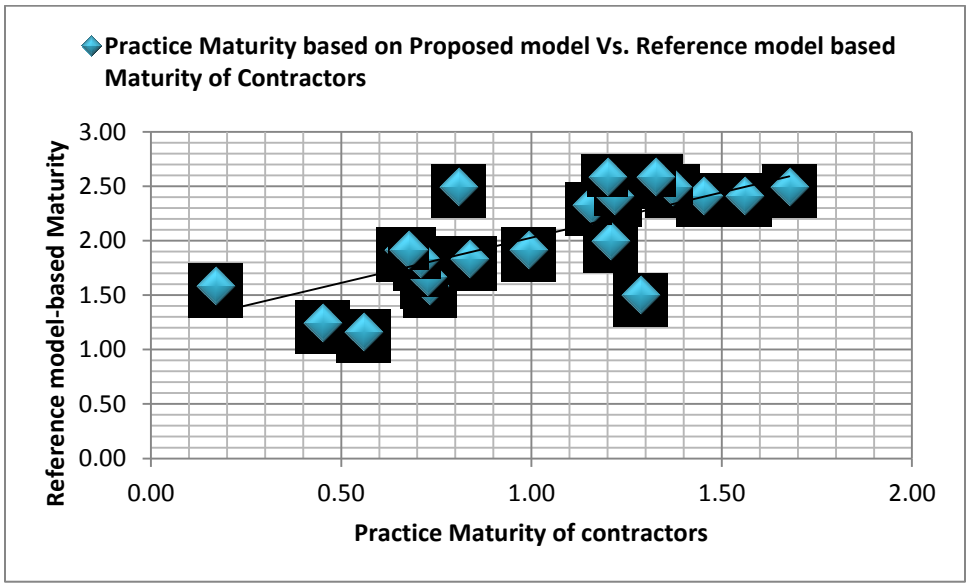

Figure 7: Contractors PM maturity: Practice dimension vs. Reference Model

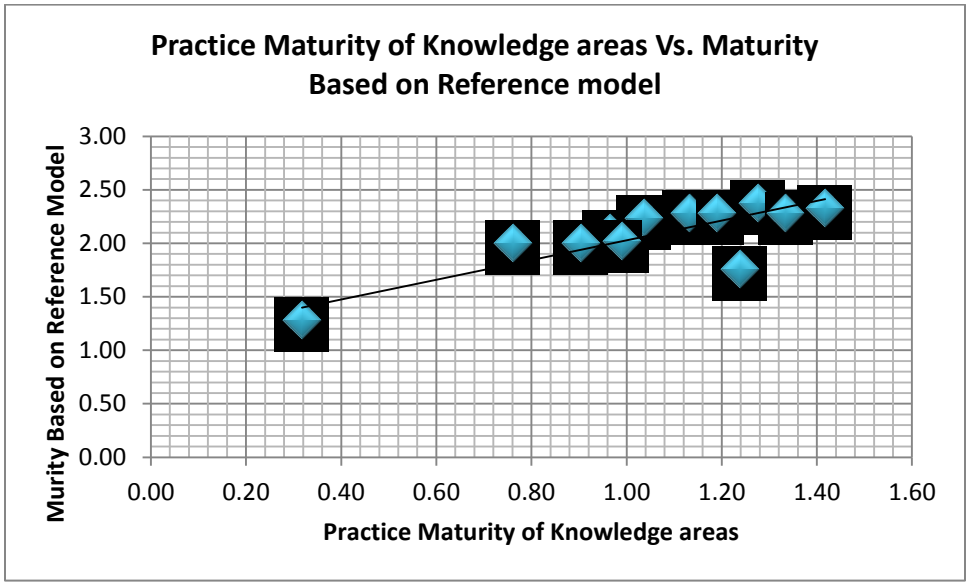

Figure 8: PM knowledge Areas maturity: Practice dimension vs. Reference Model

PART V: RESEARCH ANALYSIS

CHAPTER 10: RESEARCH RESULT AND DISCUSSION

Introduction

The research questionnaire was initially delivered to 40 contractors of which 32 are local contractors and eight international contractors (seven Chinese and one Indian contractor doing business in Ethiopia). 26 of the 32 the local contractors have returned the questionnaire and unfortunately none among the eight international contractors returned the maturity assessment questionnaire. Of those 26 which returned the survey a response from five was rejected as the responses were not complete or properly responded. Hence, only response from the 21 contractor was used in performing the maturity analysis.

This chapter presents only the result of maturity assessment of the 21 organizations and the practice rating of the PM practices by 15 Practitioners.

Table 8: Summary of the demographics of participating contractors

Contractor's Category	Number of contractors in the category
Based on Ownership Type	
Public Construction Companies	3
Private Construction Companies	18
Non-Identified	0
Based on the contractor's major work	
General Contractors(both road and building works)	7
Building Contractors	9
Road Contractors	5
Based on Participation in Capacity Building Program	
Capacity Building Program	10

Participant	
Non-Capacity Building Program Participant	8
Unidentified	3
Based on ISO-Certification	
ISO-Certified	5
In process for ISO certification	6
Neither certified nor in Process	9
Unidentified	1

Practitioners interviewed

In order to develop the proposed model, two additional questionnaires were prepared distributed to a total of 18 selected Practitioners and Academicians in areas of construction Project Management. Fifteen of the respondents have returned the first questionnaire (Survey-questionnaire II) of which the result of one was rejected due to incompletes. For the third questionnaire (survey –Questionnaire III), 12 respondents have returned the questionnaire of which the result of three respondents were rejected due to incompleteness. Generally, Nine of the 15 practitioners that have returned the questioners have PM training at masters level (Construction management program) one of the respondents has PhD level training and the remaining five have short term PM training. Two respondents have less than two years of experience as PM, Four of them have experience between two to four years, six respondents have 5 to 10 years experience working as PM and the remaining three have indicated working as PM above 10 years. The respondents have an average of seven years of PM experience.

Maturity Assessment Result and Discussion

The maturity assessment has been performed for the 12 construction PM knowledge areas covered by the research. The assessment is performed in two dimension of Practice maturity dimension and Process maturity dimension. Subsequent parts provide assessment summary result and discussion.

Maturity Assessment Result- Process maturity Dimension

As can be seen in Figure 9,approximately 50% of the contractors are found to be at incomplete level of PM process maturity (that is on average 50% of the contractors do not perform all the necessary processes that are required to manage construction projects successfully). On average these contractors do not perform 1 in 4 of processes or practices that are expected to be performed to achieve knowledge area goals. Further, 1/3 of the contractors perform the majority of necessary PM processes informally, and only 20% perform the majority of the PM processes formally .There was no single contractor which has attained the managed level process maturity. This result supports the research assumption to use maturity level up to defined level only. Moreover, the result is indicative of the low level of PM development in the country's construction industry.

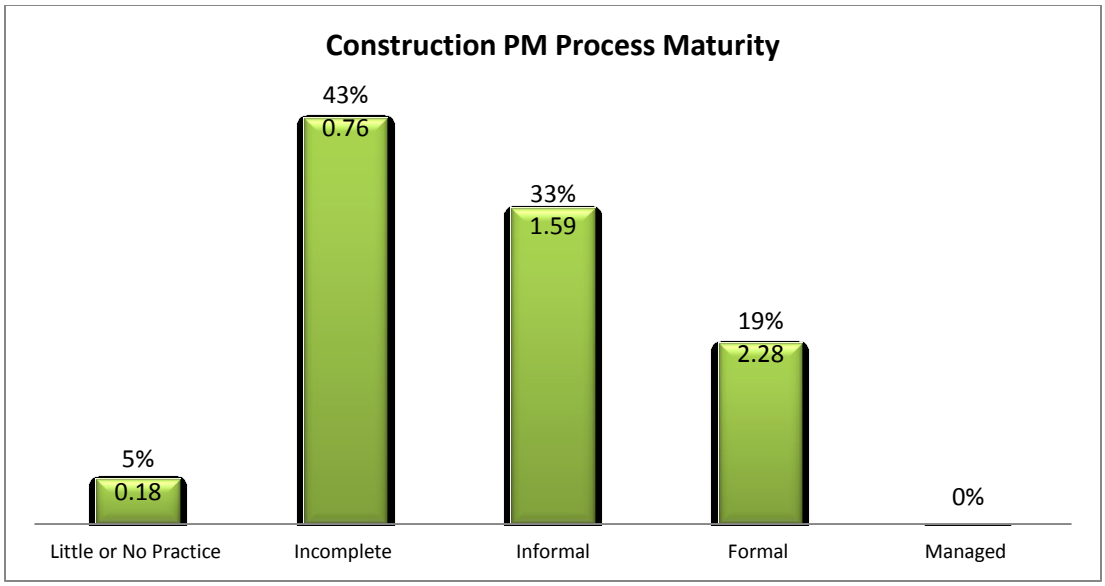

Figure 9: Construction PM Process Maturity summary of Contractors

The research finding indicates that overall the maturity of the process dimension of construction project management is found to be at informal process maturity level (1.30-see Figure 10).

As seen in Figure 10 the knowledge areas of material, procurement, cost, time, financial and human resource management have shown comparatively higher level of maturity compared with other PM knowledge areas. These knowledge areas are more or less being performed formally by the majorities of the contractors. Whereas the knowledge areas of scope, equipment, quality and communication management are comparatively at lower level and could be considered to be performed informally by the majorities of the contractors. The remaining two knowledge areas of risk and safety management are the least matured

knowledge areas. For practical purpose one can consider these two to be totally unknown or practiced by very few in the industry.

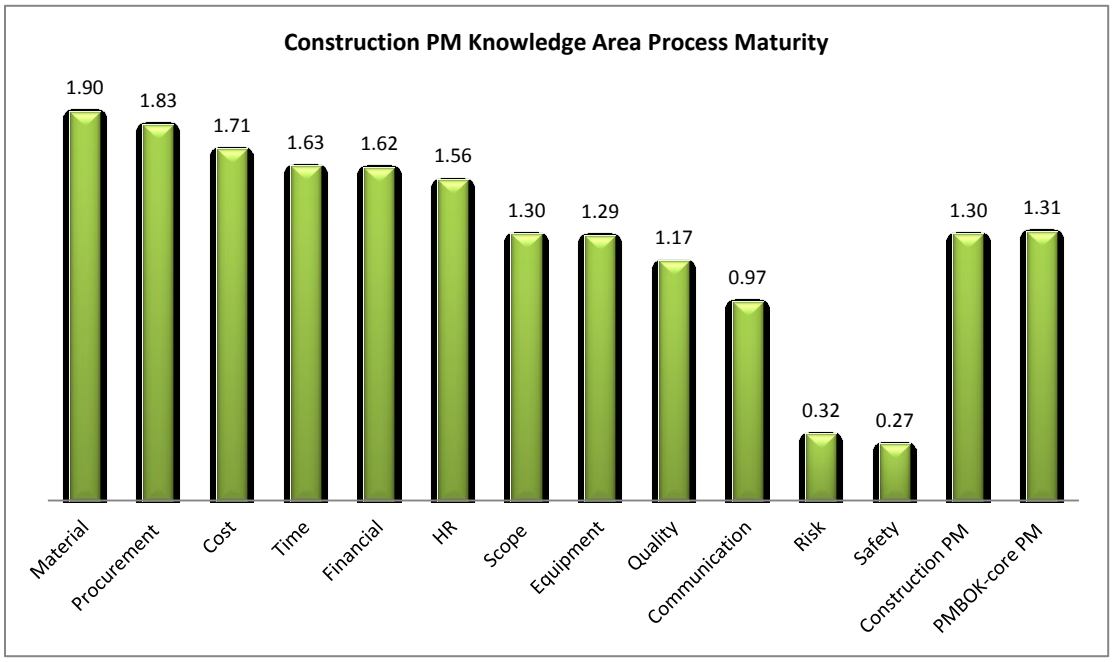

Figure 10: Construction PM Knowledge Area Process Maturity

Maturity Assessment Result- Practice maturity Dimension

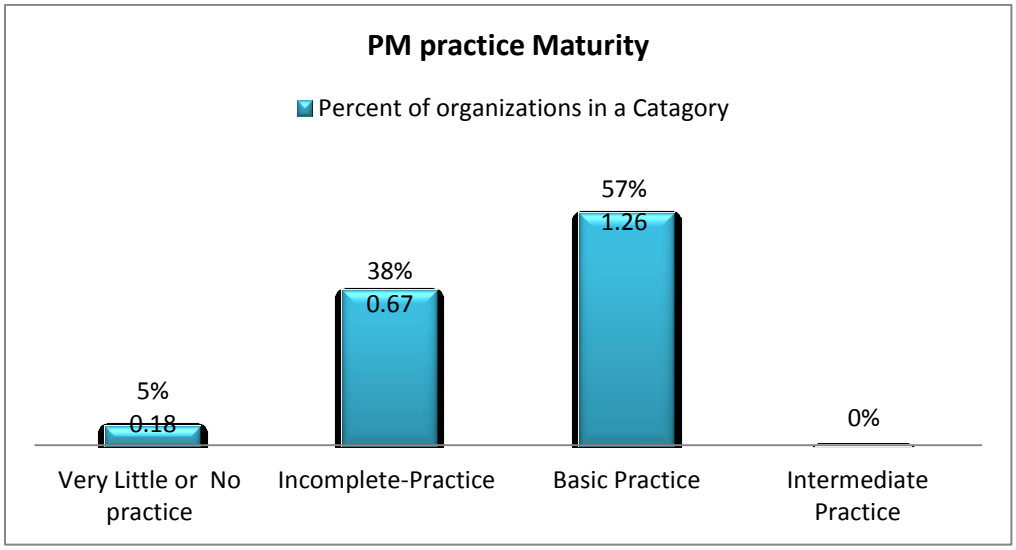

Figure 11: Construction PM Practice Maturity Summary of Contractors

The assessment result shows that almost 40 % of the contractors to be at incomplete level of practice maturity. That means on average 40% of the contractors do not perform all the practices considered to be basic. In fact, on average 40% of the contractors perform only 2/3 of the PM practices that are considered to be basic in managing construction projects. This is indicative of the very low level of PM maturity in the country's construction industry. The rest 60% of the contractors are at basic level of practice maturity. Not a single contractor has managed to achieve even intermediate level of PM practice maturity. The assessment result also indicates that on average about 60% of the contractors perform all the practices which are considered to be basic in managing construction projects and they also perform approximately 1 in 4 of the practices that are considered to be of intermediate or average importance in managing construction projects.

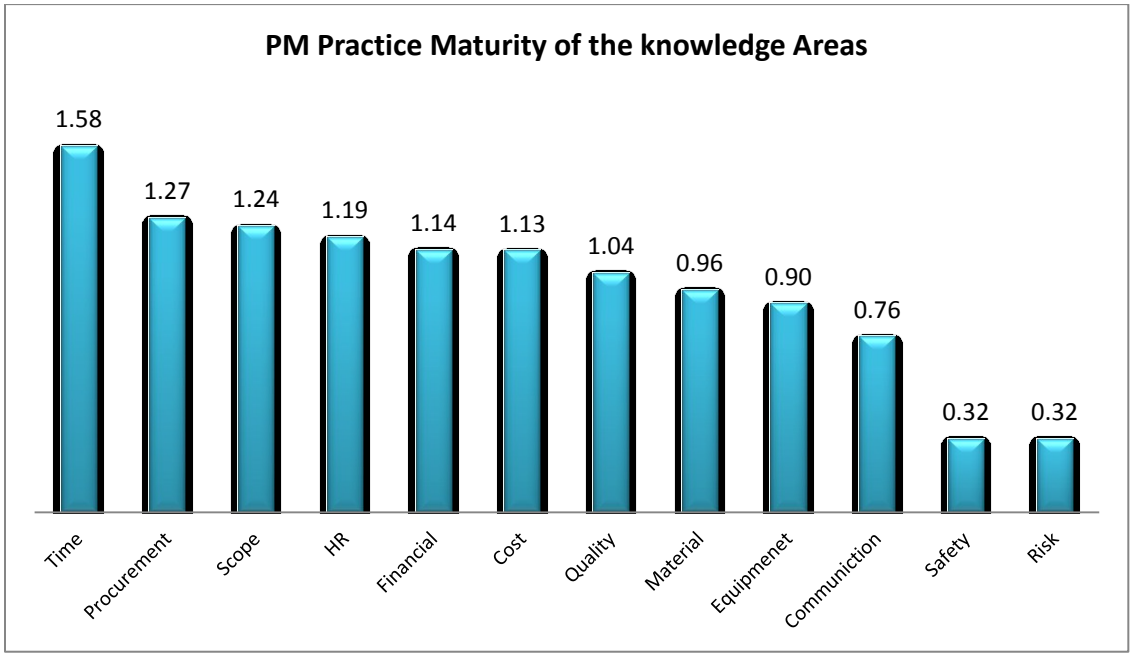

Figure 12: Construction PM Practice Maturity of the Knowledge Areas

The research finding also indicates that safety and risk management are totally neglected in managing construction projects in the industry. On average only 1/3 of the basic practices in the two knowledge areas were being performed. Next to the above two, communication management is another knowledge area which is comparatively at lower level of practice maturity. Here also contractors on average do not perform one in four of the practices that are considered basic in managing communication in construction projects.

The comparatively lower level of practice maturity of equipment management and material management could be because of the common practice in the industry to treat them as tasks to be managed by functional departments and are not usually considered to be the PM function. It seems there is similar understanding in the developed world. For example, even though HR is taken as one of the core functions or knowledge areas of PMBOK, equipment management and material management are not considered, even in the construction extension to PMBOK. Two major factors may have contributed to the low importance given to the two knowledge areas. The first is that the procurement dimension of both material and equipment have already been considered in procurement management and the second is the lower importance given to these two knowledge areas in the developed world compared to HR in controlling cost. In the developed world, human resource cost is expensive than material and equipment. Whereas, in many projects in developing countries, the two accounts for about 75% of the project cost and thus it means their consideration should be of high importance. Further, in developing countries due to scarcity of resources, managing these two important resources is critical for success of construction projects. Because of their importance in developing countries

construction PM, the two knowledge areas have been considered as additional construction PM knowledge areas in this research.

There is generally a direct relationship between process maturity and practice maturity with coefficient of correlation of 0.936, which means, more matured processes are associated with more matured or advanced practices. Test of significance has been undertaken and it was found to be significant even at 1 %.(see Appendix-I: Hypothesis Test Result)

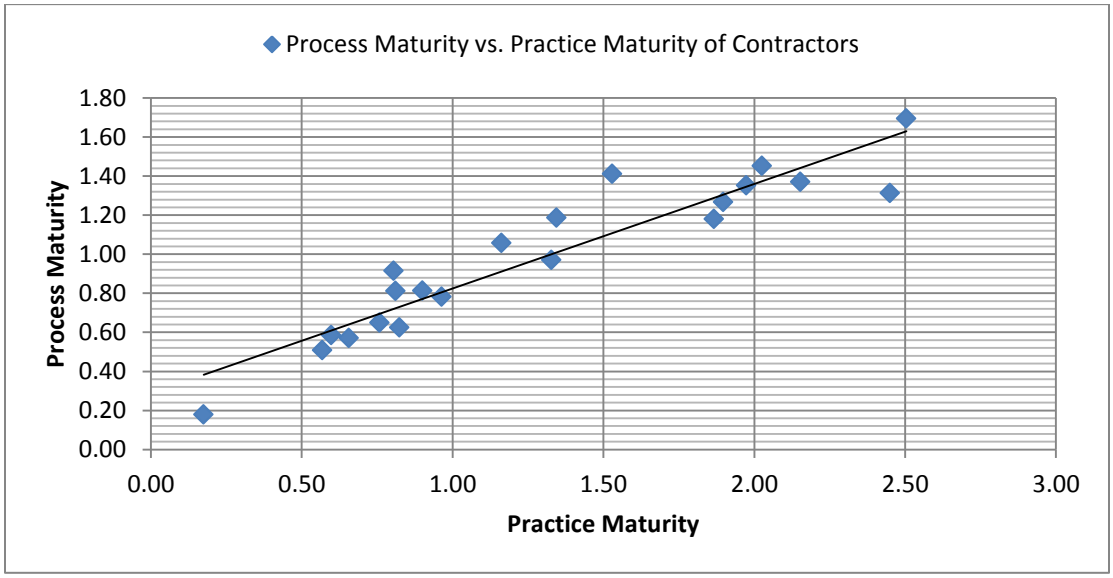

Figure 13: Process Maturity vs. Practice Maturity of Contractors

CHAPTER 11: PM MATURITY ACROSS CATAEGORIES

ISO vs. Non-ISO Contractors' PM Maturity

The research finding shows significant difference in maturity among different categories of contractors. Figure 14 shows the process maturity assessment result for contractors which are ISO certified in a process for certification and those which are neither ISO certified nor in a process.

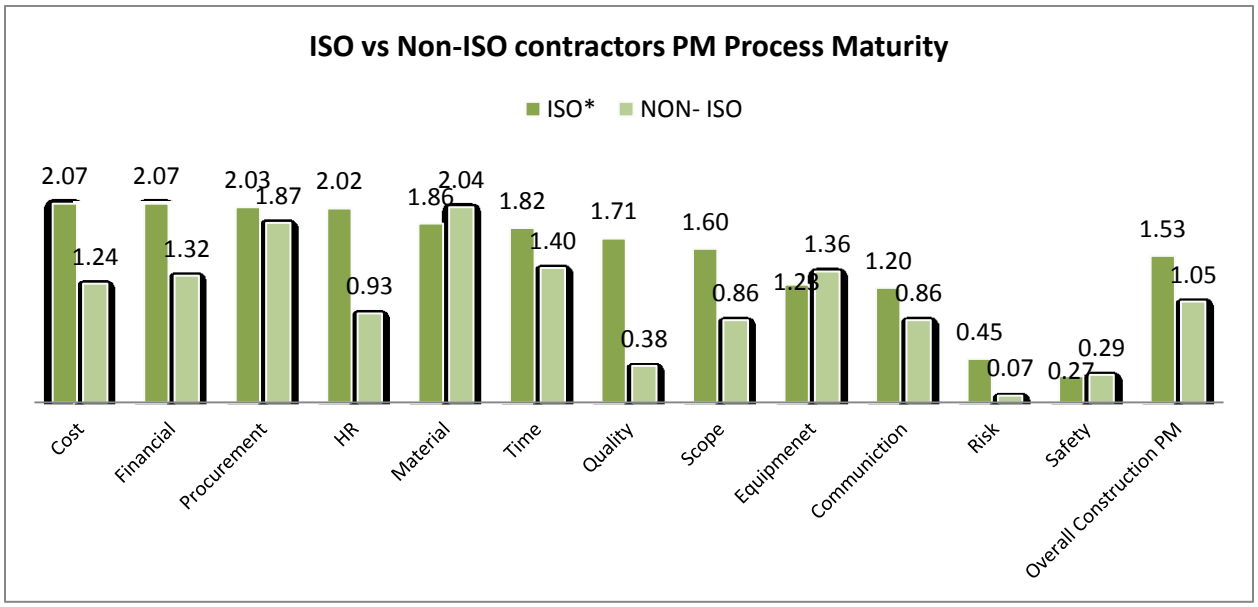

Figure 14: ISO vs. Non-ISO Contractors Construction PM Process Maturity

As Figure 14 shows, except for material and equipment management; overall PM process maturity of the contractors which are ISO certified or in a process to obtain the certification is found to be higher compared with the overall PM maturity of those contractors which are neither ISO certified nor in process to obtain the certification (an average process maturity score of 1.53 and 1.05 is found for the two groups respectively). Spearman's rank correlation coefficient of 0.575 is obtained for the two categories of

contractors, and a hypothesis test was conducted to test the significance. The result is found to be significant at 5% (see Appendix-I: Hypothesis Test Result). Thus, it could be considered that, on average, those contractors which are ISO certified perform construction PM formally where as those which are none ISO perform informally. The higher maturity of ISO contractors is perhaps due to the focus on process and documentation and formal implementation that is advocated in the ISO certification and perhaps due to the training and mentoring organizations obtained on their way to the certification. The highest difference in maturity between the two groups of contractors is found for maturity of quality management. A value of 1.71vs 0.38 respectively is obtained for the two categories of contractors. This indicates that on average ISO contractors perform quality management formally whereas Non-ISO contractors practically perform little or no quality management. This difference is expected given ISO's emphasis on quality.

Similar to the case with process maturity, the practice maturity of contractors which are ISO certified or in a process is found to be higher than those which are not.

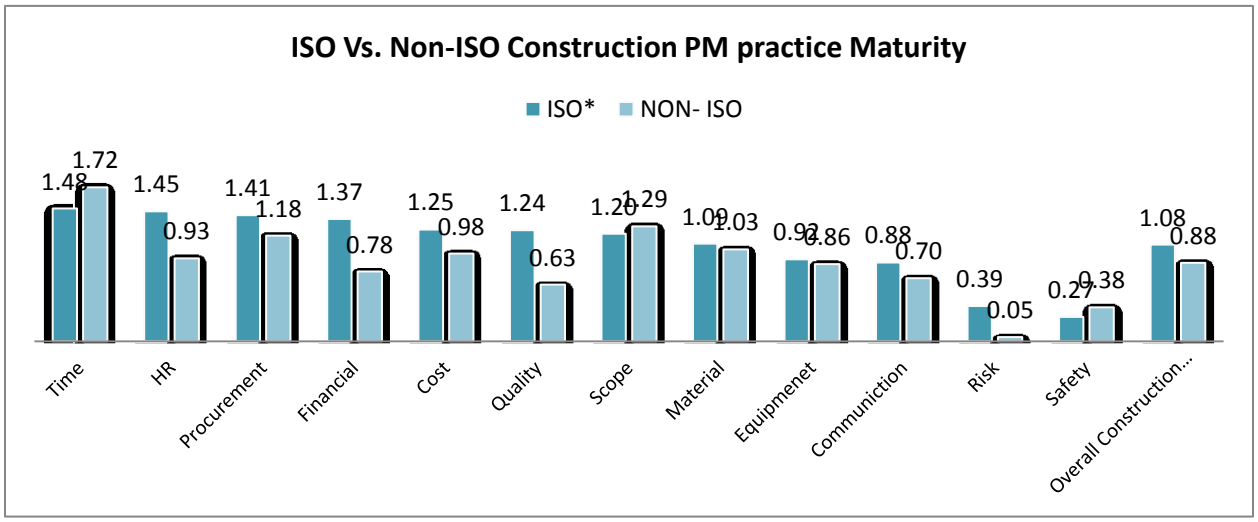

Figure 15: ISO vs. Non-ISO Contractors Practice Maturity

(An average practice maturity score of 1.08 and 0.88 is found for the two groups respectively). Spearman's rank correlation coefficient of 0.755 is obtained for the two categories of contractors, and a hypothesis test was conducted to test the significance. The result is found to be significant at 1% (see Appendix-I: Hypothesis Test Result)

Capacity Building Program (CBP) Vs (Non-CBP) Contractors PM Maturity

Figure 16, shows the process maturity assessment result for contractors which have participated in Capacity Building Program (CBP) and those which did not participate (Non-CBP).

The maturity assessment result shows that, contractors which participate in capacity building program have shown consistently higher maturity in all knowledge areas of construction management except for that of material management. An average maturity of 1.52 is recorded for contractors which participate whereas; an average maturity of 1.11 is recorded for those which did not participate. That is, on average contractors which participate in capacity building program perform construction PM formally, whereas, those contractors which did not participate perform construction PM informally. This finding indicates the potential high improvement that could be achieved through training and mentoring at lower maturity levels. Spearman's rank correlation coefficient of 0.771 is obtained for the two categories of contractors, and a hypothesis test was conducted to test the significance. The result is found to be significant at 1% (see Appendix-I: Hypothesis Test Result).

The highest difference in maturity is recorded in this category in the HR knowledge area. (1.52 for CBP vs. 1.11 for Non-CBP). Material management knowledge area maturity of the Non-CBP contractors is found to be slightly higher than the CBP contractors.

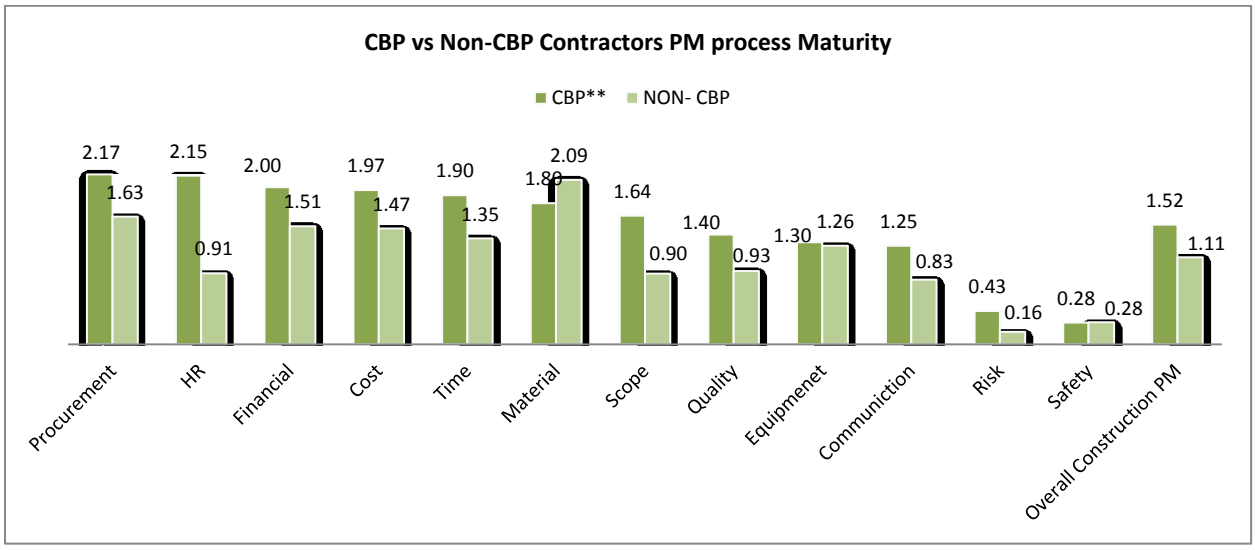

Figure 16: CBP vs. Non CBP Contractors PM Process Maturity

The practice maturity of contractors which participate in capacity building program have also shown higher maturity compared with those which did not. (1.08 for CBP vs. 0.93 for Non-CBP) Similar significance tests have been done and result is found to be significant at 5% (see Appendix-I: Hypothesis Test Result).

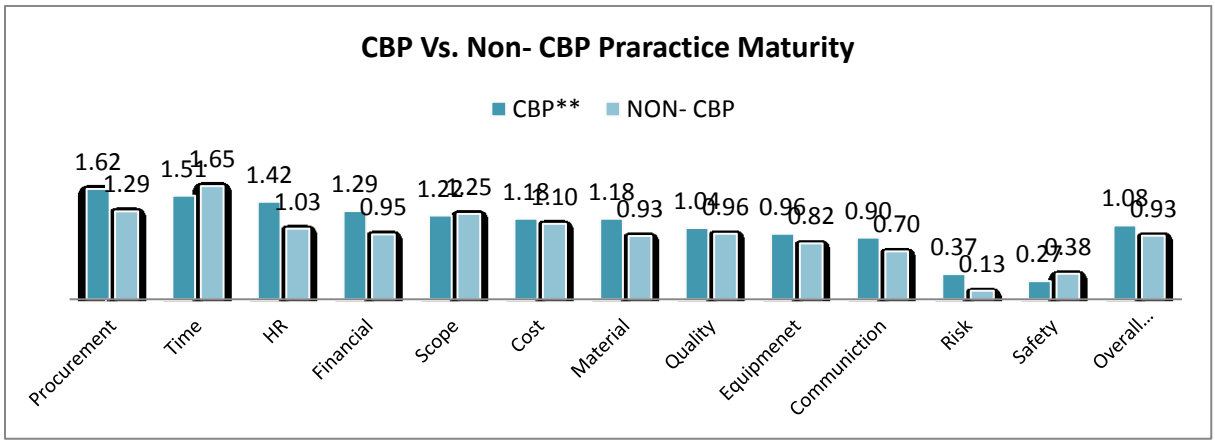

Figure 17: CBP vs. Non-CBP Contractors Practice Maturity

Road Contractors vs. Building Contractors PM Maturity

Figure 18 shows the process maturity assessment result for Road contractors and Building contractors

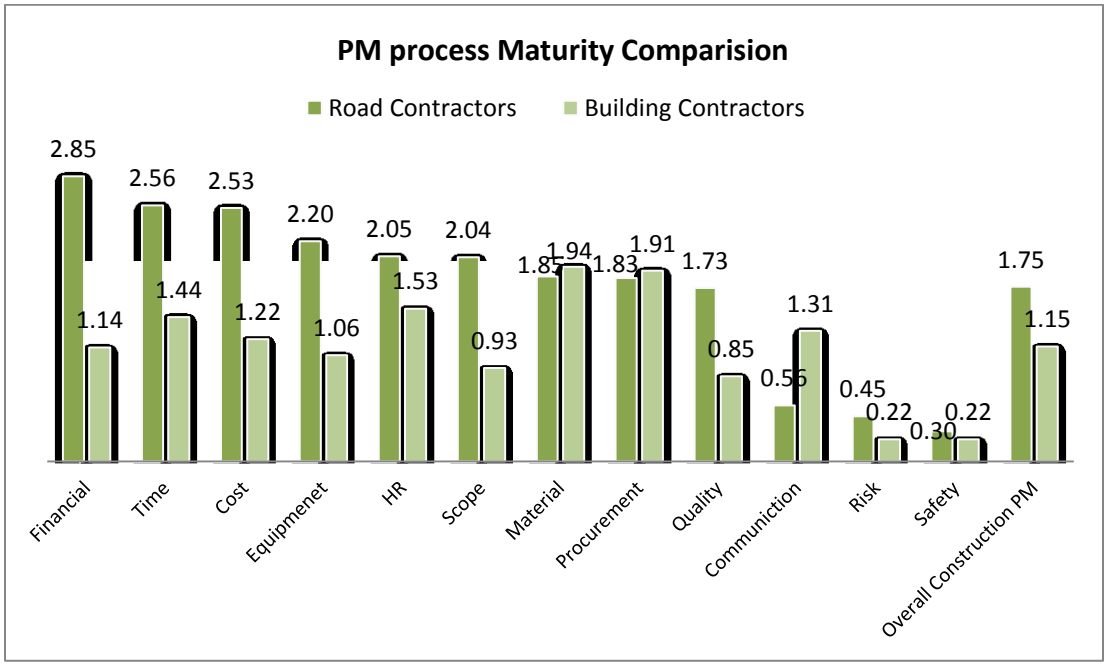

Figure 18: Road Contractors vs. Building Contractors Process Maturity

Generally, construction PM Maturity of Road contractors is found to be higher than those of Building contractors construction PM process Maturity (1.75 Vs 1.15).Spearman's rank correlation coefficient of 0.593 is obtained for the two categories of contractors, and a hypothesis test was conducted to test the significance. The result is found to be significant at 5% (see Appendix-I: Hypothesis Test Result).The maturity score shows that on average road contractors are managing their projects formally whereas, building contractors manage informally. The main reason for higher maturity of road contractors could be the fact that road contractors are usually large companies that perform large works and operate with comparatively huge capital and large number of employees.

Thus, it becomes very difficult for such contractors to manage informally and hence the contractors are forced to use a formal approach. In addition, in such cases companies will have the capacity to install the required system and recruit relatively more experienced and trained professionals in the management. On the other hand, building contractors usually operate with relatively lower capital and perform relatively lower volume of work in terms of scope and capital; this implies the degree of necessity to use a more formal approach like the road contractors will be less. These perhaps could be the major reasons for comparatively higher maturity of road contractors over those of building contractors. The other major factor that could explain the difference is the impact of clients and donors or financers .In the case of road contractors, most of the time the client of the contractors is the Ethiopian Road authority(ERA) ,which has been managing road projects for decades. Due to its long time enriched experience in managing its projects, the standard set by ERA and its controlling capability is expected to be higher for the contractors that work for it compared with the clients of the building contractors which are the private sector and various public institutions which have little experience managing construction projects. In addition, as most of road projects are financed by foreign organizations, in such cases those financers put higher requirements that force the contractors to develop comparatively higher capability. This is not the case for most building contractors whose clients are the private sector and different government organizations that have little or no organizational capability and experience managing such projects .Thus the standard that would be set in such cases is most likely to be lower.

The higher maturity of road contractors could be more associated to the nature of their projects rather than other factors such as being ISO certified or participating in the capacity building program. Because out of the 5 road contractors only 2 are ISO certified whereas among the 9 building contractors 6 of them are ISO certified or in a process to get the certification .the same holds true for the effect of participating in the capacity building program.

Similar to the case of process maturity, road contractors have also shown higher level of practice maturity compared with building contractors.

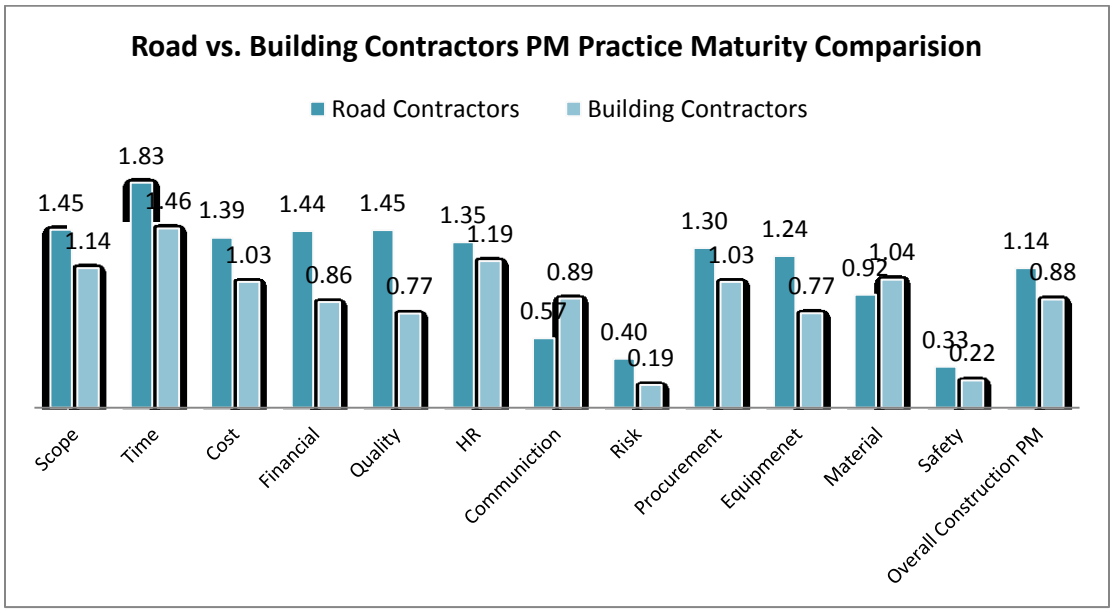

Figure 19: Road vs. Building Contractors Construction PM Practice Maturity

Road contractors showed comparatively higher maturity in Quality, Equipment and Financial management compared with the rest. Similar correlation analysis has been performed and spearman rank correlation coefficient of 0.646 is found), further, similar significance tests have been done and result is found to be significant at 5% (see Appendix-I: Hypothesis Test Result)

CHAPTER 12: MATURITY ACROSS PM KNOWLEDGE AREAS

Maturity of Project Scope Management

PMBOK(4th edition) defines Project Scope Management as set of processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully. The PMBOK's project scope management process involves the processes: Identify Requirement, Define scope, Create WBS (Work Breakdown Structure), Verify Scope, and Control scope. From contractors' perspective scope management is mainly about ensuring that all the works the contractor is doing is what originally agreed on and covered by the contract documents. According to (Sarshar, et al., 2000) "During the construction phase, (Scope management) has no specific meaning, as the (scope) has already been defined by this phase. Thus, at this stage scope management for a contractor is mainly concerned with scope control".

Scope Management Process Maturity Figure 20 shows the scope management process maturity result of participating contractors. The overall scope management process maturity is found to be 1.30.

Figure 20: Scope Management Process Maturity

Generally the scope management could be considered to be at informal level

According to the result of the research about 20% of the contractors practice little or no scope management (performing only 1 in 5 of the practices expected to be performed in scope management). Approximately, 30% contractor's scope management practice is incomplete (performing approximately 3 out of 4 practices expected to be performed in project scope management). About 53 % of the contractors perform scope management fully; however, 20% of the contractors perform scope management informally, the rest 33 % practicing formally or at managed level .Not a single contractor is found to perform scope management at a defined level.

Next to change management and risk management (Voropajev, 1998) Study ranks scope management as the second most important knowledge area in managing projects in transition economies(developing countries). However, rating by the practitioners in Ethiopia placed scope management 6th in the ranking of the 12 knowledge areas. The low level of the scope practice maturity and the low value given by the practitioners could be due to the lower importance given by contractors to it as managing scope is mainly the duty and interest of the client (owner). The (Voropajev, 1998) study may be based on the perspective of the entire stakeholders or clients.

Scope Management Practice Maturity

Four of the 5 PMBOK scope management processes were categorized as basic and the other one as intermediate importance practices. The average practice of the PMBOK scope management processes is found to be 77%. That is on average PMBOK's scope management practices are performed by 77% of the contractors.

Even though it is rated as a basic practice by the practitioners, approximately 1/3 of the contractors do not prepare Work Breakdown structure when defining the project scope.

Figure 21 shows the scope management practice maturity

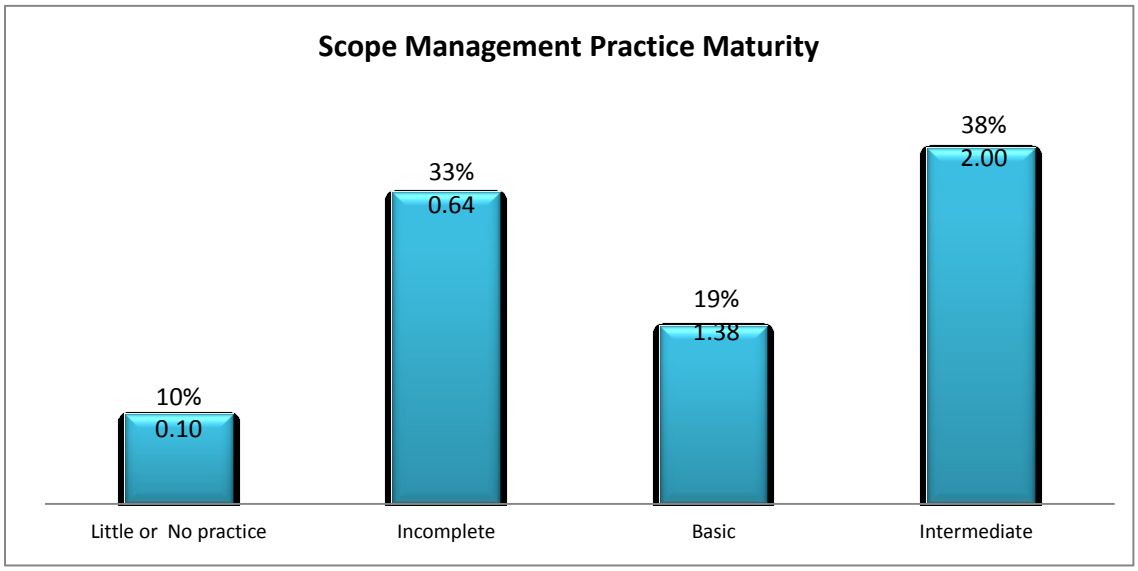

Figure 21: Scope Management Practice Maturity

The maturity survey indicates that the scope management practice maturity is found to be at basic level (1.24).That means on average contractors are performing basic scope management practices and 1 in four of the intermediate or average scope management practices. Approximately 40 % of the contractors are at incomplete practice level maturity performing only 3 in 5 of the scope management practices that are considered to be basic in managing project scope. The remaining 60% perform all the basic scope management practices with approximately 40% performing also all intermediate or average importance scope management practices.

Maturity of Project Time management

Project time management includes the processes required to ensure timely completion of a project. PMBOK's Project time management involves the processes: Define Activity, Sequence activities, Identify and document relationship among project activities, Estimate activity resource, Estimate activity Duration, Develop schedule and Control schedule. PMOBOK's construction extension includes three additional processes of Activity Weights Definition, Progress Curves Development, and Progress Monitoring.

Time management Process Maturity

The research finding indicates that Project time management is considered to be more important than managing other knowledge areas. In addition, the maturity of time management practice is higher compared to others. Overall, the time management process maturity of the contractors is found to be somewhat at formally performed level (1.63).

Figure 22 shows the time management process maturity. The maturity assessment result indicates that 33% of the contractors' time management process maturity is at incomplete level, this indicates that 1/3 of the contractors do not perform all the practices that are required to attain the time management knowledge area goals. The result indicates that on average 1/3 of the contractors perform only 3 out of 4 PMBOK time management processes that are necessary to achieve the project time management goal. The remaining 2/3 of the contractors perform all processes that are expected in managing project time, however, about 29% of the contractors perform time management informally, only about 40% of the contractors perform time management formally or at higher level.

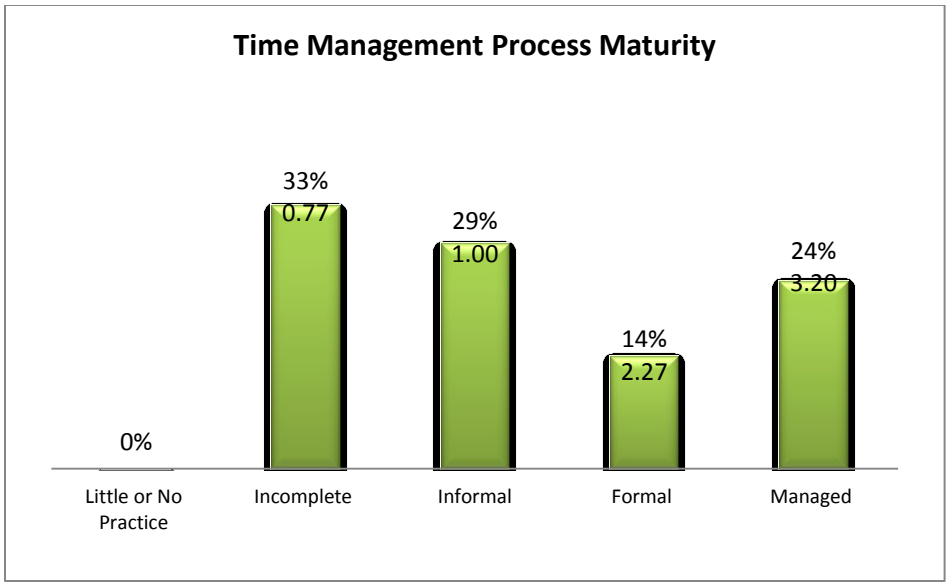

Figure 22: Time Management Process Maturity

Time Management Practice Maturity

Over all the time management practice maturity of the contractors is found to be somewhat at Basic practice maturity level (1.42). This means, on average contractors are performing all the basic practices under time management and 2 out of 5 intermediate (average) time management practices. All of the six processes in PMBOK time management process were rated as basic by the practitioners in the industry. On average PMBOK's time management process application is found to be 92%. However, about 30% of contractors do not practice monitoring and control of the schedule, which is one of the PMBOK time management process. Approximately about 50% of the contractors reported that they collect actual activity duration data and use it for estimating activity time in schedule preparation. In addition about 60% of the contractors said they prepare and use network schedule and perform resource leveling. Moreover about 95%of the contractors reported usage of computer tools (at least Excel) in preparing schedule. Further about 50% of the contractors said they prepare S-curve (progress curve) to

monitor and control project time. Figure 23 shows the time management practice maturity.

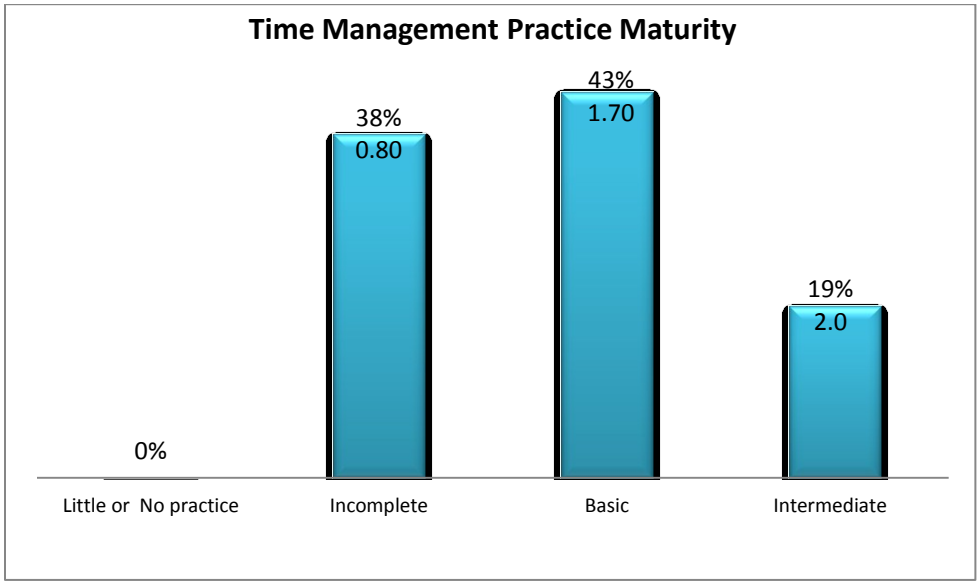

Figure 23: Time Management Practice Maturity Summary

Approximately, 40% of the contractors are found to be at Incomplete Level practice maturity, performing on average 4 out of 5 basic time management practices in the management of project time. The other 40% of the contractors are at Basic Level Practice Maturity performing on average, all the practices that are considered to be basic and performing on average 70% practices that are considered to be of intermediate importance. The rest 20% of the contractors are at intermediate level practice maturity performing all basic and intermediate practices found in project time management.

Unlike the process dimension the time management practice maturity dimension

Maturity of Project Cost Management

Project cost management includes the processes involved in estimating, budgeting and controlling costs so that the project can be completed within the approved budget. Project cost management includes the processes of: Estimate costs, Determine Budget and Control Cost.

Cost Management process Maturity

The overall cost management process maturity of the contractors is found to be 1.70, which means on average the contractors perform cost management formally.

Figure 24 shows the cost management process maturity.

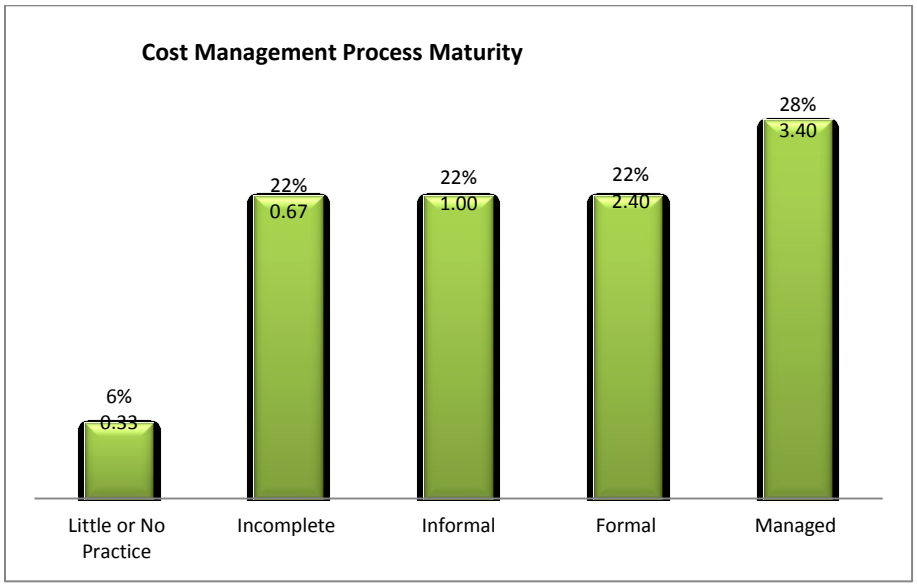

Figure 24: Project Cost Management Process Maturity Summary

The result shows that approximately 30% of the contractors' cost management process is incomplete, on average performing only 2 of 3 processes that are to be performed to achieve the goal of project cost management. About 20% of the contractors perform on average all the processes that are expected to be performed in managing project cost

informally; and only about 50% of the contractors are performing cost management formally or at higher level.

Cost Management Practice Maturity

The overall cost management practice maturity of the contractors is found to be 1.13, which means on average the cost management practice of the contractors is somehow at basic level practice maturity. Those contractors perform on average only 13% of the intermediate or average practices. All the three PMBOK cost management processes of prepare estimate, prepare budget and control budget are considered to be basic practices. The average PMBOK cost management process application is found to be 87%. Generally, about 90% of the contractors reported that they prepare detailed estimate of cost of labor, material and machinery, however, only 75% of the contractors reported that they prepare detailed budget. About 70 % said they track cost of labor, material and machinery separately. About 67% have also reported that they collect and use company's historical data for preparation of cost estimate. However, only 1/3 of the contractors indicated that they use computer tools for cost estimate preparation. Further, about 2/3 of the contractors have reported that they update their budget regularly at least once in a month.

Figure 25 shows the cost management practice maturity.

About 60% of the contractors are at incomplete practice maturity level performing on average 3 out of 4 practices expected to be performed in cost management. The rest 40% are at basic level of maturity performing on average all the basic practices and 70% of the intermediate or average practices. Of the 21 contractors, only one contractor has achieved

the intermediate level cost management practice maturity performing all the basic and intermediate practices.

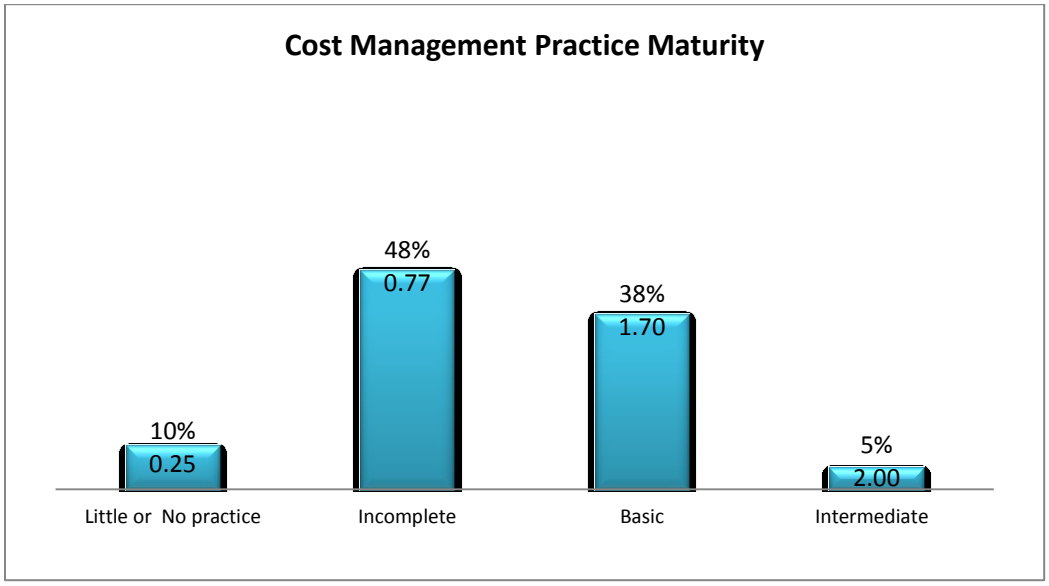

Figure 25: Project Cost Management Practice Maturity

Maturity of Project Financial Management

Financial management includes the processes of acquiring and managing the financial resources for the project. Compared to project cost management, project financial management is more concerned with revenue sources and monitoring net cash flows for the construction project than with managing day-to-day costs. The major processes involved in financial management are Financial Planning, Financial Control, Administration and Records.

Financial Management Process Maturity

The overall financial management process maturity of the contractors is found to be 1.62 that means on average the contractors perform financial management formally. Figure 26 shows the financial management process maturity

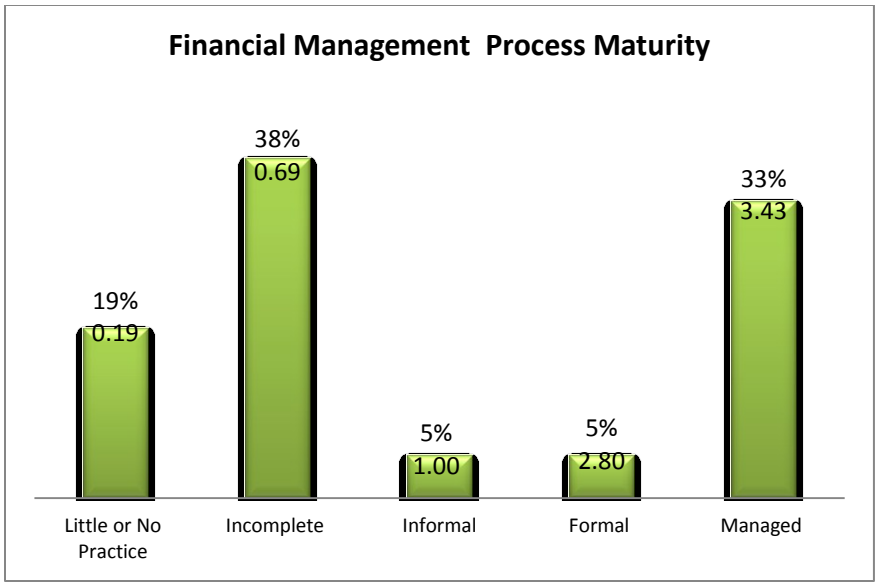

Figure 26: Financial Management Process Maturity Summary

The result shows that approximately 60% of the contractors' financial management process is incomplete, about a third of the contractors perform little or no financial management, performing on average only 3 out of 5 processes that are to be performed to achieve the goal of project financial management. The rest 40% of the contractors perform on average all the processes that are expected to be performed in managing project financial management formally or at higher level.

Financial Management Practice Maturity

Over all the financial management practice maturity of the contractors is found to be somewhat at Basic practice maturity level (0.96). This means, on average contractors are performing all the basic practices under financial management.

All of the four processes in PMBOK financial management process were rated as basic. On average PMBOK's financial management process application is found to be 73%. The maturity of financial control practice is found to be higher than that of financial planning (81% vs. 67%). This is perhaps due to the common misunderstanding in the

contractors to equate informal control of finance with financial management. The reported maturity of financial administration and records is also higher than financial planning. Only 2/3 of contractors reported that they perform financial planning. Ninety percent of the contractors have also responded that they perform project cash flow analysis. This higher level maturity may be b/se of the common contractual requirements to prepare project cash flow analysis. About 75% of the contractors have reported that they perform project financial audit. However, despite frequent price fluctuations only 43 % of the contractors reported that they consider effects of change in exchange rate, escalation of labor and material price etc in their financial planning.

Figure 27 shows the time management practice maturity

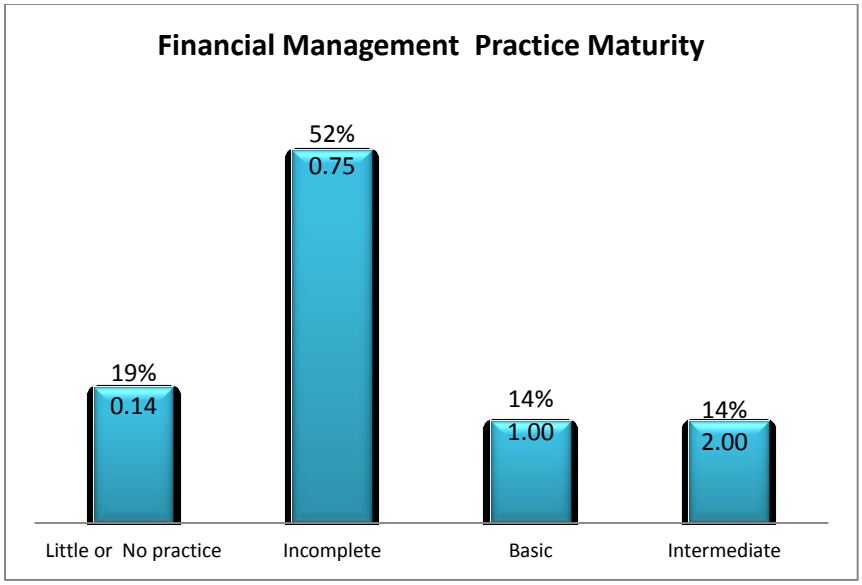

Figure 27: Financial management Practice Maturity

Approximately 20% of the contractors perform little or no financial management; the other 50% of the contractors perform incomplete financial management practices, performing on average 3 out of 4 basic financial management practices. The other 15% of the contractors are at Basic Level Practice Maturity performing on average, all the

practices that are considered to be basic .The rest 15% of the contractors are at intermediate level practice maturity level performing all basic and intermediate practices found in project financial management.

Maturity of Project Quality Management

Project Quality Management includes the processes and activities of the performing organization that determine quality policies, objectives, and responsibilities so that the project will satisfy the needs for which it was undertaken. PMBOK's Project quality management includes the processes: Plan Quality, Perform Quality Assurance and Perform Quality control.

Quality Management Process Maturity

Over all the quality management process maturity of the contractors is found to be somewhat at informally performed level (1.17).

Figure 28 shows the quality management process maturity.

The research finding shows that about 43% of the contractors perform little or no quality management; the other 24% perform only 2 out of 3 quality management processes that are expected to be performed to achieve the goal of project quality management. The rest 33% of the contractors perform quality management formally or at higher process maturity level.

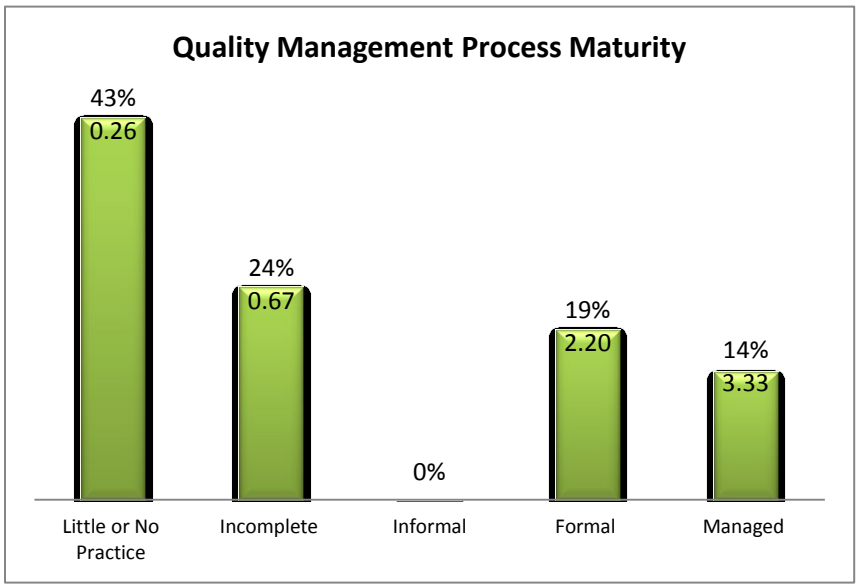

Figure 28: Quality Management Process Maturity

Almost all the PMBOK quality management practices and the lists of practices identified by the research under this knowledge area were rated as intermediate level of importance by the practitioners. This could explain why maturity of quality management (1.17) is low compared to others such as financial management (1.62) and cost management (1.71). (Practitioners consider it somehow second in importance).

Quality Management Practice Maturity

Twenty out of the 21 contractors indicated that there is awareness about the importance of quality management in their organization. Also about 85% of the contractors said there is some effort of managing quality in their organizations. The overall quality management practice maturity of the contractors is found to be 1.04, which means on average the contractors are performing all the basic quality management practices. The average PMBOK quality management process implementation of the contractors is found to be 60%. Fifty seven percent7% of the contractors have reported that they have quality

management policies, procedures and guidelines, however, only 24% said they have department or employees specializing in quality management.

Similar to the case with that of financial management the maturity of quality monitoring and control practice is found to be higher than quality planning (81% vs. 48%).This is perhaps due to the attitude of equating quality management with quality control. Further, the emphasis and requirement of quality control in contract may have contributed for the higher maturity level of quality control.

Figure 29 shows the quality management practice maturity of the contractors.

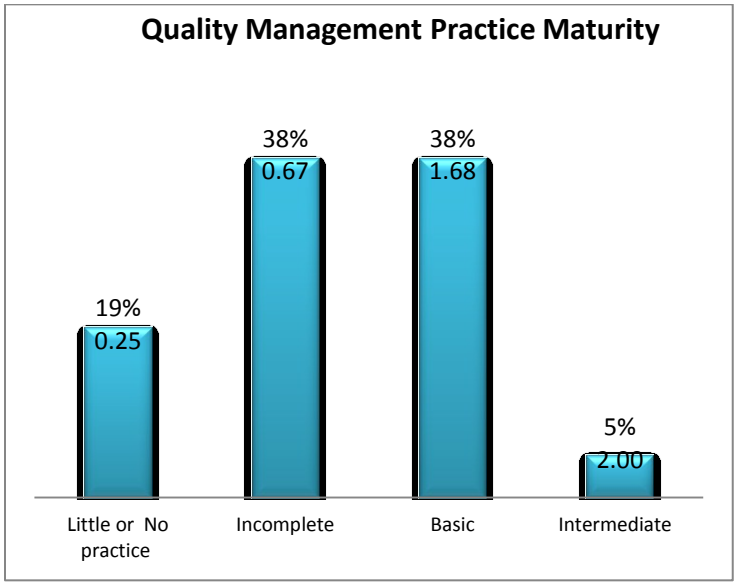

Figure 29: Quality Management Practice Maturity

About 20% of the contractors perform little or no quality management practices; the other 40% of the contractors' quality management practices is at incomplete practice maturity level, performing only 2 out of 3 basic quality management practices. The remaining about 40% of the contractors are at basic practice maturity level (1.68) performing all the basic practices and 68% of the intermediate practices. Only 1 of the 21 contractors has

achieved intermediate level of practice maturity, performing all practices that are considered basic and all those which are considered average in construction project quality management.

Maturity of Project Human Resource Management

Project Human Resource Management includes the processes that organize, manage, and lead the project team. The project human resource management involves the processes: Develop Human Resource Plan, Acquire Project Team, Develop Project Team and Manage Project Team. The Construction extension to PMBOK 3rd edition includes a Fifth construction-related process, of Close Project Team.

Human Resource Management Process Maturity

Overall the human resource management process maturity of the contractors is found to be somewhat at formally performed level (1.56).

Figure 30 shows the Human resource management process maturity.

The research finding shows that about 62% of the contractors HR management process is incomplete. On average these contractors perform only 3 out of 5 HR management processes that are expected to be performed to achieve the goal of project HR management. The rest 38% of the contractors perform HR management formally or at higher process maturity level.

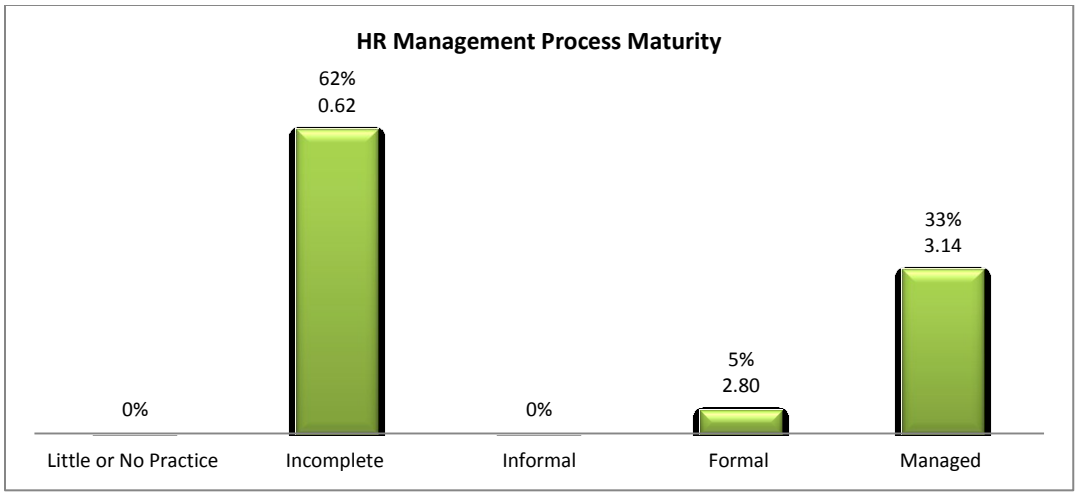

Figure 30: Project Human Resource Management Process Maturity

HR Management Practice Maturity

Overall the HR management practice maturity of the contractors is found to be somewhat at Basic practice maturity level (1.19). This means, on average contractors are performing all the basic practices and 1 in 5 of the intermediate practices under HR management. Four of the five HR management processes in PMBOK were rated as basic. On average PMBOK's HR management process application is found to be 76%. Even though all contractors have indicated that they perform HR management, only 48% reported of tracking performance of project team. About 60% of the contractors have indicated that they provide training for their project team.

Figure 31 shows the HR management practice maturity.

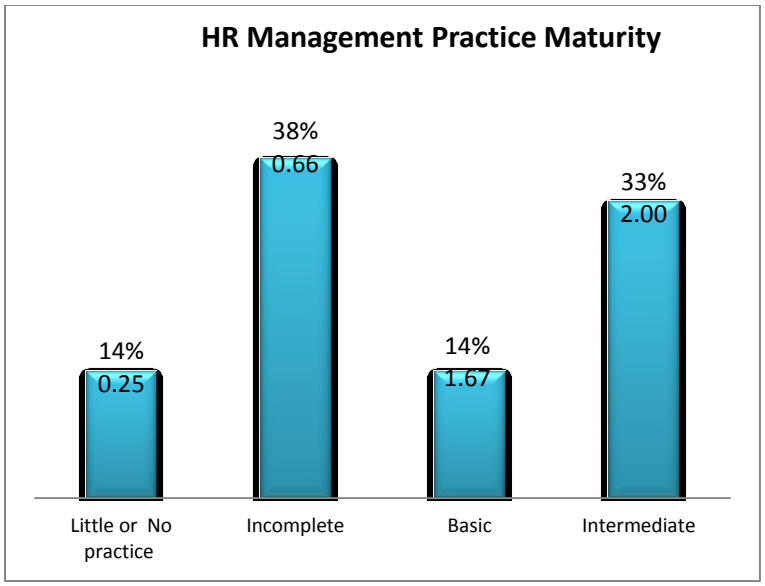

Figure 31: HR Practice Maturity

Approximately, 15% of the contractors perform little or no HR management; the other 40% of the contractors perform incomplete HR management practices, performing on average only 2 out of 3 basic HR management practices in the management of project HR management. The other 15% percent of the contractors are at Basic Level Practice Maturity performing on average; all the practices that are considered to be basic and 2 out of 3 practices that are considered to be average .The rest 30% of the contractors are at intermediate level practice maturity performing all basic and intermediate practices found in project HR management.

Maturity of Project Communication Management

Project Communications Management includes the processes required to ensure timely and appropriate generation, collection, distribution, storage, retrieval, and ultimate disposition of project information. PMBOK's Project communication management

includes the processes: Identify Stakeholders, Plan communications, Distribute Information, Manage Stakeholder Expectations, and Report Performance.

Communication Management Process Maturity

Overall the communication management process maturity of the contractors is found to be somewhat at informally performed level (0.97).

Figure 32 shows communication management process maturity.

The research finding shows that about 43% of the contractors perform little or no communication management; the other 38% of the contractors are at incomplete process maturity level performing only 3 out of 4 communication management processes that are expected to be performed to achieve the goal of project communication management. Only 20% of the contractors perform communication management formally or at higher process maturity level.

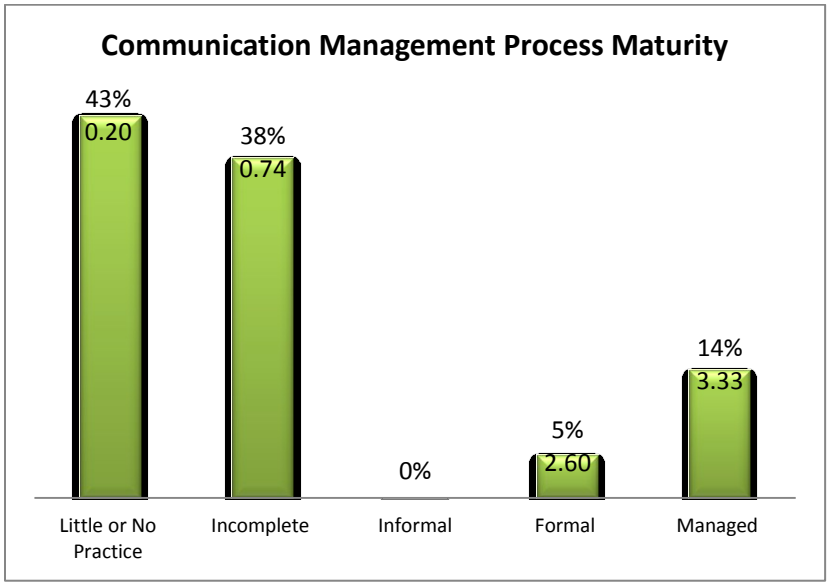

Figure 32: Communication Management Process Maturity

Communication Management Practice Maturity

Overall, the communication management practice maturity of the contractors is found to be somewhat at incomplete practice maturity level (0.76). This means, on average, contractors are performing only 3 out of 4 practices that are considered to be basic in project communication management. Four of the five Communication management processes in PMBOK were rated as basic. On average PMBOK's communication management process application is found to be 56%.Comparatively, reporting performance is found to be more practiced by the contractors compared with the other practices in communication management. This can be due to the contractual reporting requirement.

Figure 33 shows the communication management practice maturity.

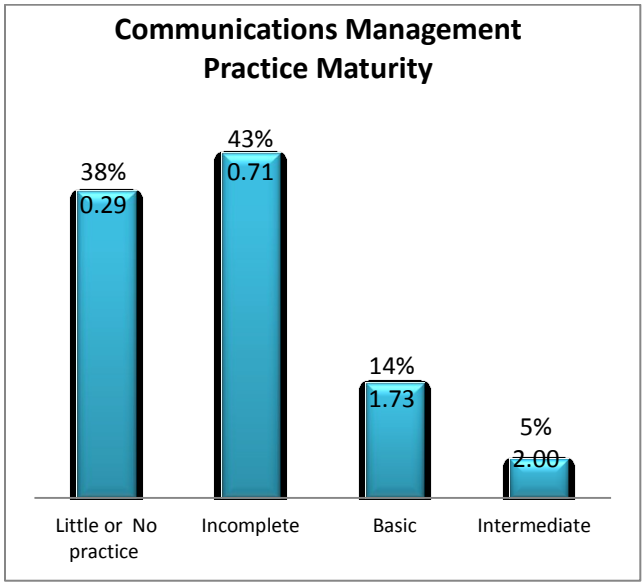

Figure 33: Communication Management Practice Maturity

Approximately, 40% of the contractors perform little or no Communication management; the other 40% of the contractors perform incomplete Communication management practices, performing on average only 2 out of 3 basic Communication management practices. The other 15% percent of the contractors are at Basic Level Practice Maturity, performing on average, all the practices that are considered to be basic and 3 out of 4 practices that are considered to be average .Only one of the 21 contractors attained intermediate level practice maturity performing all basic and intermediate practices found in project communication management.

Maturity of Project Risk Management

Project risk management includes the processes of conducting risk management planning, identification, analysis, response planning, and monitoring and control of project risk. The objectives of risk management are to increase the probability and impact of positive events, and decrease the probability and impact of negative events in the project.

PMBOK's risk management processes are Plan Risk Management[36], Identify Risks, Perform Qualitative risk analysis, Perform Quantitative risk analysis, Plan risk Responses, Monitor and Control risks.

Risk Management Process Maturity

Figure 34 shows project risk management process maturity result. The average risk management process maturity is found to be very low 0.32. It could be generalized that there is little or no risk management practice by the contractors.

---

[36] this is not considered for this thesis ,as for all knowledge areas, it is part of the project management plan; and it is measured as criterion for Managed level process maturity

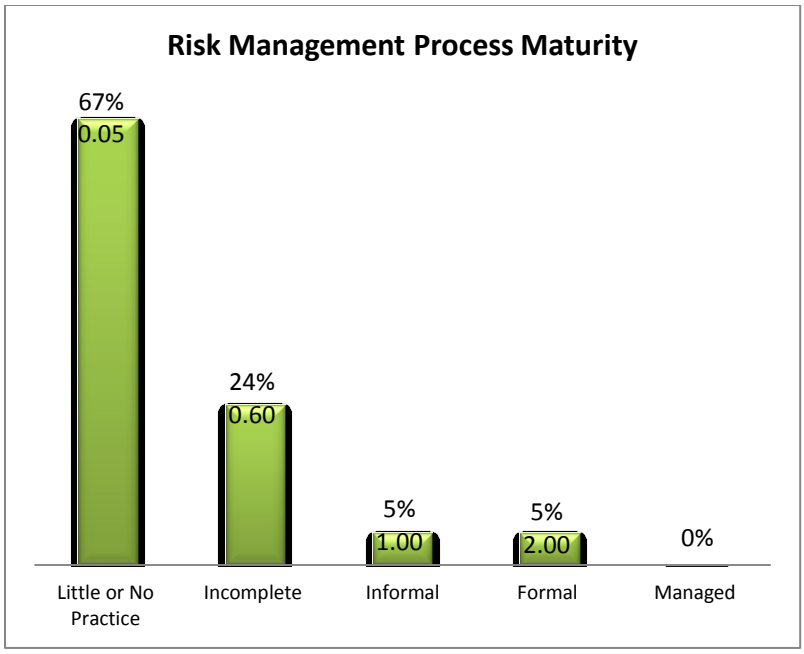

Figure 34: Risk Management Process Maturity

According to the result of the research, about 2/3 of the contractors practice almost no risk management. Approximately, 24% of contractor's risk management practice is incomplete (performing approximately 3 out of 5 practices expected to be performed in project risk management). Only 2 out of the 21 contractors assessed perform risk management fully at informal or formal level .Not a single contractor is found to perform risk management at a managed level.

Next to change management (Voropajev, 1998) Study ranks risk management as the second most important knowledge area in managing projects in transition economy(developing countries). However, rating by the practitioners in Ethiopia placed risk management 10th in the ranking of the 12 knowledge areas. This indicates that risk management is known little and given little attention and importance. The very low level of its maturity explains the importance given to it.

Risk Management Practice Maturity

None of the PMBOK risk management processes were categorized as basic, 3 of the 5 process were rated as advanced and the other two as intermediate processes. The average practice of the PMBOK risk management processes is found to be 27%. That is, on average PMBOKs risk management practices are performed by 27% of the contractors or contractors perform only 1 in 4 of the PMBOKs risk management process. Only 38% indicated that they identify and document risks and 33% said they perform some analysis to the chance and impact. No contractor reported using quantitative risk analysis which is rated by practitioners as an advanced practice. Only one contractor has reported the use of risk register or log .Assigning risk response owner to take responsibility for the management of selected risks was reported by none .Only 2 out of the 21 contractors indicated that they prepare risk response plan.

Figure 35 shows the risk management practice maturity

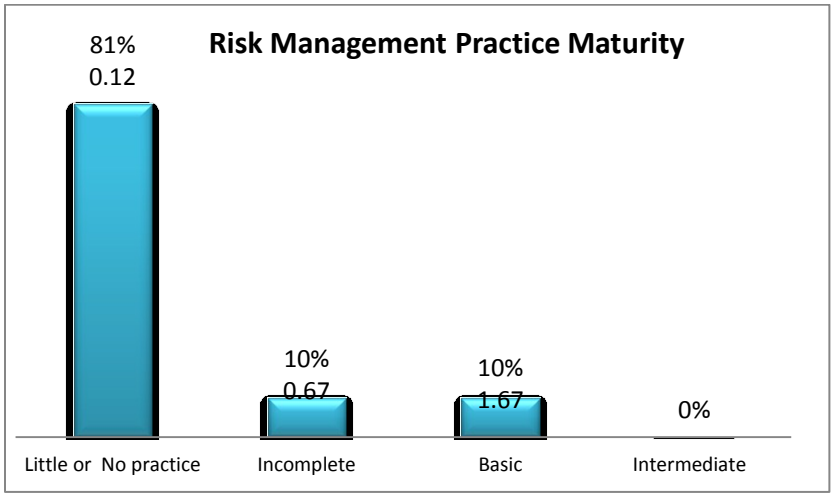

Figure 35: Risk Management Practice Maturity

The maturity survey indicates that practically there is little or no risk management (0.32) for 81% of the contractors. This shows that on average contractors perform only 1 in 3 of

the basic risk management practices. Only10 % of the contractors are at incomplete practice level maturity performing only 2 in 3 of the risk management practices that are considered to be basic in managing project risk. The remaining 10% perform all the basic risk management practices and 2/3 of the intermediate risk management practices. Not a single contractor attained intermediate level of risk management practice maturity level.

Seventy six percent of the contractors have summarized their risk management practice as "There are no established project risk management practices or standards." And 19% said "There is basic risk management process". This is totally in agreement with the proposed models finding.

Other studies done in the country in the areas have also found similar findings. According to (Gessesse, 2009), formal risk management is not instituted and rarely practiced. "In Ethiopian risk analysis is preliminary and undeveloped practice... The use of easy to use risk management tools and techniques is not generally known."

The very low level of reported maturity for risk management and the low importance given to it (risk management is ranked to be less important than all the other knowledge areas except safety management and communication management). This may indicate the low level of awareness about the importance of risk management in the construction industry of the country. As developing countries are characterized by very volatile and uncertain environment, management of risk should have been a logical priority. However, the low level of importance and the low maturity recorded for risk management could be due to the inapplicability of current risk management processes. As the PM environment in developing countries is highly uncertain and volatile, that current practices which were

developed in the developed world may fail to serve when comes to the developing countries context. Moreover, unavailability of data and the high unpredictability of events in developing countries may make any risk management practice effort futile.

Maturity of Project Procurement Management

Project procurement management includes the processes necessary to purchase or acquire products and services. Procurement management includes the contract management issued by an outside organization (Buyer) or issued by the performing organization to an outside organization (sub contract management) and change control processes required to develop and administer contracts or purchase orders issued by authorized project team members. From Contractors perspective procurement management is concerned mainly with subcontract management, supply purchase management and administering the contract that it entered with the client. PMBOK's Project procurement management process includes the processes: Plan Procurements, Conduct Procurement, Administer, and Close Procurement.

Procurement Management Process Maturity

The overall procurement management process maturity of the contractors is found to be 1.83, which means on average the contractors perform procurement management formally.

Figure 36 shows the procurement management process maturity.

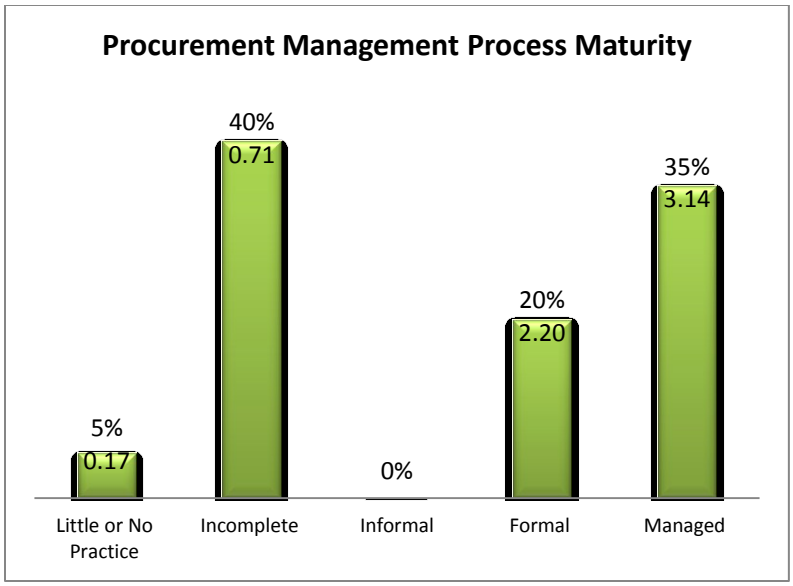

Figure 36: Procurement Management Process Maturity

The result shows that approximately 45% of the contractors' procurement management process is incomplete, on average performing roughly only 2 of 3 processes that are expected to be performed to achieve the goal of project procurement management. About 20% of the contractors perform on average all the processes that are expected to be performed in managing project procurement formally and the rest about 35% of the contractors are performing procurement management at managed level.

Procurement Management Practice Maturity

The overall procurement management practice maturity of the contractors is found to be 1.28, which means on average the procurement management practice of the contractors is somehow at basic level; these contractors perform on average all basic practices and 30% of the intermediate or average practices. Only one of the processes in procurement management is rated as a basic practice, the rest being an intermediate practice. The average PMBOK procurement management processes application is found to be

85%.About 85% of the contractors have reported that they prepare procurement plan , about 75% said they identify major or special supply item and consider them in planning, 80% said they use preferred supplier/subcontractor or pre- qualify them. Eighty percent of the contractors said they use a documented contract management/administration processes. Moreover, 65 % of the contractors said they hire/assign a staff that is trained in contract /procurement management and claim management. About 70% of the contractors reported to have process /procedure for managing claim.

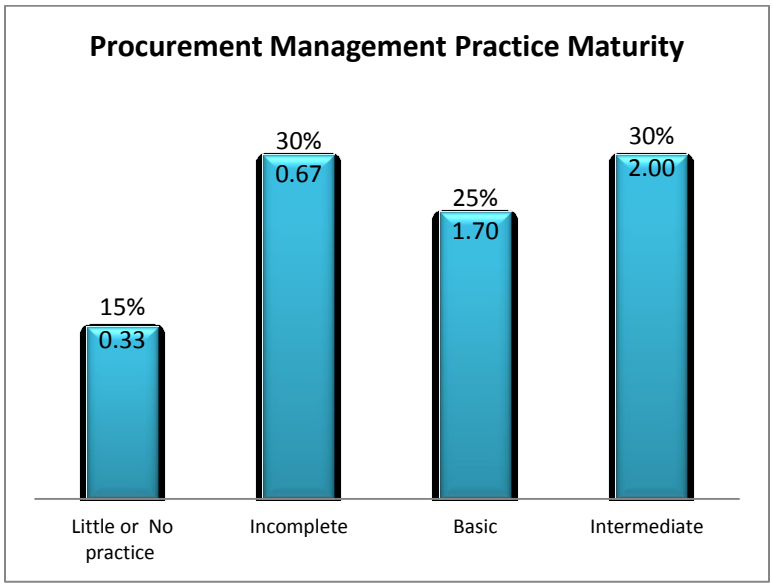

Figure 37: Procurement Management Practice Maturity

About 15 % of contractors perform little or no procurement management, another 30% of the contractors are at incomplete practice maturity level performing on average 3 out of 4 practices expected to be performed in procurement management. The other 25% are at basic level of maturity performing on average all the basic practices and 70% of the intermediate or average practices. The rest 30% of the contractors are at intermediate

level procurement management practice maturity performing all the basic and intermediate practices.

Maturity of Project Equipment Management

Project Equipment Management is not included as the knowledge area of construction project management in both the PMBOK and its construction extension. However, it is considered here in this research as one of the knowledge areas of construction project management due to its relevance for construction project in general and in the developing countries in particular. Many studies such as[(Jekale, 2004), (Cusworth & Franks, 1993)]indicated that resource scarcity is prevalent and is one of the major causes for the poor performance of projects in developing countries. Thus the management of resources should be one of priority areas in managing construction projects in developing countries. Human resource management and financial management in this regard have already been considered by PMBOK and its construction extension. However, equipment management and material management account for about75% of the project cost in developing countries. Because of their significant impact on project cost and performance, it was decided to include the two in the maturity assessment as one of the knowledge areas of construction project management.

Project equipment management process in this research is thought to include basically the processes of equipment acquisition and assignment planning, equipment tracking and monitoring and maintenance.

The overall Equipment management process maturity of the contractors is found to be 1.29 which means on average the contractors perform Equipment management somehow informally.

Figure 38 shows the Equipment management process maturity.

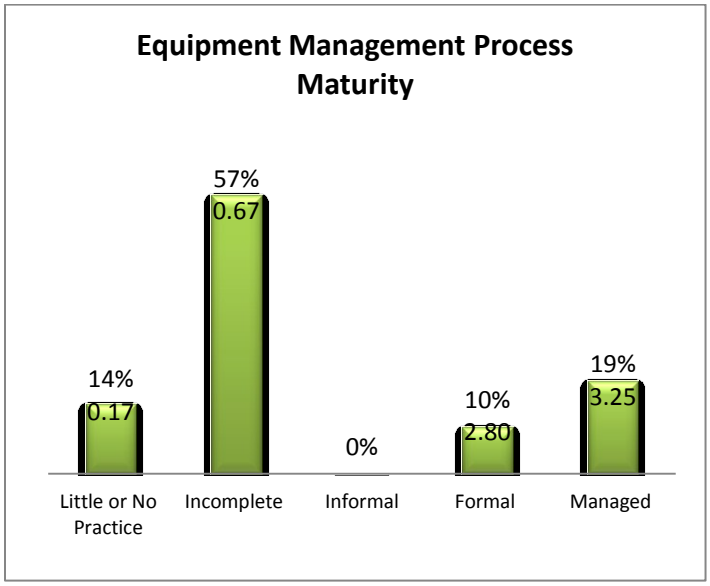

Figure 38: Equipment Management Process Maturity

The maturity assessment result shows that approximately 15% of the contractors perform little or no equipment management. About 57% of the contractors' equipment management process is incomplete, on average performing roughly only 2 of 3 processes that are expected to be performed to achieve the goal of project Equipment management. About 30% of the contractors perform on average all the processes that are expected to be performed in managing project equipment formally or at a managed level.

Equipment Management Practice Maturity

The overall equipment management practice maturity of the contractors is found to be 0.90, which means on average the equipment management practice of the contractors is somehow at basic level. Only one of the processes in equipment management is rated as a basic practice, the rest being an intermediate practice. Seventy one percent of the contractors said they have equipment policy that guides acquisition, use, and replacement

decisions. Sixty seven percent of the contractors responded that they prepare all; long term (more than 3 month), medium (1 to 3-month) and short-term (weekly and daily) equipment plan. About 42% said they perform formal economic and risk analysis in deciding; buy, lease or rent options for equipment acquisition. Seventy one percent of the contractors said they share equipment among projects and centrally facilitate it. About 83% of the contractors said they have equipment maintenance plan and policy.

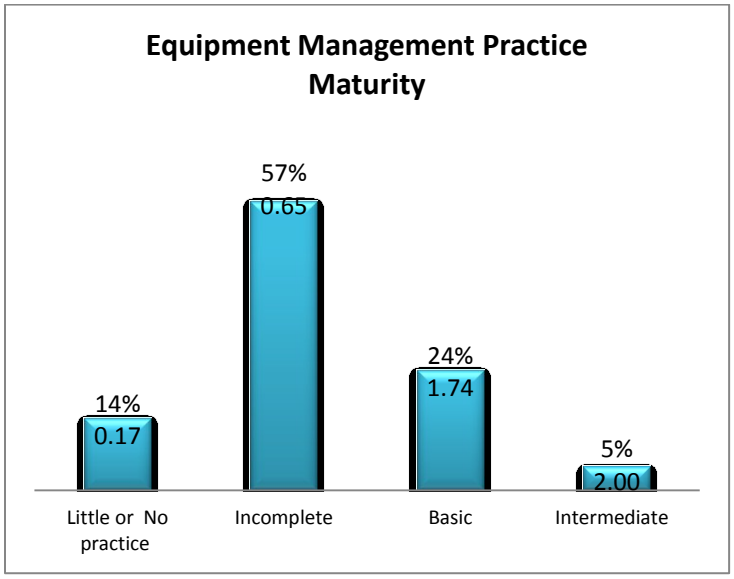

Figure 39: Equipment Management Practice Maturity

About 15 % of contractors perform little or no equipment management; another 57% of the contractors are at incomplete practice maturity level performing on average 2 out of 3 practices that are considered to be basic in equipment management. The other 25% are at basic level of practice maturity performing on average all the basic practices and 75% of the intermediate or average practices. Only one of the 21 contractors is at intermediate level equipment management practice maturity performing all the basic and intermediate practices.

Maturity of Project Materials Management

Similar to project equipment management, project material management is not included as a knowledge area of construction project management in both the PMBOK and its construction extension. However, as it is explained in the part that deal with project equipment management; project material management is considered here in this research as one of the knowledge area of construction project management, mainly due to its relevance for construction project in general and in the developing countries in particular. Project material management process in this research is thought to include basically the processes of material planning, managing material procurement process, monitoring and control of material use and availability.

The overall material management process maturity of the contractors is found to be 1.90, which means on average the contractors perform material management somehow formally.

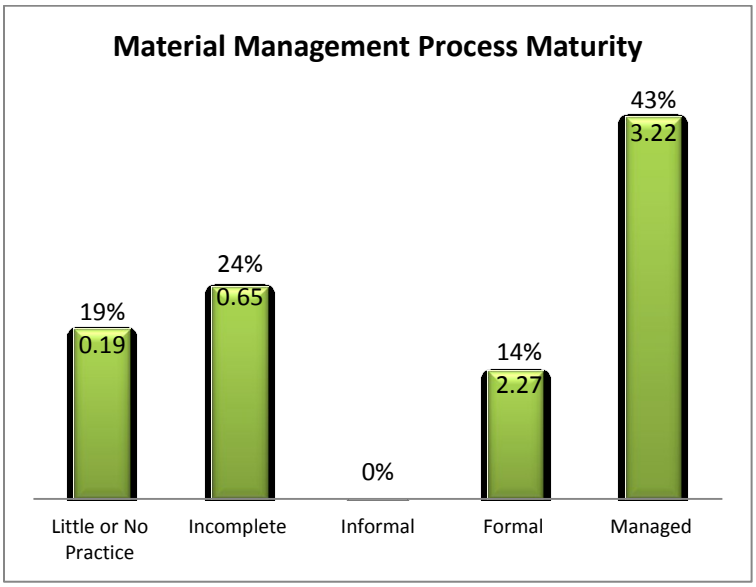

Figure 40: Material Management Process Maturity

The result shows that approximately 20% of the contractors perform little or no material management. About 25% of the contractors' material management process is incomplete, on average performing roughly only 2 of 3 processes that are expected to be performed to achieve the goal of project material management. About 55% of the contractors perform on average all the processes that are expected to be performed in managing project material management formally or at a managed level.

Material Management Practice Maturity

The overall material management practice maturity of the contractors is found to be 0.96; which means on average the material management practice of the contractors could considered to be at basic level. Only one of the processes in material management is rated as a basic practice; the rest being an intermediate practice. Fifty four percent of the contractors said they consider risk associated with unavailability, cost increase in material planning and all costs (purchase costs, order cost, holding costs, and unavailability cost) in material planning /management. Sixty seven percent of the contractors said materials requiring long lead-time and critical items are given special consideration in planning and monitoring, Eighty eight percent said they have preferred suppliers; ninety six percent of the contractors said their company centrally coordinates material purchase for its different projects.

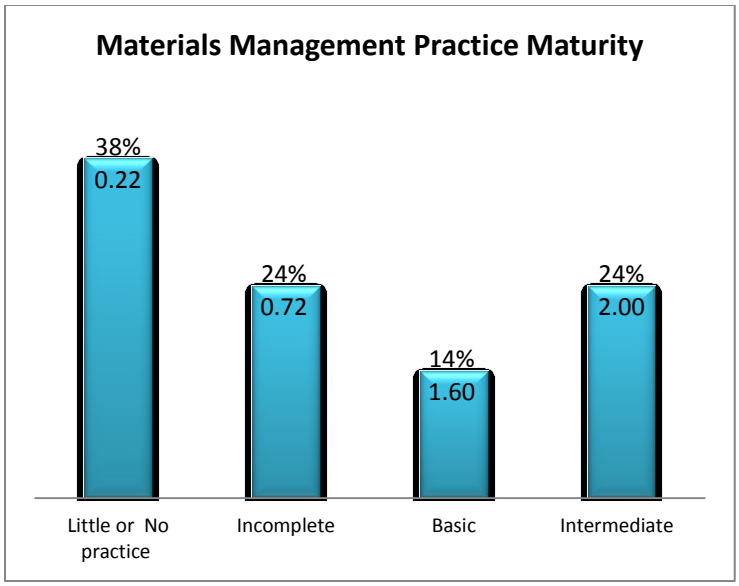

Figure 41: Material Management Practice Maturity

About 38 % of contractors perform little or no material management; another 24% of the contractors are at incomplete practice maturity level performing on average 3 out of 4 practices that are considered to be basic in material management. The other 14% are at basic level of maturity performing on average all the basic practices and 70% of the intermediate or average practices. The rest 24% of the contractors are at intermediate level material management practice maturity performing all the basic and intermediate practices.

Maturity of Project Safety Management

Project Safety Management includes the processes and activities of the performing organization that determine safety policies, objectives, and responsibilities so that the project will satisfy the needs for which it was undertaken.

PMBOK's project safety management includes the processes: Plan Safety, Perform Safety Assurance and Perform Safety Control.

Safety Management Process Maturity

Overall, it could be considered that safety management is performed very little or not at all in the management of construction projects. An average maturity of 0.27 is determined for the contractor's safety management process.

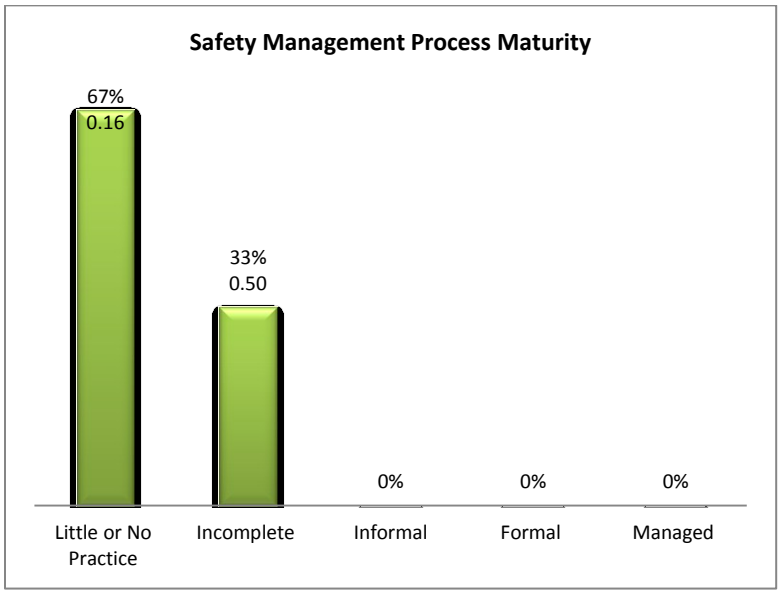

Figure 42: Safety Management Process Maturity

The research finding shows that about 2/3 of the contractors perform little or no safety management, the other 1/3 have incomplete safety management process performing on average 1 out of 2 safety management processes that are expected to be performed to achieve the goal of project safety management.

Only two of the three PMBOKs (construction extension) safety management are considered to be basic in managing safety in projects.

Safety Management Practice Maturity

Twenty out of the 21 contractors indicated that there is awareness about the importance of safety management in their organization; 80% of the contractors said there is some effort of managing safety in their organization. The overall safety management practice

maturity of the contractors is found to be 0.32, which means on average the contractors perform little or no safety management in managing their construction projects. The average PMBOK safety management process practice of the contractors is found to be only 33%. Thirty three percent of the contractors said their organizations have organizational policies, procedures and guidelines for safety management, about 21% of the contractors said they perform Site Neighborhood Safety Characteristics Study for their project, about 42% said their organizations provide safety training for workers; 67% said their project provide Personal Protective Equipment for site employees; 21% said their organizations have safety management personnel/coordinator.

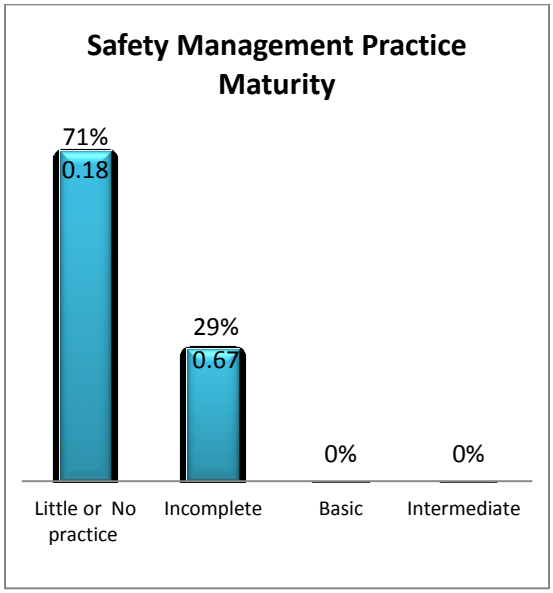

Figure 43: Safety Management Practice Maturity

About 70% of the contractors perform little or no safety management practices; the other 30% of the contractors their safety management practices is incomplete. Those contractors perform only 2 out of 3 basic safety management practices.

PART VI: RESEARCH FINDINGS AND RECOMMENDATIONS

CHAPTER 13: RESEARCH MAJOR FINDINGS

The main goal of this thesis research was to assess the PM maturity of the construction industry in developing countries (Ethiopia) and identify priority and problem area and propose framework for improvement efforts. Additional goal of this research was to propose a maturity model that could be used for the assessment purpose. Further it was the objective of this research to see if there is difference in PM maturity between different categories of contractors. Thus in this regard this research result has found the following major findings.

- Generally, the construction PM process maturity and practices maturity of the contractors (Grade-1 contractors in Ethiopia) is found to be at low level. (Average maturity of 1.30 for the process maturity and 0.99 for practice maturity dimensions). This shows on average the contractors PM process maturity is at informal level and their PM practice maturity is at basic level. This means on average the contractors perform the knowledge areas informally without following structured approach or guide line, relying solely on the knowledge and experience of the project manager or project team, and on average the contractors are performing only the basic practices under each knowledge area. Moreover, about 50% of the contractors are found to be at incomplete level of PM process maturity (that is on average 50% of the contractors do not perform all the necessary processes that are required to manage construction projects

successfully). Further, there was no single contractor which has attained the managed level process maturity. On average 40% of the contractors do not perform all the practices considered to be basic. In fact on average 40% of the contractors perform only 2/3 of the PM practices that are considered to be basic in managing construction projects. The rest 60% of the contractors are at basic level of practice maturity. Not a single contractor has managed to achieve even intermediate level of PM practice maturity. Given the fact that contractors at lower grade (category-2, 3, 4, 5…) are comparatively less experienced and highly constrained in capacity; the overall PM maturity of the contractors in the country could be worse than what this research found for grade-1 contractors. These findings are indicative of the low level of PM development in the country's construction industry. The findings also support the research assumption that the construction PM maturity of the contractors in Ethiopia will not exceed the defined level (the third Level in CMMI and other maturity models).

- Generally, the knowledge areas of material, procurement; cost, time, financial and human resource management have shown comparatively higher maturity compared with other PM knowledge areas. These knowledge areas are more or less being performed formally by the majorities of the contractors. Further, the practitioners in the country consider the above knowledge areas to be more important for success of the construction PM, whereas the knowledge areas of scope, equipment, quality, and communication management are found to be comparatively at lower level of maturity and could be considered generally to be performed informally by the majorities of the contractors. In addition, the

practitioners in the country consider them to be, somehow, less important for success of the construction PM than the former six knowledge areas. The remaining two knowledge areas of risk and safety management are the least matured knowledge areas. On average only 1/3 of the basic practices in the two knowledge areas were being performed. Moreover, the practitioners in the country consider them to be the least important in the management of construction projects. For practical purpose the two knowledge areas could be consider to be totally unknown in the management of construction project in the country or practiced little or by very few in the industry. This is perhaps due to the low level of awareness and importance given to the two knowledge areas. Next to the above two knowledge areas, communication management is another knowledge area which is comparatively at lower level of maturity.

- Generally, except for Material and Equipment Management knowledge areas, the construction PM maturity of contractors which are ISO certified or in a process to obtain the certification (ISO Contractors) is found to be higher than those which are neither ISO certified nor in a process to obtain the certification (Non-ISO Contractors). Hypothesis test is undertaken and found to be significant at 5% .see (Appendix-I: Hypothesis Test Result). On average, it can be considered, that those contractors which are ISO certified perform construction PM formally, whereas those which are Non- ISO perform informally. The higher maturity of ISO contractors is perhaps due to the focus on process and documentation and formal implementation that is advocated in the ISO standards and perhaps due to the training and mentoring organizations obtained on their way to the certification.

The highest difference in maturity between the two groups of contractors is found in the maturity of quality management. A value of 1.71vs 0.38 respectively is obtained for the two categories of contractors. This indicates that on average ISO contractors perform quality management formally whereas Non-ISO contractors practically perform little or no quality management. This difference is expected given ISO's emphasis on quality. This finding indicates to some extent the potential improvement to be obtained by attaining ISO certification. The fact that maturity model use concept of quality management and the emphasis by ISO to follow structured and documented processes perhaps may have contributed to the improvement in maturity of the contractors in the category compared with those contractors which are Non-ISO.

- The PM maturity of the contractors which took part in Capacity Building Program (CBP contractors) is found to be higher than those which did not participate in the capacity building program (Non- CBP Contractors). Hypothesis test at 5% is found to be significant see (Appendix-I: Hypothesis Test Result). Overall, CBP contractors have shown consistently higher maturity in all knowledge areas of construction management except that of material management. An average maturity of 1.52 is recorded for CBP contractors whereas; an average maturity of 1.11 is recorded for the Non-CBP contractors. Thus it could be considered that, on average CBP contractors perform construction PM formally, whereas, the Non-CBP contractors perform construction PM informally. This finding to some extent indicates the positive contribution of such improvement effort. The fact that a very low PM maturity is found overall for the contractors; implies that there is a

gap in awareness and knowledge in the practice of PM, hence, such efforts as CBP can significantly help filling the gap through the training provided to the contractors. Further, the mentoring given to the contractors by the Capacity Building Program significantly help the contractors easily implement the knowledge they gained through training and bring an improvement in their practice. Overall, the finding indicates the high potential improvement that could be achieved through training and mentoring when the PM maturity is at very low level.

- Similar to the case with ISO and CBP contractors , the PM maturity of Road contractors is found to be higher than Building contractors' PM maturity (1.75 Vs 1.15). Hypothesis test is undertaken and found to be significant at 5% .see (Appendix-I: Hypothesis Test Result). Thus, from the maturity score it could be considered that on average road contractors are managing their projects formally, whereas building contractors are managing informally. The road contractors higher maturity score could be mainly because of the fact that, road contractors generally are large in size and have higher capital and undertake relatively high volume of work that requires formal management to ensure control of the project. In addition larger capacity of the road contractors means better capacity to pay and hire more experienced and knowledgeable professionals. Further, comparatively road projects are partially financed by foreign funds that usually demand more formal and better management capacity, forcing the contractors' to perform better to meet requirements and win jobs.

- The process maturity of contractors is found to be highly correlated with the practice maturity (coefficient of correlation of 0.936). This shows that, more matured processes are associated with more matured or advanced practices. Hypothesis test is undertaken and found to be significant at 5% .see (Appendix-I: Hypothesis Test Result).
- The maturity level determined by proposed model's both process maturity and practice maturity dimensions are found to be highly correlated with maturity levels determined based on the reference model. Hypothesis test is undertaken and found to be significant at 5% .see (Appendix-I: Hypothesis Test Result). This is indicative of the validity of the proposed model. Thus, the proposed model could be used in assessment of PM maturity of contractors

Chapter 14: RESEARCH RECOMMENDATIONS

Recommendation for Action

The low level of construction PM maturity found for the Grade-1 Contractors shows how poor the PM practice in the industry overall is. Thus, improvement efforts need be under taken to improve the current condition. In this regard this research recommends the following specific actions to be undertaken.

1. Providing training and mentoring to the contractors to improve their PM knowledge and practice capacity. In this regard, the higher maturity found for contractors that have participated in the Capacity Building program (CBP), to some extent, shows the potential success to be gained.
2. Encouraging contractors to obtain ISO certification as this would help them improve also their PM capability. The high maturity found for ISO contractors, in this regard, indicates the potential success to be achieved.
3. Giving special attention to resource, risk and change management. As the review of literature showed management of projects in developing countries is highly constrained by scarcity of resources and high uncertainty (very volatile environment, extremely fast and less predictable changes). Thus, focusing on the management of resource, risk and change can significantly help lower their negative impact and improve performance of projects through better planning and use of the resources; planning and monitoring of the risks and management of change.

4. Encouraging contractors to attain at least formal level of process maturity and basic level of practice maturity in order to obtain successful result and ensure control of their projects. As the review of literature showed, the high uncertainty avoidance and power distance common in developing countries means workers in developing countries have a tendency to avoid risk and tend to prefer clarity and rules, and defer making decision to their superiors. At formal level of process maturity; structured approach, guides and standards are used, and expectations are more or less clarified, thus helping create clarity and lowering risks assumed by subordinates and increase their confidence to make decision. Further, the use of guides ensures consideration of important aspects, thus significantly contributing to the performance of the knowledge areas. The use of generic guides such as PMBOK in this regard may significantly help. The attainment of basic level of practice maturity means that the organization is performing all the practices that are basic (must) to attain the goal of the knowledge areas, thus maximizing the chance of attaining knowledge area goals and hence, attainment of project objectives.
5. Conducting continuous assessment of maturity by the contractors to know the success of improvement efforts they undertook and to chart a new action plan for further improvement measures.

Recommendations for Further Research

This research work is a starting one and needs be followed by a number of researches to investigate scopes which are not considered in this research and to refine the concepts raised and further enhance our understanding, and contribute to the construction PM knowledge pool. Thus this research recommends the following for further research and investigation:

1. Conducting a detailed research to identify the processes and practices to be included under the equipment management and materials management knowledge areas.
2. Conduct research to Improve /increase listing of practices under each of the construction PM knowledge areas.
3. To determine the overall PM capability of the industry, conducting similar studies by including contractors at different grades or categories and from the perspective of clients and or all stakeholders.
4. Conducting further research to improve the proposed model to make it a generic model that could be used for assessment of PM maturity of any organization in any industry.
5. Conducting PM maturity of major public clients to determine the PM maturity of the clients and hence contribute to development of PM in the construction industry overall.
6. Conducting in-depth research to determine in detail how each of the construction PM knowledge area is being performed by the contractors so as to be able to

prepare a detailed improvement framework .possibly using case study approach to get a deeper insight.

7. Extend the proposed maturity model/s process dimension of maturity definition and the assessment tools to the continually improved (optimization) maturity level for possible use in developed countries.
8. Extend the proposed model to include other knowledge areas left such as environmental management
9. Conduct further research to refine the model the models and the assessment questionnaire through active involvement of academicians and professionals using focus group and further extensive literatures review

Concluding Remarks

This master's thesis research has tried to assess the extent of use (maturity) of project management processes and practices in the construction industry of Ethiopia. Further, the research has provided bench mark data on the current status of PM practice in the industry for use in continuous assessment of future improvement efforts. Moreover, the research has proposed a maturity model that could be used to frame improvement efforts and assess PM maturity of contractors. The proposed model can also be used by contractors for self-assessment purpose and to guide their improvement effort. Nevertheless, this thesis research is meant only a starting work towards a long journey to the development of PM practice in the country as a whole and the construction industry specifically. The main goal was to do a starting work and open the door for further refinement and investigation and demonstrate the application of the concepts raised. The research presumed that future works will address the rest and the details.

APPENDICES

Appendix-A: Cover Letter sent to Contractors

Dear Respondent:

The e-Construction Group at the University of Maryland, USA is conducting research on Maturity of Project Management Practice in Construction Industry in the developing countries with focus on Ethiopia.

The research will investigate the following issues:

1. Whether and to what extent each of the Project Management knowledge areas and processes are being applied in managing construction projects in developing countries in general and, in Ethiopia in particular.
2. The areas that need focus for development and improvement of Project Management in developing countries in general, and in Ethiopia in particular.

The research output will provide information about Project Management Maturity and Capability in construction firms in all areas of project management: scope, time, cost, quality, risk, resource, communication, contract, safety, etc. In addition, the result provides a framework for prioritization and development of project management improvement initiative.

Through your participation in this research, you would be able to assess the maturity of project management function in your organization; where your organization is competent and where it lags; how well your organization is doing compared to your peers internationally, and that you need to focus on to develop and improve project management functions in your organization. Up on completion of our research; we will share with you a copy of the technical report and an individual report prepared specific to your organization.

Your precious time and effort in participating in this research will also contribute to the development and improvement of Project Management in Ethiopia and in other developing countries. Thus, you are kindly invited to fill out the questionnaire and return it to the researcher in Ethiopia within 10 days of the receipt of the questionnaire. Please call 0912- 791369 for pickup of the completed questionnaire from your office.

Thank you for your interest in participating in the research.

Supervisor: Miroslaw J. Skibniewski (Ph.D)

CHAIR PROFESSOR OF PROJECT MANAGEMENT

E-MAIL: mirek@umd.edu

http://e-construction.pm.umd.edu

Reseacher: Abadir H Yimam

E-Mail - ayimam@umd.edu

Or abadir4@gmail.com

Mobile: 0912- 791369

Appendix-B: Questionnaire sent to Contractors

Part I – General Information

Direction: Please provide the requested information on the space provided

Name of the person filling the questionnaire (optional)_____

1. Position/role in the company (Required) _____

2. Have you received any Project Management related training? **A.** Yes **B.** No

If yes what was the highest level of training you received?

A. Masters level **B.** Bachelors **C**. Certificate **D.** Short-term training

E. As a course in a related program of study **F.** Other (please specify)

3. Have you worked as Project Manager?

A. Yes **B**. No If yes for how long? ……..

4. Your organization is …

A. Local private company **B**. Local Public/government Company

C. Foreign company **D.** Joint venture of local and foreign company

E. Local Endowment **F.** Other (please specify)

5. Name of your organization (Optional) _____

6. What is the category of your organization?

A. General contractor (GC) **B.** Building contractor (BC)

C. Road contractor (RC) **D.** Specialized Contractor (SC)

E. Other (please specify)

7. What is the grade of your organization? ……..

A.Grade-1(GC1/BC1/RC1) **B.**Grade-2 (GC2/BC2/RC2)

C. Grade-3(GC3/BC3/RC3) **D**. Other (please specify)

8. Approximately, for how long has your organization been in the construction business?.....

9. What is the major type of construction your organization usually performs?

A. Building (residential, office, commercial) **B**. Road

C. Civil Engineering works (water supply, hydropower etc) **D.** Other (please specify)

10. Has your company participated on Capacity Building Program (UCBP)?

A. Yes **B** .No **C.** I do not know

11. Your company is

A. ISO <u>certified or compliant</u> B . In a <u>process</u> to get the certification Neither

C. ISO certified nor in a process to be certified **D.** Other (please specify)

Part II- Project management practice maturity questions

General Direction

Answer all the Questions that follow based on your knowledge of practice of Project Management in the project you are participating or in the organization you are working...

Please Choose:

Yes: If the description approximates the condition in your project (organization).

No: If the description does not come close to the condition in you project (organization).

N/A: (Not applicable): If you think the practice or the description is inapplicable for your case.

D/K (I do not know): If you do not have information/knowledge about the question.

1. Project Management Process-General

	Yes	No	N/A	I/DK
1. Is the need and benefit of Project Management recognized by your organization's management?	☐	☐	☐	☐
2. Does your organization's management provide support for Project Management development?	☐	☐	☐	☐
3. Does your organization have a central Project Management office that provides project management support for the projects of the organization?	☐	☐	☐	☐
4. Does your organization have standard Project Management processes and methodologies?	☐	☐	☐	☐
5. Does your organization provide Project Management training for its Project Management team?	☐	☐	☐	☐
6. Do Project Managers of your organization have solid knowledge base of Project Management?	☐	☐	☐	☐
7. Are Project Management processes, methodologies and procedures applied formally in managing projects in your organization?	☐	☐	☐	☐

2. Project Scope Management

	Yes	No	N/A	I/DK
1. Is there awareness about the need or importance of project scope management in your organization's and Project Management team?	☐	☐	☐	☐
2. Is there any effort of managing project scope in your organization/project?	☐	☐	☐	☐
3. Is the effort of scope management formal?	☐	☐	☐	☐
4. Are Computer applications or tools used in scope management process?	☐	☐	☐	☐
5. Is the project's scope defined?	☐	☐	☐	☐
6. Is WBS[37] (work breakdown structure) prepared in defining scope in your project?	☐	☐	☐	☐
7. Is a WBS Dictionary prepared ?(document providing description of work ,code of accounts identifier , responsible department ,resource required etc	☐	☐	☐	☐
8. Is there any effort of monitoring and controlling scope in your project?	☐	☐	☐	☐
9. Are work results reviewed or inspected to ensure or verify that all scope of the work is complete?	☐	☐	☐	☐

Legend: **N/A -**Non Applicable **I/DK-** I do not know

3. Project Time Management

[37] WBS is the breakdown of the project work into smaller, more manageable pieces of work, with each descending level of the WBS representing an increasing detailed definition of the project work

	Yes	No	N/A	I/DK
1. Is there awareness about the importance of project time management in your organization's and project management team?	☐	☐	☐	☐
2. Is there any effort of managing time in your project?	☐	☐	☐	☐
3. Is the effort of time management formal?	☐	☐	☐	☐
4. Is a schedule (plan) prepared for the project?	☐	☐	☐	☐
5. Is the schedule base lined? (start and finish date are approved and fixed)	☐	☐	☐	☐
6. Are Network scheduling method (such as CPM, or PERT) used?	☐	☐	☐	☐
7. Are computer tools such as Microsoft project, Primavera , Excel etc used for scheduling If yes; Please write the name of tool …….	☐	☐	☐	☐
8. Is WBS used when defining the schedule activities?	☐	☐	☐	☐
9. Are relationships among activities identified and the activities sequenced?	☐	☐	☐	☐
10. Is estimate of resources (materials, people, equipment …) needed prepared?	☐	☐	☐	☐
11. Is resource leveling done?	☐	☐	☐	☐
12. Is activity duration estimate prepared?	☐	☐	☐	☐
12. Are the company's historical data used in estimating activity duration?	☐	☐	☐	☐
13. Is progress of project activities continuously monitored and controlled?	☐	☐	☐	☐
15. Is Earned value management used in controlling the schedule?	☐	☐	☐	☐

16. Is S-curve method used in monitoring and controlling the schedule?	☐	☐	☐	☐
17. Is the project schedule updated?	☐	☐	☐	☐

Project Cost Management

	Yes	No	N/A	I/DK
1. Is there awareness about the importance of project cost management in your	☐	☐	☐	☐
2. Is there any effort of managing cost in your project?	☐	☐	☐	☐
3. Is the effort of cost management formal?	☐	☐	☐	☐
4. Is estimate of the project cost prepared?	☐	☐	☐	☐
5. Does the estimate detail cost of labor, material, and machinery separately?	☐	☐	☐	☐
6. Is WBS used in preparing the estimate?	☐	☐	☐	☐
7. Is the company's historical actual cost data consulted in preparing the	☐	☐	☐	☐
8. Is cost-estimating software used in preparing the estimate or managing cost?	☐	☐	☐	☐
9. Is a budget prepared for the project?	☐	☐	☐	☐
10. Is the budget time phased? (Does the budget indicate the amount on	☐	☐	☐	☐
11. Does the budget show the amount allocated for resources by category	☐	☐	☐	☐
12. Is WBS used in preparing the budget?	☐	☐	☐	☐
13. Is the budget base lined?(the budget allocated to work packages and	☐	☐	☐	☐
14. Is the budget updated regularly?	☐	☐	☐	☐
15. Is there any effort to monitor and control the project cost?	☐	☐	☐	☐
16. Is the project cost tracked against the baseline on regular update cycle?	☐	☐	☐	☐
17. Are costs of labor, equipment, and material, tracked separately?	☐	☐	☐	☐

18. Is variance analysis (difference of budgeted and actual cost) performed? ☐ ☐ ☐ ☐

19. Are Budget forecasts (cost to completion,) prepared and updated? ☐ ☐ ☐ ☐

Legend: **N/A -**Non Applicable **I/DK-** I do not know

5. Project Financial Management

	Yes	No	N/A	I/DK
1. Is there awareness about the importance of Project Financial Management in your organization's and Project management team?	☐	☐	☐	☐
2. Is there any effort of managing finance in your project?	☐	☐	☐	☐
3. Is the effort of managing Project Finance formal?	☐	☐	☐	☐
4. Is a Financial plan prepared for the project?	☐	☐	☐	☐
5. Does the financial plan details how much and when funding is needed?	☐	☐	☐	☐
6. Are effects of change in exchange rate, escalation of labor and material cost etc considered in your financial plan?	☐	☐	☐	☐
7. Is project cash flow analysis performed for the project?	☐	☐	☐	☐
8. Is there any effort to control the project finance to ensure that money is spent appropriately as planned and with proper authorization?	☐	☐	☐	☐
9. Does the project/company have clear expenditure authorization policy and procedure?	☐	☐	☐	☐
10. Is financial audit done in your project?	☐	☐	☐	☐
11. Are Financial Reports prepared regularly for the project?	☐	☐	☐	☐

12. Does the project have an established system/procedure for creating and handling financial documents	☐	☐	☐	☐
13.Does your project/organization use standardized process and format for financial information recording, storage and reporting?	☐	☐	☐	☐
14. Are computer systems used in filing and retrieval of financial information in your project?	☐	☐	☐	☐

6. Project Quality Management

	Yes	No	N/A	I/DK
1. Is there awareness about the importance of Project Quality Management in your organization's and project management team?	☐	☐	☐	☐
2. Is there any effort of managing quality in your project?	☐	☐	☐	☐
3. Is the project quality management effort formal?	☐	☐	☐	☐
4. Does your organization have quality management policies, procedures and guidelines?	☐	☐	☐	☐
5. Is quality planning performed for your project? (requirements and quality standards are determined and strategies are devised)	☐	☐	☐	☐
6. Are Quality Assurance activities implemented in your project?(these are processes, procedures and standards defined/developed to assure quality objectives are met)	☐	☐	☐	☐
7. Is quality audit done in your project? (a review to determine whether project activities comply with policies, processes, and and quality requirements)	☐	☐	☐	☐
8. Is TQM (Total Quality Management) implemented in your project?	☐	☐	☐	☐

9. Is quality control process implemented in your project ?(determining whether project products and activities comply with relevant quality standards/plans)	☐	☐	☐	☐
10. Does your project/organization inspect and control quality of subcontractors' work to ensure compliance with quality requirement?	☐	☐	☐	☐
11. Is there quality department or employees specializing in quality management?	☐	☐	☐	☐

Legend: **N/A -**Non Applicable **I/DK-** I do not know

7. Project Human Resource Management

	Yes	No	N/A	I/DK
1. Is there awareness about the importance of Project Human Resource management in your organization's and Project Management team?	☐	☐	☐	☐
2. Is there any effort of Human resource management in your organization or project?	☐	☐	☐	☐
3. Is the effort of Human resource management formal?	☐	☐	☐	☐
4. Is there any planning for acquisition and management of human resource?	☐	☐	☐	☐
5. Is project organization chart prepared for your project?	☐	☐	☐	☐
6. Are Skill requirement, Roles and Responsibilities defined for all Project positions?	☐	☐	☐	☐
7. Is training (formal/informal) provided to project team members?	☐	☐	☐	☐

8. Is performance of team members tracked regularly and feedback provided? ☐ ☐ ☐ ☐

9. Is human resource cost and time formally tracked, and monitored in your project? ☐ ☐ ☐ ☐

Legend: **N/A -**Non Applicable **I/DK-** I do not know

8. Project Communication Management

	Yes	No	N/A	I/DK
1. Is there awareness about the importance of project Communication management in your organization's and Project Management team?	☐	☐	☐	☐
2. Is Communication management performed?	☐	☐	☐	☐
4. Is Project Communication requirement analysis performed in your project?	☐	☐	☐	☐
5. Is a plan/strategy prepared to address identified communication needs?	☐	☐	☐	☐
6. Does your project have a system/procedure for handling project documents?	☐	☐	☐	☐
7. Does your project have a system for collecting and distributing information?				
8. Are performance reports prepared and provided to relevant stakeholders?	☐	☐	☐	☐
9. Does your project/organization have a standard format for preparation of reports?	☐	☐	☐	☐

10. Is there awareness about the importance of stakeholder management in your organization's and project management team?	☐	☐	☐	☐
11. Is there any effort of identifying stakeholders and responding to their need?	☐	☐	☐	☐
12. Is stakeholder management performed formally in your project?	☐	☐	☐	☐
13. Is stakeholders' analysis done for your project?	☐	☐	☐	☐
14. Is a stakeholder management plan prepared (is there a devised strategy on how to handle the stack holder's needs and expectations)?	☐	☐	☐	☐
15. Is there any continuous effort of communicating and working with stakeholders to influence their expectation, address their concern and resolve issues?	☐	☐	☐	☐
16. Is a strategy developed for managing each key stakeholder's expectation***?***	☐	☐	☐	☐

9. Project Risk Management

	Yes	**No**	**N/A**	**I/DK**
1. Is there awareness about the importance of project risk management in your organization's management and project management team?	☐	☐	☐	☐
2. Is there any effort of managing risks in your project before they cause adverse effect?	☐	☐	☐	☐
3. Is risk management performed formally in your project/organization?	☐	☐	☐	☐
4. Is there any effort of identifying and documenting risks in your project?	☐	☐	☐	☐
5. Is risk break down structure (RBS) used in the identification or planning of risk?	☐	☐	☐	☐
6. Is SWOT analysis (Strength, weakness, Opportunity and treat analysis)	☐	☐	☐	☐

performed?

7. Are identified risks analyzed to determine their potential impact? ☐ ☐ ☐ ☐

8. Is the chance of occurrence of risks estimated (for example as low, medium, High)? ☐ ☐ ☐ ☐

9. Are risks prioritized based on factors such as impact, probability, urgency etc? ☐ ☐ ☐ ☐

10. Is Quantitative risk analysis done? [example : simulation , decision tree analysis etc] ☐ ☐ ☐ ☐

11. Is risk response strategy developed for the prioritized risks? (example : avoid, transfer, mitigate, accept) ☐ ☐ ☐ ☐

12. Is a detailed risk response plan prepared for risks that warrant action/attention? ☐ ☐ ☐ ☐

13. Is the risk response plan and strategy continuously updated? ☐ ☐ ☐ ☐

14. Is contingency time allowed in project schedule for potential risk impact? ☐ ☐ ☐ ☐

15. Is contingency budget reserved for potential risk impact? ☐ ☐ ☐ ☐

16. Is risk monitoring and control performed in your project? (Is there any effort of identifying and documenting new risks, closing those outdated and tracking those already identified) ☐ ☐ ☐ ☐

17. Is risk audit performed in your project? (Examining and documenting the effectiveness of the risk response strategy, and the risk management process) ☐ ☐ ☐ ☐

18. Is risk register/log[38] used in the risk management process? (to document identified risks with their attributes and to track their status while monitoring and control) ☐ ☐ ☐ ☐

Legend: **N/A -**Non Applicable **I/DK-** I do not know

10. Project Procurement Management

	Yes	No	N/A	I/DK
1. Is there awareness about the importance of project Procurement management in your organization's or Project Management team?	☐	☐	☐	☐
2. Is there any effort of managing project procurement to ensure delivery of procured items/services as agreed in the contract?	☐	☐	☐	☐
3. Is the effort of managing project procurement formal?	☐	☐	☐	☐
4. Is planning done for procurement of goods and services needed for your project?	☐	☐	☐	☐
5. Are major and/or special supply items (such as: those required in large quantity, or those requiring special manufacturing or long lead-time etc) identified and special attention given for them?	☐	☐	☐	☐
6. Does your project/organization have standard procurement documents ?(such as standard purchase order, standard sub contract / supplier agreement)	☐	☐	☐	☐

[38] A document used to record and track identified risks

	Yes	No	N/A	I/DK
7. Does your organization use preferred supplier/subcontractor or prequalify them?	☐	☐	☐	☐
8. Does your project/organization have a documented contract management/administration processes?	☐	☐	☐	☐
9. Does your project/organization have a staff trained in contract /procurement management?	☐	☐	☐	☐
10. Does your project have a process for managing contract change?	☐	☐	☐	☐
11. Does your project monitor and control progress of subcontractor's and suppliers?	☐	☐	☐	☐
12. Does your project/organization have established process for Payment Review, Authorization, and Processing of subcontractors and suppliers work/services?	☐	☐	☐	☐
13. Does your project/organization have established process /procedure for managing claim?	☐	☐	☐	☐
14. Does your project/organization have a staff that is capable and responsible for claim management?	☐	☐	☐	☐
15. Does your project have a clear defined process for contract closing?	☐	☐	☐	☐

Legend: **N/A -**Non Applicable **I/DK-** I do not know

11. Project Equipment Management

	Yes	No	N/A	I/DK

1. Is there awareness about the importance of Project Equipment management in your organization's and project management team? ☐ ☐ ☐ ☐

2. Does your organization have equipment policy that guides acquisition, use, and replacement decisions? ☐ ☐ ☐ ☐

3. Is Equipment management performed in your project or organization? ☐ ☐ ☐ ☐

4. Is Equipment management formal? ☐ ☐ ☐ ☐

5. Is there any planning performed for acquiring and use of project equipments? ☐ ☐ ☐ ☐

6. Does the Equipment plan details what, how much and when equipments are needed? ☐ ☐ ☐ ☐

7. Are all; long term (more than 3 month), medium (1 to 3-month) and short-term (weekly and daily) equipment plan prepared in your project? ☐ ☐ ☐ ☐

8. Is formal economic and risk analysis done in deciding; buy, lease or rent option for equipment acquisition? ☐ ☐ ☐ ☐

9. Are computer software used in equipment planning, assignment and tracking? If yes Please write the name of software/tool ..... ☐ ☐ ☐ ☐

10. Is there a procedure for equipment sharing among projects of the organization? ☐ ☐ ☐ ☐

11. Is equipment sharing planned and facilitated by the organization? ☐ ☐ ☐ ☐

12. Does your project or organization have an equipment maintenance plan/ policy? ☐ ☐ ☐ ☐

13. Is scheduled preventive maintenance done for your project/organization equipments? ☐ ☐ ☐ ☐

14. Is there any effort of tracking and monitoring performance of the project equipment, their productivity, maintenance cost, time worked etc? ☐ ☐ ☐ ☐

15. Are equipment Replacement decisions based on actual performance, risk and economic analysis? ☐ ☐ ☐ ☐

Legend: **N/A -**Non Applicable **I/DK-** I do not know

12. Project Material Management

	Yes	No	N/A	I/DK
1. Is there awareness about the importance of project Material Management in your organization's and project management team?	☐	☐	☐	☐
2. Is Material management performed in your project or organization?	☐	☐	☐	☐
3. Is the effort of Material management formal?	☐	☐	☐	☐
4. Is there any planning to acquire and use project materials?	☐	☐	☐	☐

5. Are all costs (purchase costs, order cost, holding costs, and unavailability cost) considered in material planning /management? ☐ ☐ ☐ ☐

6. Is risk associated with unavailability and cost increase *considered* in material planning? ☐ ☐ ☐ ☐

7. Are Materials requiring long lead-time and critical items given special consideration in planning and monitoring? ☐ ☐ ☐ ☐

8. Does your organization have preferred material suppliers/or pre qualify suppliers? ☐ ☐ ☐ ☐

9. Is material procurement expediting[39] formally performed in your organization? ☐ ☐ ☐ ☐

10. Does your company centrally coordinate material purchase of different projects? ☐ ☐ ☐ ☐

11. Are computer software used in material planning, assignment and tracking? ☐ ☐ ☐ ☐
If yes please write the name …….

12. Does your organization have a documented process for approval, checking and testing of materials in the filed? ☐ ☐ ☐ ☐

---

[39] Expediting is the function of tracking ,monitoring and follow up of material purchase , to ensure materials are supplied on time as per the agreed delivery date

13. Is there any effort of monitoring and tracking material availability and use in the project? ☐ ☐ ☐ ☐

Legend: **N/A -**Non Applicable **I/DK-** I do not know

13. Project Safety management

	Yes	No	N/A	I/DK
1. Is there awareness about the importance of project Safety management in your organization's and Project management team?	☐	☐	☐	☐
2. Is there any effort of managing Safety in your project?	☐	☐	☐	☐
3. Is Safety management performed formally in your project /organization?	☐	☐	☐	☐
4. Does your project/organization have organizational policies, procedures and guidelines for Safety management?	☐	☐	☐	☐
5. Is Safety planning performed in your project? (determining safety standards and requirements , and devising actions plan/strategies)	☐	☐	☐	☐
6. Does the safety management plan include Staffing, budget, Records, and Documentation Requirements?	☐	☐	☐	☐
7. Is Site Neighborhood Safety Characteristics study done for your project?	☐	☐	☐	☐

8. Is Hazard Analysis performed for activities of your project? ☐ ☐ ☐ ☐

9. Is Safety audit done in your project? (a review whether project activities comply with policies, processes, and procedures and safety requirements) ☐ ☐ ☐ ☐

10. Does your organization provide Safety training for workers? ☐ ☐ ☐ ☐

11. Does your project provide Personal Protective Equipment for site employees? ☐ ☐ ☐ ☐

12. Does the project/organization have safety management personnel/coordinator? ☐ ☐ ☐ ☐

13. Is Safety control process implemented in your project?(inspecting whether project products and activities comply with relevant Safety standards/plans) ☐ ☐ ☐ ☐

14. Is project Safety monitoring and control plan[40] prepared? ☐ ☐ ☐ ☐

15. Is safety surveillance and audit (control) performed in your project? ☐ ☐ ☐ ☐

. **Legend:** **N/A -**Non Applicable **I/DK-** I do not know

[40] a plan that defines the actual monitoring and control activities to be employed and undertaken,

Part III- Project management process maturity questions

General Direction

1. *Answer the following Questions Based on your knowledge of practice of project Management in your Project or Organization.*
2. *Read each statement in the second column by inserting in the blank space provided on the question in first column and check the appropriate box for each sub question*. See the example shown below for question #1

For example question #1is read as

	Yes	No	N/A	I/DK
Does your project/organization have a defined, or standard, or generic* Scope Management process**	☐	☐	☐	☐
Does your project/organization have a defined, or standard, or generic *Time Management process**	☐	☐	☐	☐
Does your project/organization have a defined, or standard, or generic* Cost Management process**	☐	☐	☐	☐

* From first column ** from second column

1			Yes	No	N/A	I/DK
	Does your project/organization have a defined, or standard, or generic ……?	Scope Management process	☐	☐	☐	☐
		Time Management process	☐	☐	☐	☐
		Cost Management process	☐	☐	☐	☐

		Financial Management process	☐	☐	☐	☐
		Quality Management process	☐	☐	☐	☐
		Human resource management processes	☐	☐	☐	☐
		Communications Management process	☐	☐	☐	☐
		Risk Management process	☐	☐	☐	☐
		Procurement Management process	☐	☐	☐	☐
		Equipment Management process	☐	☐	☐	☐
		Material management process	☐	☐	☐	☐
		Safety Management process	☐	☐	☐	☐
2			**Yes**	**No**	**N/A**	**I/DK**
	Is a comprehensive planning done to perform the……..? *That is: Are the processes to be performed identified? Are the standards to be followed thought? Are the resources needed identified? Is a general plan showing sequence of activities of the process prepared?*	Scope Management process	☐	☐	☐	☐
		Time Management process	☐	☐	☐	☐
		Cost Management process	☐	☐	☐	☐
		Financial Management process	☐	☐	☐	☐
		Quality Management process	☐	☐	☐	☐
		Human resource management processes	☐	☐	☐	☐
		Communications Management process	☐	☐	☐	☐
		Risk Management process	☐	☐	☐	☐
		Procurement Management process	☐	☐	☐	☐
		Equipment Management process	☐	☐	☐	☐
		Material management process	☐	☐	☐	☐
		Safety Management process	☐	☐	☐	☐

Legend: N/A: Not Applicable **I/DK**: I do not know

3			Yes	No	N/A	I/DK
	Is a documented description of the plan or defined or standard or generic process available for……?	Scope Management process or plan	☐	☐	☐	☐
		Time Management process or plan	☐	☐	☐	☐
		Cost Management	☐	☐	☐	☐
		Financial Management process or plan	☐	☐	☐	☐
		Quality Management process or plan	☐	☐	☐	☐
		Human resource management process /plan	☐	☐	☐	☐
		Communications Management process/plan	☐	☐	☐	☐
		Risk Management process or plan	☐	☐	☐	☐
		Procurement Management process or plan	☐	☐	☐	☐
		Equipment Management process or plan	☐	☐	☐	☐
		Material management process or plan	☐	☐	☐	☐
		Safety Management process or plan	☐	☐	☐	☐

4			Yes	No	N/A	I/DK
	Is there a policy or direction or guideline that requires or recommends planning and performing …….?	Scope Management process/plan	☐	☐	☐	☐
		Time Management process/plan	☐	☐	☐	☐
		Cost Management process/plan	☐	☐	☐	☐
		Financial Management process/plan	☐	☐	☐	☐
		Quality Management process/plan	☐	☐	☐	☐
		Human resource management processes/plan	☐	☐	☐	☐
		Communications Management process/plan	☐	☐	☐	☐
		Risk Management process/plan	☐	☐	☐	☐

		Procurement Management process /plan	☐	☐	☐	☐
		Equipment Management process /plan	☐	☐	☐	☐
		Material management process /plan	☐	☐	☐	☐
		Safety Management process /plan	☐	☐	☐	☐
5			**Yes**	**No**	**N/A**	**I/DK**
	Does your organization have a standard process for managing ……and the process for your organization tailored or adapted from organizational standard process?	Scope Management process	☐	☐	☐	☐
		Time Management process	☐	☐	☐	☐
		Cost Management process	☐	☐	☐	☐
		Financial Management process	☐	☐	☐	☐
		Quality Management process	☐	☐	☐	☐
		Human resource management processes	☐	☐	☐	☐
		Communications Management process	☐	☐	☐	☐
		Risk Management process	☐	☐	☐	☐
		Procurement Management process	☐	☐	☐	☐
		Equipment Management process	☐	☐	☐	☐
		Material management process	☐	☐	☐	☐
		Safety Management process	☐	☐	☐	☐

Legend: N/A: Not Applicable **I/DK** : I do not know

6			**Yes**	**No**	**N/A**	**I/DK**
	Is there organizational guideline for tailoring or adapting the standard …….. to the need of your project?	Scope Management process	☐	☐	☐	☐
		Time Management process	☐	☐	☐	☐
		Cost Management process	☐	☐	☐	☐
		Financial Management process	☐	☐	☐	☐
		Quality Management process	☐	☐	☐	☐
		Human resource management processes	☐	☐	☐	☐

		Communications Management process	☐	☐	☐	☐
		Risk Management process	☐	☐	☐	☐
		Procurement Management process	☐	☐	☐	☐
		Equipment Management process	☐	☐	☐	☐
		Material management process	☐	☐	☐	☐
		Safety Management process	☐	☐	☐	☐
7			**Yes**	**No**	**N/A**	**I/DK**
	Does your organization or project have the resources needed to perform the …….?	Scope Management process	☐	☐	☐	☐
		Time Management process	☐	☐	☐	☐
		Cost Management process	☐	☐	☐	☐
		Financial Management process	☐	☐	☐	☐
		Quality Management process	☐	☐	☐	☐
		Human resource management processes	☐	☐	☐	☐
		Communications Management process	☐	☐	☐	☐
		Risk Management process	☐	☐	☐	☐
		Procurement Management process	☐	☐	☐	☐
		Equipment Management process	☐	☐	☐	☐
		Material management process	☐	☐	☐	☐
		Safety Management process	☐	☐	☐	☐
8			Yes	No	N/A	I/DK
	Is responsibility assigned to a person or a department for performing the activities of……..	Scope Management process	☐	☐	☐	☐
		Time Management process	☐	☐	☐	☐
		Cost Management process	☐	☐	☐	☐
		Financial Management process	☐	☐	☐	☐

		Quality Management process	☐	☐	☐	☐
		Human resource management processes	☐	☐	☐	☐
		Communications Management process	☐	☐	☐	☐
		Risk Management process	☐	☐	☐	☐
		Procurement Management process	☐	☐	☐	☐
		Equipment Management process	☐	☐	☐	☐
		Material management process	☐	☐	☐	☐
		Safety Management process	☐	☐	☐	☐

Legend: N/A: Not Applicable **I/DK** : I do not know

			Yes	No	N/A	I/DK
	Do the people involved in performing the ……. have knowledge or experience or receive training about activities of the process?	Scope Management process	☐	☐	☐	☐
		Time Management process	☐	☐	☐	☐
		Cost Management process	☐	☐	☐	☐
		Financial Management process	☐	☐	☐	☐
		Quality Management process	☐	☐	☐	☐
		Human resource management processes	☐	☐	☐	☐
		Communications Management process	☐	☐	☐	☐
		Risk Management process	☐	☐	☐	☐
		Procurement Management process	☐	☐	☐	☐
		Equipment Management process	☐	☐	☐	☐
		Material management process	☐	☐	☐	☐
		Safety Management process	☐	☐	☐	☐
10			**Yes**	**No**	**N/A**	**I/DK**

	Are relevant stakeholders[41] identified and involved in the planning and performing of the…….	Scope Management process	☐	☐	☐	☐
		Time Management process	☐	☐	☐	☐
		Cost Management process	☐	☐	☐	☐
		Financial Management process	☐	☐	☐	☐
		Quality Management process	☐	☐	☐	☐
		Human resource management processes	☐	☐	☐	☐
		Communications Management process	☐	☐	☐	☐
		Risk Management process	☐	☐	☐	☐
		Procurement Management process	☐	☐	☐	☐
		Equipment Management process	☐	☐	☐	☐
		Material management process	☐	☐	☐	☐
		Safety Management process	☐	☐	☐	☐
11			**Yes**	**No**	**N/A**	**I/DK**
	Does your organization/Project Monitor, control and review the process for …….. to ensure that it complies with standards, and procedures in the process description /the plan?	Scope Management	☐	☐	☐	☐
		Time Management	☐	☐	☐	☐
		Cost Management	☐	☐	☐	☐
		Financial Management	☐	☐	☐	☐
		Quality Management	☐	☐	☐	☐
		Human resource management	☐	☐	☐	☐
		Communications Management	☐	☐	☐	☐
		Risk Management	☐	☐	☐	☐
		Procurement Management	☐	☐	☐	☐

[41] (those who may affect or may be affected by the implementation of the process)

		Equipment Management	☐	☐	☐	☐
		Material management	☐	☐	☐	☐
		Safety Management	☐	☐	☐	☐

Legend: N/A: Not Applicable **I/DK** : I do not know

12			**Yes**	**No**	**N/A**	**I/DK**
	Does your project or organization collect data and lessons learned from planning and performing the …….. for the purpose of future use in improvement of the process?	Scope Management process	☐	☐	☐	☐
		Time Management process	☐	☐	☐	☐
		Cost Management process	☐	☐	☐	☐
		Financial Management process	☐	☐	☐	☐
		Quality Management process	☐	☐	☐	☐
		Human resource management processes	☐	☐	☐	☐
		Communications Management process	☐	☐	☐	☐
		Risk Management process	☐	☐	☐	☐
		Procurement Management process	☐	☐	☐	☐
		Equipment Management process	☐	☐	☐	☐
		Material management process	☐	☐	☐	☐
		Safety Management process	☐	☐	☐	☐

Legend: N/A: Not Applicable **I/DK**: I do not know

Part IV

Direction: *Please choose the statement that best describes each of the project management practice in your project or organization. Please choose only one choice for each question.*

1. Scope management practice in your project or organization is best approximated by the statement

☐ There is only general statement of the scope of the project .Little or no scope management or documentation exists.

☐ There is a basic scope management process in place. Scope management techniques such as WBS are regularly applied on larger, more visible projects.

☐ There is a documented scope management process and it is utilized by most projects. The project scope is well defined, monitored and controlled.

2. Time management practice in your project or organization is best approximated by the statement

☐ There is no established planning or scheduling standards.

☐ Basic time management processes exist. Standard scheduling approaches are utilized for large projects.

☐ Time management processes are documented and utilized by most projects.

3. Cost management practice in your project or organization is best approximated by the statement

☐ There are no established practices for managing project cost. Informal practices are common.

☐ Cost estimating, reporting, and performance measurement are used only on large projects.

☐ There is a defined and documented cost management process that is standard to the organization.

4. Financial management practice in your project or organization is best approximated by the statement

☐ There is minimal financial planning and financial controls at project level. Projects lack control mechanisms to track costs and project expenditure.

☐ Financial planning is performed and there is occasional reporting of progress and costs incurred.

☐ Financial planning is performed and financial reports are prepared routinely. Cost collection is automated, and Periodic trend analysis is performed.

5. Quality management practice in your project or organization is best approximated by the statement

☐ There are no established project quality practices or standards.

☐ There is basic organizational project quality management process. The process is used usually only on large projects.

☐ Quality management process is well documented and is an organizational standard. Management is involved in this process for most projects.

6. Human Resource management practice in your project or organization is best approximated by the statement

☐ There are no established practices, standards or guides for project Human resource management. Project Human resource time and cost is not measured

☐ There is a documented, repeatable process in place for human resource management. Human Resource plan is prepared and performance is monitored in large projects.

☐ There is a defined Human resource management process and almost all projects are expected to follow /use the process. Human resource plan is prepared and performance monitored almost in all projects.

7. Communications management practice in your project or organization is best approximated by the statement

☐ There is an ad hoc communications process in place whereby projects are expected to provide informal status reports to management.

☐ Basic communications process is established. Large projects follow the process and provide progress reporting.

☐ There is a formal, documented and clear communication management process. The process is used in most projects.

8. Risk management practice in your project or organization is best approximated by the statement

☐ There are no established project risk management practices or standards.

☐ There is basic risk management process. The process is used usually on large projects.

☐ There is a well documented standard risk management processes. The process is used in most projects of the organization.

9. Procurement management practice in your project or organization is best approximated by the statement

☐ There are no established project procurement practices or standards.

☐ There is basic procurement management process. The process is used on large projects.

☐ There is a well-documented standard procurement management processes. The process is used in most projects of the organization.

10. Equipment management practice in your project or organization is best approximated by the statement

☐ There is no established practice, policy or standard for equipment management. Ad hoc process is used to determine what kind, how many, and when equipment's would be required for the project.

☐ There is a documented, repeatable process for equipment management. Equipment planning is done and performance is monitored and evaluated.

☐ The organization has a documented equipment policy and a defined process for its management. The equipment planning includes both long term and short-term needs.

11. Material management practice in your project or organization is best approximated by the statement

☐ There is some recognition for the need to manage material systematically. However, the methods are ad hoc and inconsistently used.

☐ There is a basic process documented for procurement and management of materials for the project, but this process is not a standard practice. It is used usually by large projects.

☐ There is a defined process for managing materials from planning through delivery and final use .The material management process is considered an organizational standard

12. Safety management practice in your project or organization is best approximated by the statement

☐ There are no established project Safety management practices or standards. There are ad hoc processes and efforts to maintain safety. There is no effort of safety planning and control.

☐ There is basic Safety policy. Management takes an active role in ensuring that safety standards are accounted for and applied to most projects. The main objective is to comply with legal and contractual safety standards and requirements.

☐ Safety management process is well documented and is an organizational standard. The organization tries to build safety in its entire process .Detailed safety policies, procedures and guidance are in place, and their use is monitored and controlled

******* END *******

Appendix-C: Questions adopted from Reference[42] maturity survey questionnaire

Direction: Please choose the statement that best describes each of the project management practice in your project or organization. Please choose only one choice for each question[43]

1. Scope management practice in your project or organization is best approximated by the statement,

- ☐ There is only general statement of the scope of the project .Little or no scope management or documentation exists.
- ☐ There is a basic scope management process in place. Scope management techniques such as WBS are regularly applied on larger, more visible projects.
- ☐ There is a documented scope management process and it is utilized by most projects. The project scope is well defined, monitored and controlled.

2. Time management practice in your project or organization is best approximated by the statement,

- ☐ There is no established planning or scheduling standards.
- ☐ Basic time management processes exist. Standard scheduling approaches are utilized for large projects.
- ☐ Time management processes are documented and utilized by most projects.

3. Cost management practice in your project or organization is best approximated by the statement,

- ☐ There are no established practices for managing project cost. Informal practices are common.
- ☐ Cost estimating, reporting, and performance measurement are used only on large projects.
- ☐ There is a defined and documented cost management process that is standard to the organization.

---

[42] Obtained from www.infoedge.com/in/MAT.xls

[43] **Note:** in each question the first box describes the state of level one organization, the second box describes the state of level-2 organization, and the third box describes the state of level-3 organization (the descriptions in the questionnaires are very close the description of maturity levels in PM –solutions' maturity model)

4. Quality management practice in your project or organization is best approximated by the statement,

- ☐ There are no established project quality practices or standards.
- ☐ There is basic organizational project quality management process. The process is used usually only on large projects.
- ☐ Quality management process is well documented and is an organizational standard. Management is involved in this process for most projects.

5. Human Resource management practice in your project or organization is best approximated by the statement,

- ☐ There are no established practices, standards or guides for project Human Resource management. Project human resource time and cost is not measured.
- ☐ There is a documented, repeatable process in place for human resource management. Human resource plan is prepared and performance is monitored in large projects.
- ☐ There is defined human resource management process and almost all projects are expected to follow or use the process. Human resource plan is prepared and performance is monitored almost in all projects.

6. Communications management practice in your project or organization is best approximated by the statement,

- ☐ There is an ad hoc communications process in place whereby projects are expected to provide informal status reports to management.
- ☐ Basic communications process is established. Large projects follow the process and provide progress reporting.
- ☐ There is a formal, documented and clear communication management process. The process is used in most projects.

7. Risk management practice in your project or organization is best approximated by the statement,

- ☐ There are no established project risk management practices or standards.
- ☐ There is basic risk management process. The process is used usually on large projects.
- ☐ There is a well-documented standard risk management processes. The process is used in most projects of the organization.

8. Procurement management practice in your project or organization is best approximated by the statement,

☐ There are no established project procurement practices or standards.

☐ There is basic procurement management process. The process is used usually on large projects.

☐ There is a well-documented standard procurement management process. The process is used in most projects of the organization.

Appendix-D: Cover Letter sent to PM Practitioners

Dear Respondent:

The e-Construction Group at the University of Maryland, USA is conducting research on Maturity of Project Management Practice in the Construction industry of developing countries with focus on Ethiopia.

The research will investigate the following issues:

1. Whether and to what extent each of the Project Management knowledge areas and processes are being applied in managing construction projects.

2. The areas that need to be focused to develop and improve Project Management practice.

Even though it is expected that a project Manager should consider all relevant aspect of the project management knowledge areas/processes in managing his project; the degree of importance of knowledge areas/processes in contributing for or affecting the success of the project is generally expected to vary. Hence, this research tries to gather your professional opinion on the relative importance of the Project Management knowledge areas/processes for successful management of construction projects from a **contractor's perspective**.

The output of this research will help us in developing a frame work for development and improvement of project management in the industry.

Thus, you are kindly invited to fill out the questionnaire and return it to the researcher in Ethiopia in one week time within the receipt of the questionnaire.

Please call **+ 251 -0911- 88 73 32** for pickup of the completed questionnaire from your office.

Thank you for your interest in participating in the research

Note: This questionnaire has to be filled by a Project Manager or a person who has served as a Project Manager

Researcher: Abadir H Yimam

PROJECT MANAGEMENT PROGRAM

UNIVERSITY OF MARYLAND, MD, USA

E-Mail - abadir4@gmail.com Or ayimam@umd.edu

Mobile: (+251)-0911- 88-73-32

Supervisor: Prof Miroslaw J. Skibniewski (PhD)

CHAIR PROFESSOR OF PROJECT MANAGEMENT

A. JAMES CLARKE SCHOOL OF ENGINEERING

E-MAIL: mirek@umd.edu

http://e-construction.pm.umd.edu

Appendix-E: Questionnaire for Rating of the Practices

Part I – General Information

Direction: Please provide the requested information on the space provided

14. Name of the person filling the questionnaire (optional)_____

15. Name of the organization you are working for _____

16. Position/role in the organization (Required) _____

17. Have you received any Project Management related training?_____

A. Yes **B.** No

18. What was the highest level of Project Management training you received? _____

A. Masters level **B.** Bachelors **C**. Certificate **D.** Short-term training

E. As a course in a related program of study **F.** Other (please specify)

19. Have you worked as Project Manager? _____

A. Yes **B**. No

20. Number of years you worked as a project manager _____

Part II- Project management practice maturity questions

General Direction

Rate each practice as basic, average, and advanced practice based on the following definition.

Please write the corresponding letter on the space provided on the left side of the column.

A. Basic (a must) practice: if the practice is so important that **it should be performed** in **management of any construction project** to achieve the objective of the process area: without it there will **not** be a meaningful management of the process area (very difficult or impossible to attain the objective of the process area).

B. Average (Important- Highly recommended) practice: the practice is important, useful and enhances the attainment of objective. But it could be skipped in management of small or less important projects and it could be possible that objective of the management be realized without even if it is with lesser degree of success.

C. Advanced (Recommended – on large or complex project) practice: the practice is important, useful and enhances the attainment of objective with highest degree of predictability. It enhances control of the process. But it could be skipped in management of small or less important projects, further it is best used in large or complex projects. Or when the company desires to have a highest level of project management capability.

1. Project Scope Management Practices

Rating	
	Performing scope management formally
	Using Computer applications or tools in scope management process
	Identifying the project's requirements
	Defining the projects scope
	Using WBS[44] (work breakdown structure) to define the projects scope
	Preparing WBS Dictionary (document providing description of work ,code of accounts identifier , responsible department ,resource required etc)
	Formal monitoring and control of scope
	Reviewing or inspecting works to ensure or verify that all scope of the work is performed

[44] WBS is the breakdown of the project work into smaller, more manageable pieces of work, with each descending level of the WBS representing an increasing detailed definition of the project work

2. Project Time Management Practices

Rating	
	Performing formal project time management
	Preparing a schedule (plan) for the project
	Base lining the project schedule (fixing start and finish date and approving them as a basis for guiding work and comparison of the schedule performance)
	Using Network scheduling method (such as CPM, or PERT)
	Using computer tools such as Microsoft project, Primavera, Excel etc in project time management (preparation and update of schedule...)
	Using WBS in defining activities for project schedule preparation
	Identifying logical and other relationships among activities and sequencing accordingly (identifying precedent and successor activities)
	Preparing estimate of resources (materials, people, equipment) needed to take them in to account in the schedule preparation.
	Performing resource leveling
	Estimating activity duration
	Using the company's historical data in estimating activity duration and required resources
	Formal Monitoring and controlling progress of project activities
	Using Earned value management in monitoring and controlling the schedule
	Using of S-curve method used in monitoring and controlling the schedule
	Updating the project Schedule

3. Project Cost Management Practices

Rating	
	Performing formal project cost management
	Preparing project cost estimate
	Preparing a detailed estimate detailing cost of labor, material, and machinery separately
	Using WBS in preparing the estimate
	Consulting the company's historical actual cost data in preparing the estimate
	Using cost-estimating software in preparing the estimate or managing cost
	Preparing the projects budget
	Time phasing the project budget (by indicating the budgeted amount on monthly/weekly etc basis)
	Preparing detailed budget that indicate the amount allocated for resources by category (human, material, equipment etc)
	Using WBS used in preparing the budget
	Base lining the budget (allocating the budget to work packages and resources, and approve them as a plan for performance benchmark)
	Updating the budget regularly
	Formal Monitoring and controlling of the projects cost
	Tracking the project cost against the baseline on regular update cycle
	Tracking all costs of labor, equipment, and material, separately
	Performing variance analysis (difference of budgeted and actual cost)
	Use of Earned value management method in monitoring and controlling cost
	Preparing and updating Budget forecasts (cost to completion,)

4. Project Financial Management Practices

Rating	
	Performing formal project financial management
	Determining Project Financial (funding) requirement
	Preparing Financial plan for the project
	Indicating the required fund , source and the time the fund is required in the financial plan
	Considering effects of change in exchange rate, escalation of labor and material cost, etc in the financial plan
	Performing project cash flow analysis
	Controlling project finance to ensure that money is spent appropriately as planned and with proper authorization
	Preparing expenditure authorization policy and procedure
	Performing financial audit done
	Preparing Financial Reports regularly for the project
	Developing a system/procedure for creating and handling financial documents
	Using standardized process and format for financial information recording, storage and reporting
	Using computer systems and tools in filing and retrieval of financial information

5. **Project Quality Management Practices**

Rating	
	Performing formal project quality management
	Preparing and implementing quality management policies, procedures and guidelines
	Defining the project's quality requirement
	Performing quality planning for a project? (determining requirements and quality standards and strategies are to meet quality objectives)
	Establishing Quality Assurance activities (these are processes, procedures and standards defined/developed to assure quality objectives are met)
	Performing quality audit (reviewing the processes to determine whether project activities comply with organizational and project policies, processes, and procedures and quality requirements)
	Implementing TQM (Total Quality Management)
	Implementing quality control process (determining whether project products and activities comply with relevant quality standards/plans)
	Preparing project quality monitoring and control plan (a plan showing works to be monitored, acceptance criteria, responsible party, measurements to be taken etc)
	Inspecting and controlling quality of subcontractors' work to ensure compliance with quality requirement
	Hiring/Assigning a quality department or employees specializing in quality management

6. Project Human Resource Management

Rating	
	Performing formal project human resource management
	Planning for acquisition and management of human resource
	Preparing project organization chart
	Defining Skill requirement, Roles and Responsibilities for all Project positions
	Preparing project staffing plan
	Defining details in the staffing plan such as desired minimum experience, skill set, when to acquire and when to release project team members from the project
	Providing training (formal/informal) to project team members
	Tracking performance of team members regularly and providing feedback
	Tracking and monitoring project human resource cost and time formally

7. **Project Communication Management**

Rating	
	Performing formal project Communication management
	Performing Project Communication requirement analysis
	Preparing a plan/strategy to address identified communication needs
	Developing and implementing system/procedure for handling project documents
	Developing a system for collecting and distributing project information
	Preparing performance reports and providing them to relevant stakeholders
	Using standard format for reports preparation
	Including in reports performance and status of all knowledge areas(scope, time ,cost ,risk, human resource , communication, procurement etc)
	Performing Project stakeholder Management Formally
	Identifying project stakeholders and responding to their need
	Performing stakeholders' analysis for a project? (analyzing their interest, involvement and impact)
	Preparing stakeholder management plan (devising a strategy on how to handle the stakeholder's needs and expectations)
	Exerting continuous effort to communicate and work with stakeholders to influence their expectation, address their concern and resolve issues
	Developing a strategy for managing each key stakeholder's expectation

8. **Project Risk Management**

Rating	
	Performing formal project risk management
	Identifying and documenting project risks
	Using risk break down structure (RBS) in the identification or planning of risk
	Using SWOT analysis (Strength, Weakness, Opportunity and Threat analysis) in the identification or planning of risk
	Analyzing potential impact of identified risks
	Estimating the chance of occurrence of risks (for example as low, medium, High)
	Prioritizing risks based on factors such as impact, probability, urgency etc
	Performing Quantitative risk analysis [example : simulation , decision tree analysis etc]
	Developing risk response strategy for the prioritized risks (example : avoid, transfer, mitigate, accept)
	Preparing a detailed risk response plan for risks that warrant action/ attention
	Continuously updating the risk response plan and strategy
	Assigning risk response owner to take responsibility for the management of selected risks
	Allowing contingency time in a project schedule for potential risk impact
	Allowing contingency budget in a project budget for potential risk impact
	Performing risk monitoring and control in a project (effort of identifying and documenting new risks, closing those outdated and tracking those already identified)
	Performing risk audit in a project(Examining and documenting the effectiveness of the risk response strategy, and the risk management process)

	Using risk register/log[45] in the risk management process (to document identified risks with their attributes and to track their status while monitoring and control)

9. Project Procurement Management

Rating	
	Performing formal project procurement management
	Planning for procurement of goods and services needed for a project
	Identifying major and/or special supply items (such as: those required in large quantity, or those requiring special manufacturing or long lead-time etc) and giving special attention
	Using standard procurement documents (such as standard purchase order, standard sub contract / supplier agreement)
	Using preferred supplier/subcontractor or pre qualifying them
	Developing and using a documented contract management/administration processes
	Hiring/Assigning a staff trained in contract /procurement management
	Developing a contract change management process
	Monitoring and controlling progress of subcontractors and suppliers
	Developing and using process for Payment Review, Authorization, and Processing of subcontractors and suppliers work/services
	Developing and using process /procedure for managing claim
	Hiring/using a staff that is capable and responsible for claim management

[45] A document used to record and track identified risks

10. Project Equipment Management

Rating	
	Performing formal project equipment management
	Performing Equipment planning to acquire and use project equipments efficiently
	Detailing the plan to include information such as what kind , how much and when equipments are needed
	Preparing long term (more than 3 month), medium (1 to 3-month) and short-term (weekly and daily) equipment plan
	Performing formal economic and risk analysis in deciding: buy, lease or rent option for equipment acquisition
	Using computer software in equipment planning, assignment and tracking
	Developing a procedure for equipment sharing among projects of the organization
	Planning and facilitating equipment sharing
	Preparing and implement equipment maintenance plan/ policy
	Performing scheduled preventive maintenance for equipments
	Inspecting equipments regularly for safety
	Tracking and monitoring performance of the project equipment, their productivity, maintenance cost, time worked etc
	Preparing and implementing equipment replacement plan/policy
	Using actual performance data, risk and economic analysis in equipment Replacement decisions

11. Project Material Management

Rating	
	Performing formal project material management
	planning purchase of project materials
	Considering all costs (purchase costs, order cost, holding costs, and unavailability cost) in material planning /management
	Considering risk associated with unavailability and cost increase in material planning
	Giving special consideration for Materials requiring long lead-time and critical items during planning and monitoring
	Using preferred material suppliers/or pre qualifying suppliers
	Performing material procurement expediting[46] formally
	Coordinating centrally material purchase of different projects
	Using computer software in material planning, assignment and tracking
	Monitoring and updating material requirement and availability
	Using a documented process for approval, checking and testing of materials

[46] Expediting is the function of tracking ,monitoring and follow up of material purchase , to ensure materials are supplied on time as per the agreed delivery date

12. Project Safety Management

Rating	
	Performing formal project safety management
	Preparing organizational policies, procedures and guidelines for safety management
	Performing Safety planning (determining safety standards and requirements , and devising actions plan/strategies)
	Detailing the safety management plan to include Staffing, Budget, Records, and Documentation Requirements
	Performing Site Neighborhood Safety Characteristics Study
	Performing Hazard Analysis for activities of a project
	Performing Safety audit (a review whether project activities comply with policies, processes, and procedures and safety requirements)
	Providing Safety training for workers
	Providing Personal Protective Equipment for site employees
	Hiring or assigning safety management personnel/coordinator
	Performing Safety control (inspecting whether project products and activities comply with relevant Safety standards/plans)
	Preparing project Safety monitoring and control plan[47]
	Performing safety surveillance and audit (control)

[47] a plan that defines the actual monitoring and control activities to be employed and undertaken,

Appendix-F: Questionnaire for Rating of Importance of Knowledge Areas

Part I – General Information

Direction: Please provide the requested information on the space provided

1. Name of the person filling the questionnaire (optional)_____

2. Name of the organization you are working for _____

3. Position/role in the organization (Required) _____

4. Have you received any Project Management related training?

A. Yes **B.** No

5. What was the highest level of Project Management training you received?

A. Masters level **B.** Bachelors **C**. Certificate **D.** Short-term training

E. As a course in a related program of study **F.** Other (please specify)

6. Have you worked as Project Manager?

A. Yes **B**. No

7. Number of years you worked as a project manager _____

Part II- Project management knowledge areas comparison questions

---

General Direction

Please compare the relative importance of each of the knowledge area in the raw with the knowledge areas in each column considering their relative contribution for project success of a project from a contractor perspective. Please use the following scale to give your opinion and read the example given before you proceed.

1 = Much less important

2 = Less important

3 = Equally important

4 = More important

5 = Much more important

Example: if you fill 1 under the column of "Time management" in the table found below, it means you are saying that:

Project Scope Management is **<u>much less important</u>** than **<u>Project Time Management</u>** (for successful management of a construction projects from contractors perspective)

1. **Project Scope Management ----------compared with project----------**

Time management	Cost Management	Financial Management	Quality Management	Human Resource Management	Communication Management	Risk Management	Procurement Management	Equipment Management	Material Management	Safety Management

2. **Project Time Management ----------compared with project----------**

----------	Cost Management	Financial Management	Quality Management	Human Resource Management	Communication	Risk Management	Procurement Management	Equipment Management	Material Management	Safety Management

3. **Project Cost Management ----------compared with project----------**

Scope Management	Time Management	Financial Management	Quality Management	Human Resource Management	Communication	Risk Management	Procurement Management	Equipment Management	Material Management	Safety Management

4. **Project Financial Management ----------compared with project----------**

Scope Management	Time Management	Cost Management	Quality Management	Human Resource Management	Communication	Risk Management	Procurement Management	Equipment Management	Material Management	Safety Management

5. **Project Quality Management ----------compared with project----------**

Scope Management	Time Management	Cost Management	Financial Management	Human Resource Management	Communication	Risk Management	Procurement Management	Equipment Management	Material Management	Safety Management

6. **Project Human Resource Management ----------compared with project----------**

Scope Management	Time Management	Cost Management	Financial Management	Quality Management	Communication	Risk Management	Procurement Management	Equipment Management	Material Management	Safety Management

7. **Project Communication Management ----------compared with project----------**

Scope Management	Time Management	Cost Management	Financial Management	Quality Management	Human Resource	Risk Management	Procurement Management	Equipment Management	Material Management	Safety Management

8. **Project Risk Management ----------compared with project----------**

Scope Management	Time Management	Cost Management	Financial Management	Quality Management	Human Resource	Communication	Procurement Management	Equipment Management	Material Management	Safety Management

9. **Project Procurement Management ----------compared with project----------**

Scope Management	Time Management	Cost Management	Financial Management	Quality Management	Human Resource	Communication	Risk Management	Equipment Management	Material Management	Safety Management

10. Project Equipment Management ----------compared with project----------

Scope	Time Management	Cost Management	Financial Management	Quality Management	Human Resource	Communication	Risk Management	Procurement Management	Material Management	Safety Management

11. **Project Material Management ----------compared with project----------**

Scope Management	Time Management	Cost Management	Financial Management	Quality Management	Human Resource	Communication	Risk Management	Procurement Management	Equipment Management	Safety Management

12. **Project Safety Management ----------compared with project----------**

Scope Management	Time Management	Cost Management	Financial Management	Quality Management	Human Resource	Communication	Risk Management	Procurement Management	Equipment Management	Material Management

Appendix-G: CMMI Maturity Model Description

Description of the six Capability Levels, their Generic Goal, and Generic Practices

Note: The description of the six capability levels provided here under is directly summarized from the books written by (Chrissis, Konrad, & Shrum, 2003) and (Ahern, Clouse, & Turner, 2008).Except for some rephrasing and additional explanation, the description provided below is a shortened direct summary from the two books. Statements rephrased by the researcher and some additional explanations given by the researcher are presented in italics

Capability Level-0: Incomplete

Generic Goal: No generic goal for this level.

Generic Practices: No generic practice for this level.

Capability Level-1: Performed Process

A performed process is a process that accomplishes the work necessary to produce work products. For a performed process, the specific goals of the process area are satisfied.

Generic Goal: Achieve Specific Goals.

The process supports and enables achievement of the specific goals of the process area by transforming identifiable input work products to produce identifiable output work products.

Generic Practice

GP 1.1Perform Base Practices.

Perform the base practices of the process area to develop work products and provide services to achieve the specific goals of the process area.

The purpose of this generic practice is to produce the work products and deliver the services that are expected by performing the process. These practices may be done informally, without following a documented process description or plan.

Capability Level-2: Managed Process

A managed process is a performed (capability level 1) process that has the basic infrastructure in place to support the process. It is planned and executed in accordance with policy; employs skilled people who have adequate resources to produce controlled outputs; involves relevant stakeholders; is monitored, controlled, and reviewed; and is evaluated for adherence to its process description.

Generic Goal: Institutionalize a Managed Process.

Generic Practices:

GP 2.1 Establish and maintain an organizational policy for planning and performing the process.

The purpose of this generic practice is to define the organizational expectations for the process and make these expectations visible to those in the organization who are affected. In general, senior management is responsible for establishing and communicating guiding principles, direction, and expectations for the organization.

GP 2.2 Establish and maintain the plan for performing the process.

The purpose of this generic practice is to determine what is needed to perform the process and to achieve the established objectives, to prepare a plan for performing the process, to prepare a process description, and to get agreement on the plan from relevant stakeholders.

*For example ,in project time management, the planning include deciding the type of schedule to be prepared (Bar chart ,CPM) ,the level of detail ,the type of software to be used ,identify and prepare the processes to be performed (defining activity , estimating duration , resource etc)*Establishing a plan includes documenting the plan and providing a process description. Maintaining the plan includes changing it, as necessary, in response to either corrective actions or to changes in requirements and objectives for the process.

GP 2.3 Provide adequate resources for performing the process, developing the work products, and providing the services of the process.

The purpose of this generic practice is to ensure that the resources necessary to perform the process as defined by the plan are available when they are needed. Resources include adequate funding, appropriate physical facilities, skilled people, and appropriate tools.

GP 2.4 Assign responsibility and authority for performing the process, developing the work products, and providing the services of the process.

The purpose of this generic practice is to ensure that there is accountability for performing the process and achieving the specified results throughout the life of the process.

GP 2.5 Train the people performing or supporting the process as needed.

The purpose of this generic practice is to ensure that the people have the necessary skills and expertise to perform or support the process.

GP 2.6 Place designated work products of the process under appropriate levels of control.

The purpose of this generic practice is to establish and maintain the integrity of the designated work products of the process (or their descriptions) throughout their useful life

GP 2.7 Identify and involve relevant stakeholders of the process as planned.

The purpose of this generic practice is to establish and maintain the expected involvement of stakeholders during the execution of the process.

GP 2.8 Monitor and control the process against the plan for performing the process and take appropriate corrective action.

The purpose of this generic practice is to perform the direct day-to-day monitoring and controlling of the process. Monitoring and controlling the process involves measuring appropriate attributes of the process or work products produced by the process

GP 2.9 Objectively evaluate adherence of the process against its process description, standards, and procedures, and address noncompliance.

The purpose of this generic practice is to provide credible assurance that the process is implemented as planned and adheres to its process description, standards, and procedures.

GP 2.10 Objectively evaluate adherence of the process against its process description, standards, and procedures, and address noncompliance.

The purpose of this generic practice is to provide higher level management (managers who provide policy and overall guidance for the process) with the appropriate visibility into the process.

Capability Level-3: Defined Process

A defined process is a managed process that is tailored from the organization's set of standard processes according to the organization's tailoring guidelines; has maintained process description; and contributes work products, measures, and other process improvement information to the organizational process assets. Standard processes describe the fundamental process elements that are expected in the defined processes. A defined process clearly states the Purpose, Inputs, Entry criteria, Activities, Roles, Measures, Verification steps, Outputs, and exit criteria.

Generic Goal: Institutionalize a Defined Process.

Generic Practices:

GP 3.1 Establish and maintain the description of a defined process.

The purpose of this generic practice is to establish and maintain a description of the process that is tailored from the organization's set of standard processes to address the needs of a specific instantiation. The organization should have standard processes that cover the process area, as well as have guidelines for tailoring these standard processes to meet the needs of a project or organizational function. With a defined process, variability in how the processes are performed across the organization is reduced and process assets, data, and learning can be effectively shared. The descriptions of the defined processes provide the basis for planning, performing, and managing the activities, work products, and services associated with the process.

GP 3.2 Collect work products, measures, measurement results, and improvement information derived from planning and performing the process to support the future use and improvement of the organization's processes and process assets.

The purpose of this generic practice is to collect information and artifacts derived from planning and performing the process. This generic practice is performed so that the information and artifacts can be included in the organizational process assets and made available to those who are (or who will be) planning and performing the same or similar processes.

Capability Level-4: Quantitatively Managed Process

A quantitatively managed process is a defined process that is controlled using statistical and other quantitative techniques. The product quality, service quality, and process performance attributes are measurable and controlled throughout the project. The sub processes that are significant contributors to overall process performance are statistically managed.

Generic Goal: Institutionalize a quantitatively managed Process

Generic Practices

GP 4.1 Establish and maintain quantitative objectives for the process, which address quality and process performance, based on customer needs and business objectives.

The purpose of this generic practice is to determine and obtain agreement from relevant stakeholders about specific quantitative objectives for the process. These quantitative objectives can be expressed in terms of product quality, service quality, and process performance.

These quantitative objectives are criteria used to judge whether the products, services, and process performance will satisfy the customers, end users, organization management, and process implementers.

GP 4.2 Stabilize the performance of one or more sub processes to determine the ability of the process to achieve the established quantitative quality and process-performance objectives

The purpose of this generic practice is to stabilize the performance of one or more sub processes of the defined process that are critical contributors to the overall performance using appropriate statistical and other quantitative techniques. Stabilizing selected sub processes supports predicting the ability of the process to achieve the established quantitative quality and process-performance objectives.

Capability Level-5: Optimizing Process

An optimizing process is a quantitatively managed process that is changed and adapted to meet relevant current and projected business objectives. An optimizing process focuses on continually improving process performance through both incremental and innovative technological improvements. Process improvements that address common causes of process variation, root causes of defects and other problems, and those that would measurably improve the organization's processes are identified, evaluated, and deployed as appropriate. These improvements are selected based on a quantitative understanding of their expected contribution to achieving the organization's process-improvement objectives versus the cost and impact to the organization.

Generic Goal: GG 5 Institutionalize an optimizing Process.

Generic Practices:

GP 5.1 Ensure continuous improvement of the process in fulfilling the relevant business objectives of the organization.

The purpose of this generic practice is to select and systematically deploy process and technology improvements that contribute to meeting established quality and process-performance objectives.

GP 5.2 Identify and correct the root causes of defects and other problems in the process. The purpose of this generic practice is to analyze defects and other problems that were encountered, to correct the root causes of these types of defects and problems, and to prevent these defects and problems from occurring in the future

Appendix-H: Thesis Analysis result

1. Scope Management

Scope management practices identified by the research and their Categories

Practice Category	Practice	Percentage of organizations Performing the practice
Basic	Identifying project's requirements*	90%
	Defining project scope*	86%
	Use of WBS in defining project scope*	67%
	Monitoring and control of project scope*	71%
Intermediate	Preparing WBS dictionary	43%
	Reviewing or inspecting works(to verify scope)*	71%

*=PMBOK Process

Measure of rating agreement of the scope management practices[48]

	Percent of overall agreement by raters	Free-marginal kappa
All scope management practices considered in the research	0.46	0.19
PMBOK scope management process	0.53	0.29

[48] Randolph, J. J. (2008). *Online Kappa Calculator.* Retrieved April 12, 2010 , from http://justus.randolph.name/kappa

2. Time Management

Time management practices identified by the research and their Categories

Practice Category	**Practice**	**Percentage of organizations Performing the practice**
Basic	Preparing a schedule *	100%
	Identifying logical and other relationships*	100%
	Preparing estimate of resources*	100%
	Estimating activity duration*	100%
	Updating project schedule	95%
	Base lining project schedule	90%
	Monitoring and controlling progress*	67%
Intermediate	Using WBS in defining activities	86%
	Using Network scheduling methods (such as CPM, or PERT)	62%
	Use of company's historical data in schedule preparation	52%
	Use of computer tools such as Excel, Microsoft Project, Primavera in scheduling	95%
	Performing resource leveling	71%
	Using S-curve method for monitoring progress	52%
Advanced	Using Earned value management method	33%

*=PMBOK process

Measure of rating agreement of the time management practices

	Percent of overall agreement by raters	**Free-marginal kappa**
All time management practices considered in the research	0.45	0.17
PMBOK time management process	0.55	0.32

3. Cost Management

Cost management Practices identified by the Research and their Categories

	Practice	**Percentage of organizations Performing the practice**
Basic	Preparing project cost estimate*	90%
	Preparing a detailed estimate	90%
	Preparing the project's budget*	90%
	Preparing detailed budget	76%
	Monitoring and controlling of project cost*	81%
	Updating the budget regularly	62%
	Consulting company's historical actual cost data	62%
	Using WBS in preparing estimate	86%
	Tracking project cost separately(Human, material ,machinery)	67%

Intermediate	Using cost estimating software	29%
	Time phasing the project budget	71%
	Base lining the budget	67%
	Using WBS in preparing budget	71%
	Performing variance analysis	43%
	Preparing and updating Budget forecasts	62%
Advanced	Use of Earned value management	29%

*=PMBOK process

Measure of rating agreement of the cost management practices

	Percent of overall agreement	**Free-marginal kappa**
Research cost management practices	0.38	0.07
PMBOK cost management process	0.46	0.19

4. Financial Management

Financial Management Practices identified by the Research and their Categories

	Practice	**Percent of organizations responding yes**
	Performing project cash flow analysis	90%
	Preparing financial plan for a project*	67%
	Indicating the required fund , source and the time the fund is required in the financial plan	57%

Basic	Controlling project finance to ensure that money is spent appropriately as planned and with proper authorization*	81%
	Performing financial audit	76%
	Preparing financial reports regularly for a project	71%
	Using computer systems and tools in filing and retrieval of financial information	52%
Intermediate	Considering effects of change in exchange rate, escalation of labor and material cost etc in financial planning	43%
	Preparing expenditure authorization policy and procedure	67%
	Developing a system/procedure for creating and handling financial documents	76%
	Using standardized process and format for financial information recording, storage and reporting	95%

*=PMBOK process

Measure of rating agreement of the financial management practices

	Percent of overall agreement	**Free-marginal kappa**
Research financial management practices	0.40	0.10
PMBOK financial management process	0.40	0.09

5. Quality Management

Quality Management Practices identified by the Research and their Categories

	Practice	**Percent of organizations responding yes**
Basic	Performing quality planning for a project(determining requirements and quality standards and strategies to meet quality objectives)*	48%
	Implementing quality control process (determining whether project products and activities comply with relevant quality standards/plans)*	81%
	Inspecting and controlling quality of subcontractors' work	90%
Intermediate	Defining project's quality requirement	71%
	Preparing and implementing quality management policies, procedures and guidelines	57%
	Preparing project quality monitoring and control plan	62%
	Establishing Quality Assurance activities	57%
	Hiring/Assigning a quality department or employees	24%
	Implementing TQM (Total Quality	29%

	Management)	
	Performing quality audit (reviewing the processes to determine whether project activities comply with organizational and project policies, processes, and procedures and quality requirements)	52%

*=PMBOK process

Measure of rating agreement of the Quality management practices

	Percent of overall agreement	**Free-marginal kappa**
Research quality management practices	0.40	0.10
PMBOK quality management process	0.41	0.12

6. Human Resource (HR) Management

Human Resource (HR) Management Practices identified by the Research and their Categories

	Practice	**Percent of organizations responding yes**
Basic	Planning for acquisition and management of human resource*	100%
	Preparing project staffing plan	86%
	Defining Skill requirement, Roles and Responsibilities	71%

	Tracking Performance of team members regularly and providing feedback*	48%
Intermediate	Defining details in the staffing plan such as desired minimum experience, skill set, when to acquire and when to release project team members from a project	76%
	Preparing project organization chart	90%
	Providing training (formal/informal) to project team members*(develop Project team)	57%
	Tracking and monitoring project human resource cost and time	43%

*=PMBOK process

Measure of rating agreement of the HR management practices

	Percent of overall agreement	**Free-marginal kappa**
Research HR management practices	0.36	0.05
PMBOK HR management process	0.37	0.06

7. Communication Management

Communication Management Practices identified by the Research and their Categories

	Practice	Percent of organizations responding yes
Basic	Identifying project stakeholders and responding to their need*	62%
	Preparing a plan/strategy to address identified communication needs*	38%
	Developing a system for collecting and distributing project information	65%
	Exerting continuous effort to communicate and work with stakeholders to influence their expectation, address their concern and resolve issues*(manage stakeholders expectation)	43%
	Preparing performance reports and providing them to relevant stakeholders*	71%
	Using standard format for report preparation	86%
	Performing Project Communication requirement analysis	24%
	Performing Project stakeholder Management	24%
Intermediate	Developing a strategy for managing each key stakeholder's expectation	14%
	Developing and implementing system/procedure for handling project	86%

	documents	
	Including in reports performance and status of all knowledge areas(scope, time ,cost ,risk, human resource , communication, procurement etc)	62%
Advanced	Performing stakeholders' analysis for a project (analyzing their interest, involvement and impact)	14%
	Preparing stakeholder management plan (devising a strategy on how to handle the stakeholders' needs and expectations)	5%

*=PMBOK process

Measure of rating agreement of the communication management practices

	Percent of overall agreement	**Free-marginal kappa**
Research communication management practices	0.41	0.11
PMBOK communication management process	0.38	0.07

8. Risk Management

Risk Management Practices identified by the Research and their Categories

	Practice	**Percent of organizations responding yes**
Basic	Identifying and documenting project risks*	38%
	Developing risk response strategy (example : avoid, transfer, mitigate, accept)*	19%
	Performing risk monitoring and control (identifying and documenting new risks, closing those outdated and tracking those already identified)*	19%
Intermediate	Using SWOT analysis for risk identification (Strength, weakness, Opportunity and treat analysis)	33%
	Analyzing potential impact of identified risks	33%
	Prioritizing risks based on factors such as impact, probability, urgency etc	24%
	Assigning risk response owner to take responsibility for the management of selected risks	0%
	Allowing contingency budget for potential risk impact	33%
	Allowing contingency time potential risk	52%

	impact	
Advanced	Continuously updating the risk response plan and strategy	10%
	Using risk break down structure (RBS) in the identification or planning of risk	14%
	Estimating the chance of occurrence of risks (for example as low, medium, High)	29%
	Performing Quantitative risk analysis [example : simulation , decision tree analysis etc]*	0%
	Preparing a detailed risk response plan for risks that warrant action/ attention	10%
	Performing risk audit in a project(Examining and documenting the effectiveness of the risk response strategy, and the risk management process)	10%
	Using risk register/log in the risk management process (to document identified risks with their attributes and to track their status while monitoring and control)	0%

*=PMBOK process

Measure of rating agreement of the risk management practices

	Percent of overall agreement	**Free-marginal kappa**
Research risk management practices	0.41	0.12
PMBOK risk management process	0.37	0.06

9. Procurement Management

Procurement Management Practices identified by the Research and their Categories

	Practice	**Percent of organizations responding yes**
Basic	Planning for procurement of goods and services needed for a project*	85%
	Identifying major and/or special supply items	75%
	Developing and using a documented contract management/administration processes	80%
Intermediate	Using preferred supplier/subcontractor or pre qualifying them	80%
	Using standard procurement documents	90%
	Developing and using process for Payment Review, Authorization, and Processing of subcontractors and suppliers work/services	95%
	Monitoring and controlling progress of	90%

	subcontractors and suppliers	
	Hiring/Assigning a staff trained in contract /procurement management	65%
	Developing and using an process /procedure for managing claim	70%
	Developing a contract change management process	30%
	use a defined process for contract closing	70%
Advanced	Hiring/using a staff that is capable and responsible for claim management	65%

*=PMBOK process

Measure of rating agreement of the procurement management practices

	Percent of overall agreement	**Free-marginal kappa**
Research procurement management practices	0.40	0.10
PMBOK procurement management process	0.42	0.13

10. Equipment Management

Equipment Management Practices identified by the Research and their Categories

	Practice	**Percent of organizations responding yes**
Basic	Performing Equipment planning	90%
	Tracking and monitoring performance of the project equipment, their productivity, maintenance cost, time worked etc	52%
	Inspecting equipments regularly for safety	57%
	Performing scheduled preventive maintenance for equipments	71%
Intermediate	Preparing long term (more than 3 month), medium (1 to 3-month) and short-term (weekly and daily) equipment plan	62%
	Developing a procedure for equipment sharing among projects of the organization	67%
	Planning and facilitating equipment sharing	67%
	Performing formal economic and risk analysis in deciding: buy, lease or rent option for equipment acquisition	33%
	Preparing and implement equipment maintenance plan/ policy	81%
	Using computer software in equipment planning, assignment and tracking	24%

Measure of rating agreement of the equipment management practices

	Percent of overall agreement	**Free-marginal kappa**
Research equipment management practices	0.39	0.09
PMBOK equipment management process	-	-

11. Material Management

Material Management Practices identified by the Research and their Categories

	Practice	**Percent of organizations responding yes**
Basic	planning purchase of project materials	89%
	Giving special consideration for Materials requiring long lead-time and critical items during planning and monitoring	61%
	Considering all costs (purchase costs, order cost, holding costs, and unavailability cost) in material planning /management	50%
	Considering risk associated with unavailability and cost increase in material planning	44%
	Monitoring and updating material requirement and availability	72%

Intermediate	Coordinating centrally material purchase of different projects	94%
	Performing material procurement expediting3 formally	72%
	Using a documented process for approval, checking and testing of materials	83%
	Using computer software in material planning, assignment and tracking	28%
	Using preferred material suppliers/or pre qualifying suppliers	83%

Measure of rating agreement of the material management practices

	Percent of overall agreement	**Free-marginal kappa**
Research material management practices	0.37	0.06
PMBOK material management process	-	-

12. Safety Management

Safety Management Practices identified by the Research and their Categories

	Practice	**Percent of organizations responding yes**
	Performing Safety planning*	0%

Basic	Providing Safety training for workers	33%
	Providing Personal Protective Equipment for site employees	62%
Intermediate	Performing safety surveillance and audit (control)	5%
	Hiring or assigning safety management personnel/coordinator	10%
	Performing Hazard Analysis for activities of a project	14%
	Performing Safety control*	14%
	Preparing organizational policies, procedures and guidelines for Safety management	24%
Advanced	Performing Site Neighborhood Safety Characteristics study	10%
	Performing Safety audit	5%
	Preparing project Safety monitoring and control plan	5%

*=PMBOK process

Measure of rating agreement of the safety management practices

	Percent of overall agreement	**Free-marginal kappa**
Research cost management practices	0.34	0.02
PMBOK Cost management process	0.30	-0.05

Appendix-I: Hypothesis Test Result

Comparison of PM Maturity of Contractors

Based on Reference model & Proposed model's process maturity dimension

Input Table

Contractor	Reference model based maturity-Contractors	Proposed process model based maturity-Contractors
A	2.00	1.16
B	1.58	0.18
C	1.50	1.34
D	1.17	0.60
E	1.92	1.33
F	2.42	2.03
G	1.92	0.76
I	2.42	2.45
J	2.50	2.50
K	1.83	0.81
L	1.67	0.82
M	2.50	1.90
N	2.58	2.15
P	2.50	0.90
Q	2.42	1.53
S	2.58	1.97
T	2.33	1.87
W	1.83	0.96
X	1.58	0.80
Y	1.92	0.66
Z	1.25	0.57

SPSS out Put Summary

Correlations			Reference model based maturity-Contractors	Proposed process model based maturity-Contractors
Spearman's rho	Reference model based maturity-Contractors	Correlation Coefficient	1.000	.777**
		Sig. (2-tailed)	.	.000
		N	21	21
	Proposed process model based maturity-Contractors	Correlation Coefficient	.777**	1.000
		Sig. (2-tailed)	.000	.
		N	21	21

****. Correlation is significant at the 0.01 level (2-tailed).**

Comparison of Maturity of PM Knowledge Areas Based on Reference model & proposed model's Process maturity dimension

Input Table

Contractor	Reference model based maturity-knowledge areas	Proposed Process model based maturity-Knowledge Areas
Communication	0.97	2.00
Cost	1.71	2.29
Equipment	1.29	2.00
Financial	1.62	2.10
HR	1.56	2.29
Material	1.90	2.29
Procurement	1.83	2.38
Quality	1.17	2.24
Risk	0.32	1.29
Safety	0.27	1.29
Scope	1.30	1.76
Time	1.63	2.33

SPSS out Put Summary

Correlations			Reference model based maturity-knowledge areas	Proposed process model based maturity-Knowledge Areas
Spearman's rho	Reference model based maturity-knowledge areas	Correlation Coefficient	1.000	.845**
		Sig. (2-tailed)	.	.001
		N	12	12
	Proposed process model based maturity-Knowledge Areas	Correlation Coefficient	.845**	1.000
		Sig. (2-tailed)	.001	.
		N	12	12

**. Correlation is significant at the 0.01 level (2-tailed).

Comparison of PM Maturity of Contractors
Based on Reference model & Proposed model's Practice maturity dimension
Input Table

Contractor	Reference model based maturity-Contractors	Proposed Practice model based maturity-Contractors
A	2.00	1.06
B	1.58	0.18
C	1.50	1.19
D	1.17	0.59
E	1.92	0.97
F	2.42	1.45
G	1.92	0.65
I	2.42	1.31
J	2.50	1.69

K	1.83	0.81
L	1.67	0.63
M	2.50	1.27
N	2.58	1.37
P	2.50	0.81
Q	2.42	1.41
S	2.58	1.35
T	2.33	1.18
W	1.83	0.78
X	1.58	0.92
Y	1.92	0.57
Z	1.25	0.51

SPSS out Put Summary

Correlations			Proposed Practice model based maturity-Contractors	Reference model based maturity-Contractors
Spearman's rho	Proposed Practice model based maturity-Contractors	Correlation Coefficient	1.000	.739**
		Sig. (2-tailed)	.	.000
		N	21	21
	Reference model based maturity-Contractors	Correlation Coefficient	.739**	1.000
		Sig. (2-tailed)	.000	.
		N	21	21

**. Correlation is significant at the 0.01 level (2-tailed).

Comparison of Maturity of PM Knowledge Areas

Based on Reference model & Proposed model's Practice maturity dimension

Input Table

Contractor	Reference model based maturity-knowledge areas	Proposed Practice model based maturity-Knowledge Areas
Communication	0.97	0.76
Cost	1.71	1.13
Equipment	1.29	0.90
Financial	1.62	0.96
HR	1.56	1.19
Material	1.90	0.96
Procurement	1.83	1.28
Quality	1.17	1.04
Risk	0.32	0.32
Safety	0.27	0.32
Scope	1.30	1.24
Time	1.63	1.42

SPSS out Put Summary

Correlations			Proposed Practice model based maturity-Knowledge Areas	Reference model based maturity-Knowledge Areas
Spearman's rho	Proposed Practice model based maturity-Knowledge Areas	Correlation Coefficient	1.000	.762**
		Sig. (2-tailed)	.	.004
		N	12	12
	Reference model based maturity-Knowledge Area	Correlation Coefficient	.762**	1.000
		Sig. (2-tailed)	.004	.
		N	12	12

Correlations			Proposed Practice model based maturity-Knowledge Areas	Reference model based maturity-Knowledge Areas
Spearman's rho	Proposed Practice model based maturity-Knowledge Areas	Correlation Coefficient	1.000	.762**
		Sig. (2-tailed)	.	.004
		N	12	12
	Reference model based maturity-Knowledge Area	Correlation Coefficient	.762**	1.000
		Sig. (2-tailed)	.004	.
		N	12	12

**. Correlation is significant at the 0.01 level (2-tailed).

Proposed Practice model based maturity vs Proposed Process model based maturity of Contractors

Input Table

Contractor	Proposed Process model based maturity-Contractors	Proposed Practice model based maturity-Contractors
A	1.16	1.06
B	0.18	0.18
C	1.34	1.19
D	0.60	0.59
E	1.33	0.97
F	2.03	1.45
G	0.76	0.65
I	2.45	1.31
J	2.50	1.69
K	0.81	0.81
L	0.82	0.63

M	1.90	1.27
N	2.15	1.37
P	0.90	0.81
Q	1.53	1.41
S	1.97	1.35
T	1.87	1.18
W	0.96	0.78
X	0.80	0.92
Y	0.66	0.57
Z	0.57	0.51

SPSS out Put Summary

Correlations			Proposed Practice model based maturity-Contractors	Proposed Process model based maturity-Contractors
Spearman's rho	Proposed Practice model based maturity-Contractors	Correlation Coefficient	1.000	.939**
		Sig. (2-tailed)	.	.000
		N	12	12
	Proposed Process model based maturity-Contractors	Correlation Coefficient	.939**	1.000
		Sig. (2-tailed)	.000	.
		N	12	12

**. Correlation is significant at the 0.01 level (2-tailed).

Test for the Hypothesis that ISO contractors PM process maturity is higher than the NON-ISO's PM process Maturity

Input Table

Contractor	ISO contractors maturity-process	Non-ISO contractors maturity-process

Communication	1.89	2.36
Cost	2.25	1.28
Equipment	2.07	1.24
Financial	1.82	1.40
HR	2.07	1.32
Material	2.02	0.93
Procurement	1.60	0.86
Quality	1.23	1.36
Risk	1.71	0.38
Safety	1.20	0.86
Scope	0.45	0.07
Time	0.27	0.29

SPSS out Put Summary

Correlations			ISO contractors maturity-process	Non-ISO contractors maturity-process
Spearman's rho	ISO contractors maturity-process	Correlation Coefficient	1.000	.575**
		Sig. (1-tailed)	.	.025
		N	12	12
	Non-ISO contractors maturity-process	Correlation Coefficient	.575**	1.000
		Sig. (1-tailed)	.025	.
		N	12	12

. **Correlation is significant at the 0.05 level (1-tailed).

Test for **the Hypothesis that ISO contractors PM practice maturity is higher than the NON-ISO's PM practice Maturity**

Input Table

Contractor	ISO contractors maturity-practice	Non-ISO contractors maturity-practice
Communication	1.20	1.29

Cost	1.39	1.60
Equipment	1.25	0.98
Financial	1.13	0.67
HR	1.24	0.63
Material	1.45	0.93
Procurement	0.88	0.70
Quality	0.39	0.05
Risk	1.43	1.52
Safety	0.92	0.86
Scope	1.16	0.83
Time	0.27	0.38

SPSS out Put Summary

Correlations			ISO contractors maturity-practice	Non-ISO contractors maturity-practice
Spearman's rho	ISO contractors maturity- practice	Correlation Coefficient	1.000	.755**
		Sig. (1-tailed)	.	.002
		N	12	12
	Non-ISO contractors maturity-practice	Correlation Coefficient	.755**	1.000
		Sig. (1-tailed)	.002	.
		N	12	12

****. Correlation is significant at the 0.05 level (1-tailed).**

Test for the Hypothesis that CBP contractors PM process maturity is higher than the NON-CBP contractors PM process Maturity

Input Table

Contractor	CBP contractors maturity-process	Non-CBP contractors maturity-process
Communication	2.06	2.09

Cost	2.15	1.54
Equipment	1.97	1.48
Financial	1.90	1.35
HR	2.00	1.51
Material	2.15	0.91
Procurement	1.64	0.90
Quality	1.30	1.26
Risk	1.40	0.93
Safety	1.26	0.83
Scope	0.43	0.16
Time	0.28	0.28

SPSS out Put Summary

Correlations			CBP contractors maturity-process	Non-CBP contractors maturity-process
Spearman's rho	CBP contractors maturity-process	Correlation Coefficient	1.000	.771**
		Sig. (1-tailed)	.	.002
		N	12	12
	Non-CBP contractors maturity-process	Correlation Coefficient	.771**	1.000
		Sig. (1-tailed)	.002	.
		N	12	12

**. Correlation is significant at the 0.01 level (1-tailed).

Test for **the Hypothesis that CBP contractors PM practice maturity is higher than the NON-CBP contractors PM practice Maturity**

Input Table

Contractor	CBP contractors maturity-practice	Non-CBP contractors maturity-practice

Communication	1.23	1.25
Cost	1.38	1.59
Equipment	1.18	1.10
Financial	1.03	0.85
HR	1.04	0.96
Material	1.43	1.03
Procurement	0.90	0.70
Quality	0.37	0.13
Risk	1.50	1.38
Safety	0.96	0.82
Scope	1.06	1.00
Time	0.27	0.38

SPSS out Put Summary

Correlations			CBP contractors maturity-practice	Non-CBP contractors maturity-practice
Spearman's rho	CBP contractors maturity-practice	Correlation Coefficient	1.000	.646**
		Sig. (1-tailed)	.	.012
		N	12	12
	Non-CBP contractors maturity-practice	Correlation Coefficient	.646**	1.000
		Sig. (1-tailed)	.012	.
		N	12	12

****. Correlation is significant at the 0.05 level (1-tailed). Hence**

Test for the Hypothesis that the Road contractors PM process maturity is higher than the Building contractors PM process Maturity

Input Table

Contractor	Road	Building contractors

	contractors maturity-process	maturity-process
Communication	2.30	1.98
Cost	2.53	1.38
Equipment	2.53	1.22
Financial	2.56	1.44
HR	2.85	1.14
Material	2.05	1.53
Procurement	2.04	0.93
Quality	2.20	1.06
Risk	1.73	0.85
Safety	0.56	1.31
Scope	0.45	0.22
Time	0.30	0.22

SPSS out Put Summary

Correlations			Road contractors maturity-process	Building contractors maturity-process
Spearman's rho	Road contractors maturity-process	Correlation Coefficient	1.000	.593**
		Sig. (1-tailed)	.	.042
		N	12	12
	Building contractors maturity-process	Correlation Coefficient	.593**	1.000
		Sig. (1-tailed)	.042	.
		N	12	12

**. Correlation is significant at the 0.05 level (1-tailed).

Test for **the Hypothesis that Road contractors PM practice maturity is higher than the Building contractors PM practice Maturity**

Input Table

Contractor	Road contractors maturity-practice	Building contractors maturity-practice
Communication	1.45	1.14
Cost	1.83	1.31
Equipment	1.39	1.03
Financial	1.12	0.77
HR	1.45	0.77
Material	1.35	1.19
Procurement	0.57	0.89
Quality	0.40	0.19
Risk	1.33	1.35
Safety	1.24	0.77
Scope	0.88	0.93
Time	0.33	0.22

SPSS out Put Summary

Correlations			CBP contractors maturity-practice	Non-CBP contractors maturity-practice
Spearman's rho	CBP contractors maturity-practice	Correlation Coefficient	1.000	.646**
		Sig. (1-tailed)	.	.012
		N	12	12
	Non-CBP contractors maturity-practice	Correlation Coefficient	.646**	1.000
		Sig. (1-tailed)	.012	.
		N	12	12

****. Correlation is significant at the 0.05 level (1-tailed). Hence**

Analysis of relative importance of knowledge areas

Non Parametric test for rater's agreement on

The relative importance of knowledge Areas

Input data: relative weight assigned by each rater (from analysis of pair wise comparison)

Rater	Scope	Time	Cost	Financial	Quality	Human Resource	Communication	Risk	Procurement	Equipment	Material	Safety
A	0.07	0.09	0.09	0.09	0.05	0.10	0.05	0.05	0.11	0.11	0.11	0.06
B	0.11	0.08	0.08	0.08	0.09	0.08	0.06	0.11	0.07	0.07	0.08	0.07
C	0.12	0.08	0.08	0.08	0.08	0.08	0.07	0.08	0.08	0.08	0.08	0.08
D	0.08	0.11	0.11	0.08	0.09	0.08	0.06	0.07	0.06	0.09	0.08	0.08
E	0.08	0.09	0.09	0.09	0.09	0.08	0.07	0.07	0.08	0.09	0.09	0.07
F	0.07	0.10	0.10	0.10	0.09	0.07	0.07	0.09	0.07	0.08	0.08	0.07
G	0.09	0.09	0.09	0.09	0.07	0.09	0.07	0.07	0.09	0.09	0.09	0.07
H	0.09	0.12	0.12	0.09	0.07	0.06	0.07	0.05	0.10	0.08	0.08	0.06
I	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.07	0.10	0.07	0.07	0.06

SPSS out Put

Descriptive Statistics

	N of raters	Mean weight	Std. Deviation	Minimum weight	Maximum weight
scope	9	.0900	.0175	.0684	.1197
Time	9	.0958	.0144	.0751	.1230
Cost	9	.0972	.0123	.0849	.1230
Financial	9	.0908	.0069	.0809	.1027
Quality	9	.0805	.0153	.0486	.0949
Human Resource	9	.0812	.0097	.0637	.0959
Communication	9	.0664	.0076	.0530	.0774
Risk	9	.0735	.0171	.0516	.1066
equipment	9	.0859	.0156	.0631	.1130
Equipment	9	.0856	.0127	.0689	.1130
Material	9	.0848	.01274	.0682	.1130
Safety	9	.0682	.0088	.0558	.0837

Kendall's W Test

Ranks

	Mean Rank
scope	7.22
Time	8.50
Cost	9.67
Financial	8.78
Quality	6.83
Human Resource	5.83
Communication	2.61
Risk	4.33
equipment	6.94
Equipment	7.22
Material	7.00
Safety	3.06

Test Statistics

N	9
Kendall's W[a]	.382
Chi-square	37.799
df	11
Asymp. Sig.	**.000**

a. Kendall's Coefficient of Concordance

As the significance is less than 0.05 do not reject the null hypothesis (there is no agreement between raters)

Hence the ratings could not be used to the population of practitioners rating of relative importance of the knowledge areas.

Appendix-J: PM Solution Time Management Maturity[49]

Practice Maturity Progression	
Level-1	Schedule is typically limited to independent milestones**. Few or no activities** are defined. Work breakdown structure consists of a **basic set of milestones and occasionally deliverables.** Durations between milestones are rough guesses (crude estimates). Network diagrams with dependencies **do not** usually exist. Changes are unequally managed and, in many cases, not monitored, and seldom involve corrective actions. Usually Ad hoc schedule reports are provided **upon request.**
Level-2	Summary level schedule is prepared. There is access to scheduling methods such as CPM, GERT and PERT. **Summary activities** are defined. The project schedule is at a **detailed level for large, visible projects.** Durations are estimated based on expert knowledge and access to industry methods, commercial databases, and industry standards and factors. Network diagrams exist at a summary level. Schedule baselines are established, but may change frequently. Summary and detailed schedule reports are developed. Concept of a schedule change control system is introduced .process includes items such as a change control form, a change log, and an issues log/form. Schedules are statused and tracked using planned versus actual and milestone percent complete. The organization is capable of simple variance analysis of schedule status. The project office closely monitors and supports the development of schedules, and establishment of project baseline

[49] Summarized from PM Solution's Time Management Maturity description provided in the book…

Level-3	It is the norm to have a project schedule at appropriate levels of detail. Usually A detailed schedule with detailed activities is prepared.. The WBS is always used as the basis for determining project activities. Durations are estimated based on expert knowledge, industry standards, simulation techniques, and several organization specific standards and factors. Historical database is established and used for similar activities. Network diagrams exist at detailed level with discretionary, mandatory, and external dependencies. Baselines are established, adhered to, and managed. Cost and schedule reports are integrated with technical reports. The schedule change control system is integrated with the organization's control systems, monitoring programs, and scope management process. Performance metrics (such as schedule variance and estimates at completion) are monitored and analyzed, and corrective actions are implemented. The schedule change control system, schedule reporting process, and earned value analysis are used. The scheduling process is fully integrated with the project office, strategic planning systems, and scope management process
Process Maturity Progression	
Level-1	There is **no organizational process** (Schedule development is ad hoc).No established practices or standards ad **hoc, informal** fashion .Documentation of the processes is loose and there is no tool commonality in the organization.
Level-2	**There is a basic full, documented, repeatable process** for developing schedules. Processes are not considered an organizational standard. Project management software tools are standard for large, visible project
Level-3	All processes defined and documented. **The processes are considered an organizational standard** and are being **utilized by nearly all of the projects**. Project management software tools are standard for all projects. the schedule management processes are integrated with the project office, finance/accounting, strategic planning systems, and scope management process

Appendix-K: Mapping of Specific Goals and Specific Practices

Table: Mapping of Specific Goals and Specific Practices of knowledge area

	knowledge area	Specific Goal	Specific Practice(process)
1	Project Scope Management	SG1. Define Project Scope	SP1.1 Identify Requirement SP1.2.Define Scope SP1.3 Create WBS
		SG2. Control Project Scope	SP2.1 Verify Scope SP2.2 Control Scope
2	Project Time Management	SG1. Prepare Project Schedule	SP1.1. Define Activity SP1.2. Sequence Activity SP1.3.Estimate Activity Resource SP1.4.Estimate Activity Duration SP1.5.Develop Schedule
		SG2. Control the Project Schedule	SP2.1. Monitor and Control Schedule
3	Project Cost Management	SG1.Estemate Project Cost	SP1.1 Estimate Cost SP2.1 Prepare Budget
		SG2 Control Project Cost	SP2.1. Monitor and Control cost
4	Project Financial Management	SG1: Prepare Financial Plan	SP1.1: Prepare Financial
		SG2: control Finance	SP2.1 Control Finance SP2.2 Perform Financial Administration and Records

	knowledge area	Specific Goal	Specific Practice(process)
5	Project Quality Management	SG1. Plan quality	SP1.1 Plan Quality
		SG2.Assure Quality	SP2.1. Perform Quality Assurance SP2.2 Perform Quality Control
6	Project Human Resource Management	SG1: Plan Human Resource Requirement	SP.1.1 Develop HR plan
		SG2: Acquire and Manage Project Team	SP.2.1: Acquire Project Team SP.2.2: Develop Project Team SP.2.3: Manage Project Team
7	Project Communication Management	SG1.Identify Communication need and Plan	SP1.1 Identify Stakeholders SP 1.2 Plan Communication
		SG2. Provide Information	SP2.1. Distribute Information SP2.2 Manage Stakeholder Expectations: SP2.3 Report Performance
8	Project Risk Management	SG1.Identify Risk	SP1.1 Identify Risk SP1.2 Perform Qualitative Risk Analysis SP1.3 Perform Quantitative Risk Analysis
		SG2.Develope Strategy	SP2.1. Perform Risk Response

	knowledge area	Specific Goal	Specific Practice(process)
			Strategy
		SG3.Monitor and Control Risk	SP3.1. Monitor and Control Risk
9	Project Procurement Management	SG1 Plan Procurement	SP1.1 Plan Procurement
		SG2 Manage /Administer Procurement	SP2.1 Conduct Procurement SP2.2 Administer Contract SP2.2.1 Manage Change SP2.2.2 Control Progress SP2.2.3 Manage Quality SP2.2.4 Manage Claim SP2.3 Close contract
10	Project Equipment management	SG1 Perform Equipment Planning	SP1.1 Plan Acquisition SP1.2 Plan Assignment SP1.3 Plan Replacement & Release
		SG2Administer Equipment	SP2.1 Perform Maintenance SP2.2Track & Monitor Availability of Equipment and Productivity
11	Project Material Management	SG1: Plan material requirement and delivery	SP1.1: Plan Material Requirement and Delivery
		SG2: Manage Material Procurement	SP2.1: Manage Material Procurement
		SG3: Monitor & Control Material use &	SP3.1: Monitor & Control Use and Availability

	knowledge area	Specific Goal	Specific Practice(process)
		availability	
12	Project Safety Management	SG1: Plan Safety	SG1.1: Plan Safety
		SG2 : Assure Safety	SG2.1 : Assure Safety SG2.2 : Control Safety

SG= Specific Goal SP= Specific Practice

Appendix-L: List of Contractors that Participated on the Research

	Name of the company	Telephone	P.O.Box	Email Address
1	Zamra Construction	(+251) 911 43 06 55 (+251) 911 20 22 42 (+251) 911 83 17 50	16255 Addis Ababa Ethiopia	zamcom@ethinet.et
2	Geomluigi Varnero plc	(+251) 115 51 45 11	3118 Addis Ababa Ethiopia	jlvarnero@ethionet.et
3	Blue Nile Construction Sh.co.	(+251) 115 54 03 42 (+251) 115 51 30 00	1182 Addis Ababa Ethiopia	bncsc@ethionet.et
4	Santa Maria Construction P.L.C	(+251) 911 43 50 14 (+251) 116 63 77 63	10704 Addis Ababa Ethiopia	Santamaria.const@ethionet.et
5	N.K.H Construction P.L.C	(+251) 911 83 90 90 (+251) 114 67 30 02 (+251) 114 67 30 03	121963 Addis Ababa Ethiopia	nkhconsbid@ethionet.et
6	Yotek Construction P.L.C	(+251) 113 72 52 18 (+251) 113 72 52 19 (+251) 115 53 44 01	1451 code 1110 Addis Ababa Ethiopia	amaremuye@yahoo.com

7	A.M.B Construction P.L.C	(+251) 911 42 46 69 (+251) 114 42 01 11 (+251) 114 42 01 10	22228 code 100 Addis Ababa Ethiopia	amc_plc1@yahoo.com
8	Flintstone Engineering	(+251) 114 66 36 29 (+251) 114 66 36 31	559 Code 1110 Addis Ababa Ethiopia	flintstone@ethionet.et
9	Kabew Construction plc	(+251) 911 65 82 05	11403 Addis Ababa Ethiopia	kabewgbe@ethionet.et http://kabewconstruction.com/contact.html
10	Akir Construction P.L.C	(+251) 911 13 16 26 (+251) 114 42 04 01	13456 Addis Ababa Ethiopia	akirone@ethionet.et
11	Sunshine Construction P.L.C	(+251) 115 51 32 89	107 Addis Ababa Ethiopia	sunshinerealestate@telecom.net.et

12	Norincon Lalibela Engineering & Construction Share Company	(+251) 911 19 13 04 (+251) 911 18 31 88	4690 Addis Ababa Ethiopia	www.nori-la.com.et
13	Nasew Construction P.L.C.	(+251) 911 75 29 05 (+251) 114 42 54 90	8826 Addis Ababa Ethiopia	naco@ethionet.et
14	Sur Construction P.L.C	(+251) 113 73 66 30 (+251) 911 24 26 66	34360 Addis Ababa Ethiopia	sur@ethionet.et
15	Magercon P.L.C	(+251) 911 36 73 34 (+251) 116 62 67 91	5220 Addis Ababa Ethiopia	magercon@hotmail.com
16	Afro Tsioon Construction P.L.C.	(+251) 115 52 78 69 (+251) 911 20 92 52	7808 Addis Ababa Ethiopia	info@afrotsionconstruction.com sd.b.c@ethionet.et
17	Yencomad Inc PLC	(+251) 115 53 37 66	9517 Addis Ababa Ethiopia	shimekittuji@yahoo.com
18	Macro General Contractor & Trading P.L.C	(+251) 911 20 28 14 (+251) 116 63 41 44	122479 Addis Ababa Ethiopia	macro@ethionet.et

19	Awash Construction Share Company	(+251) 114 40 44 02	2193 Addis Ababa Ethiopia	Not available
20	Defence Construction & Engineering Enterprise	(+251) 911 69 70 59	Not Available	habt12@yahoo.com
21	Midroc Constructio P.L.C.	(+251) 911 23 24 35 (+251) 115 51 08 99	16960 Addis Ababa Ethiopia	midroc.conet@ethionet.et
22	Demere Engineering & Construction	(+251) 911 47 71 80	25781 Addis Ababa Ethiopia	decon@ethionet.et
23	Bereket Endashaw w/Hana	(+251) 114 65 43 74 (+251) 911 38 03 19	22661 Code 1000 Addis Ababa Ethiopia	Not available
24	AB Construction	(+251) 911 40 38 50 (+251) 115 50 46 96	31826 Addis Ababa Ethiopia	abcon@ethionet.et
25	Grace Engineering	(+251) 911 43 04 05 (+251) 116 29 41 89	90181 Addis Ababa Ethiopia	graceng@ethionet.et
26	Mela Engineering & Construction P.L.C.	(+251) 911 19 23 44	7021 Addis Ababa Ethiopia	m1mic@ethionet.et

Bibliography

Abbasi, H. Y., & Al-Mharmah, H. (2000, April). Project management practice by the public sector in a developing country. *International Journal of Project Management, 18*(2), 105-109.

Adams, O. (1997). Contractor development in Nigeria: Perceptions of contractors and professionals. *Journal of Construction Management and Economics, 15*(1), 95-108.

Ahern, D. M., Clouse, A., & Turner, R. (2008). *CMMI distilled: A practical introduction to integrated process improvement* (3rd ed.). Upper Saddle River, NJ: Addison-Wesley Professional.

Ahuja, R. (2001). *Research Methods* . New Delhi : Rawat Publications .

Alutu, O. E., & Udhawuve, M. L. (2009, January). Unethical practices in Nigerian engineering industries: Complications for project management. *Journal of Management in Engineering, 25*(1), 40-43.

Andersen, S. W. (2008). Can project management support poverty reduction in Africa. *PMI Global Congress 2008 Proceedings* . (R. Akiri, Ed.) Project Management Institute (PMI).

Bennett, F. L. (2003). *The management of construction : A project life cycle approch.* Burlington, MA: Butterworth- Heinemann.

Bourne, L. M. (2008, May 19-21). SRMM : Stakeholder relationship maturity model. *PMI Global Congress 2008.* St. Julians: Retrieved March17,2010 ,from http://www.stakeholdermapping.com/PDFs/SRMM_Paper.pdf.

Bruin, T. d., Rosemann, M., Freeze, R., & Kulkarnil, U. (2005). Understanding the main phases of developing a maturity assessment model. *Australasian(ACIS) 2005 Proceedings.* Sydney: Association for Information systems, Retrieved April 17, 2010, from http://www.followscience.com/library_uploads/ceba558bded879ccc0b45cd2c657e870/123/understanding_the_main_phases_of_developing_a_maturity_assessment_model.pdf.

Carmichael, D. G. (2004). *Project management framework.* Lisse: Swets & Zeitlinger B.V.

Chartered Institute of Building . (2002). *Code of practice for project management for construction and development* (3 rd ed.). Blackwell Publishing.

Chen, P., Partington, D., & Qiang, a. M. (2009, June). Cross-cultural understanding of construction project managers' conceptions of their work. *Journal of Construction Engineering and Management, 135*(6), 477-487.

Chmieliauskas, A. (n.d.). *Implementing strategy through project management*. Retrieved 09 15, 2009, from ZTI Institut web site: http://www.zti.com.pl/instytut/pp/referaty/ref20_full.html

Chrissis, M. B., Konrad, M., & Shrum, S. (2003). *CMMI: Guidelines for process integration and product improvement.* Addison Wesley.

Cleland, D. I., & Ireland, L. R. (2002). *Project management strategic design and implementation* (4th ed.). The McGraw-Hill Comapnies.

Cooke-Davies, T. J. (2005). Measurement of organizational maturity:What are the relevant questions about maturity and metrics for a project-based organization to ask, and what do these imply for project management research? In P. M. (PMI), D. P. Slevin, D. I. Cleland, & J. K. Pinto (Eds.), *Innovations: Project management research 2004* (pp. 1-13). Project Management Institute (PMI).

Crawford, J. K. (2002). *Project management maturity model :Providing a proven path to project management excellence.* Basel, Switzerland: Marcel Dekke.

Cusworth, J. W., & Franks, T. R. (Eds.). (1993). *Managing projects in developing countries.* Longman Publishing Group.

Dessa, A. (2003). *Claims in Ethiopian construction industry.* MS Thesis, Addis Ababa University, School of Graduate Studies, Addis Ababa.

Dlungwana, W., & Rwelamila, P. (2004). Contractor development models that meet the challenges of globalization- A case for developing management capability of local contractors . *Proceedings of Sustainable Building*, (pp. 13-18). Stellenbosch,South Africa.

Dowdy, S., Wearden, S., & Chilko, D. (2004). *Statistics for Research* (3rd ed.). Hoboken, NJ: John Wiley & Sons, Inc.

Fewings, P. (2005). *Construction project management: An integrated approch* (Third ed.). New York, NY: Taylor & Francis Group.

Finnemore, M., Sarshar, M., & Haigh, R. (2000). *Case studies in construction process Improvement.* Research report , University of Salford, SPICE Project Research Centre for the Built and Human Environment, Salford ,UK.

Gessesse, A. (2009). *Risk management and responsibility allocation of large EPC turnkey construction projects in Ethiopia.* Addis Ababa University , School of graduate studies.

Guangshe, J., Jiangua, C. L., Shuisen, Z., & Jun, W. (2008). Application of Organizational Project Management Maturity Model (OPM3) to construction in China: An Empirical study. *International Conference on Information Management, Innovation Management and Industrial Engineering, 2008. ICIII '08*, (pp. 56-62). Taipei.

Hendrickson, C. (n.d.). *Project Management for Construction*. Retrieved 03 17, 2010, from The Project Management Hut web site: http://www.pmhut.com/project-management-for-construction

Idoko, L. A. (2008). Developing local capacity for project management - Key to social and business transformation in developing countries. *PMI Global Congress 2008*. Project Management Institute.

Jekale, W. (2004). *Performance for public construction projects in developing countries:Federal road and educational building projects in Ethiopia.* Norwegian University of Science & Technology.

Jugdev, K., & Thomas, J. (2002, December). Project management maturity models: The silver bullets of competitive advantage. *Project Management Journal*, 4-14.

Kawak, Young Hoon. (1997). *A systematic approch to evaluate quantitative impact of PM.* PhD Dissertation, University of California, Civil Engineering Department, Berkelely.

Kaya, Y., & Iyigun, I. (2001). Case Study: Assessment of R&D project management maturity and improvement in project management process. *Management of Engineering and Technology, 2001. PICMET '01*, *1*, pp. 416-417. Portland,OR.

Kerzner, H. (2001). *Strategic planning for project management using a project management maturity model.* John Wiley & Sons, Inc.

Konrad, M., Young, R., & Hayes, W. (2009, February 10). *CMMI version 1.3 product suite:what may change.* Retrieved September 12, 2009, from http://www.sei.cmu.edu/library/assets/20090210webinar.pdf

Kululanga, G. K., Kuotcha, W., McCaffer, R., & Edum-Fotwe, F. (2001). Construction contractors' claim process framework. *Journal Of Construction Engineering and Management*, 309-314.

Kuruoglu, M., & E.Ergen. (n.d.). *The effect of economic development on project management in developing countries.* Retrieved 10 13, 2009, from Istanbul Technical University web site: www.ins.itu.edu.tr/MURKUR/documam/pdf/THE/%EFFECTS%20OF%20ECONOMIC%20DEVELOPMENT%20ON%20ON%20PROJECT%20mANAGEMENT%20IN%20DEVELOPING%20COUNTRIES

Kwak, Y. H., & Ibbs, C. W. (2002, July). Project management process maturity- PM2 model. *Journal of Management in Engineering*, 150-155.

Long, N. D., Ogunlana, S., Quang, T., & Lam, K. C. (2004). Large construction projects in developing coutries : A case study from Vietnam. *International Journal of Project Management*, 553-561.

Malan, A., Pretorius, L., & Pretorius, J. (2007). A frame work for increasing project maturity and capability in South Africa. *Management of Engineering and Technology* (pp. 2212 - 2224). Portland ,OR: Portland International Center for Management of Engineering and Technology.

Man, T. (2007, September 21). *A frame work for comparision of maturity models for project-based management.* Utrecht University. Utrecht University.

Ministry of Finance and Economic Development (MoFED). (2006, January). *Ethiopia: Status report on the Brussels pogramme of action (BPoA) for least developed countries (LDCs).* Retrieved August 28, 2009, from http://www.un.org/special-rep/ohrlls/ldc/MTR/Ethiopia.pdf

Ministry of Finance and Economic Development (MoFED). (2008, December). *Annual report on macroeconomic developments: EFY 2000(2007/2008).* Retrieved August 28, 2009, from http://www.mofed.gov.et/Uploaded/document/Reports/Microdev/MEDR_EFY2000_Annual.pdf

Mullay, M. (2006, August). Longitudinal analysis of project management maturity. *Project Management Journal*, 62-73.

Muriithi, N., & Crawford, L. (2003). Approaches to project management in Africa: Implications for international development projects. *International Journal of Project Management, 21*, 309-319.

Nguyen, N. M. (2007). The Challenges of transferring modern project management principles and methodologies to developing countries. *Proceedings 2007 PMI Global Congress.* Hong Kong: PMI.

Norby, M., Smith, E., & Smith, R. (2004). *Guide to the Contract Management Body Of Knowledge (CMBOK)* (2nd Edition ed.). National Contract Management Association.

Office of Government Commerce (OGC). (n.d.). Portfolio, programme and project management maturity model,P3M3 public consultation document draft v 2.0. Retrieved March 03, 2009, from http://www.ogc.gov.uk/documents/p3m3.pdf

Ofori, G. (2006). Construction in developing countries: A research agenda. *Journal of Construction in Developing Countries*.

Pant, D. P., Allinson, C. W., & Hayes, J. (1996, February). Transferring the western model of project organisation to a bureaucratic culture: The case of Nepal. *International Journal of Project Management, 14*(1), 53-57.

Paulk, M. C., Curtis, B., Chrissis, M. B., & Weber, C. V. (1993). *The capability maturity model for software, version1.1.* Technical Report, Carnegie Mellon University, Software Engineering Institute, Pittsburgh.

PM Solutions. (2008). Advancing organizational project management maturity. Retrieved April 12, 2009, from PM Solutions website: http://www.pmsolutions.com/collateral/uploads/pdfs/White%20Paper_Advancing%20PM%20Maturity.pdf

Project Management Institute (PMI). (2003, December 31). *Organizational project management maturity model(OPM3) knowledge foundation.* Newtown Square: Project Management Institute (PMI).

Project Management Institute (PMI). (2004). *A guide to the project management body of knowledge (PMBOK® Guide)* (3rd ed.). Newtown Square, PA, USA: Project Management Institute(PMI).

Project Management Institute (PMI). (2007). *Construction extension: To the PMBOK guide third edition* (2nd ed.). Newtown Square, PA: Project Management Institute(PMI).

Project Management Institute (PMI). (n.d.). *An excutive's guide to OPM3.* Retrieved March 17, 2010, from http://opmexperts.com/OPM3ExecGuide.pdf

S.Pennypacker, J., & P.Grant, k. (2003). Project management maturity: An industry benchmark. *Project Management Journal, 34*(1), 4-11.

Saiedia, H., & Kuzara, R. (1995, January). SEI capability maturity model's impact on contractors. *Computer, 28*(1), 16-26.

Sarshar, M., Finnemore, M., Haigh, R., & Goulding, J. (1999). SPICE: Is a capability maturity model applicable in the construction industry? In M. Lacasse, & D. Vanier (Ed.), *Proceedings of the 8th International Conference on Durability of Building Materials and Components(CIB W78)* (pp. 2836-2843). Ottawa: Institute for Research in Construction.

Sarshar, M., Haigh, R., Finnemore, M., Aouad, G., Barrett, P., Baldry, D., et al. (2000). SPICE: a business process diagnostics tool for construction projects. *Engineering ,Construction and Architectural Management, 7*(3), 241-250.

Skulmoski, G. (2001, June). Project maturity and competence interface. *Cost Engineering, 43*(6), 11-18.

Sonuga, F., Aliboh, O., & Oloke, D. (2002, November). Particular barriers and issues associated with projects in a developing and emerging economy: Case study of some abandoned water and irrigation projects in Nigeria. *International Journal of Project Management, 20*(8), 611-616.

Stanleigh, M. (2007, 30 August). *Process management vs project management.* Retrieved 03 17, 2010, from Improvment and innovation.com: http://www.improvementandinnovation.com/features/articles/process-management-vs-project-management

Sukhoo, A., Barnard, A., Eloff, M. M., & Poll, J. A. (2005). An assessment of software project management maturity in Mauritius. *Issues in Informing Science and Information Technology, 2*, 671-690.

Supic, H. (2005). Project management maturity of selected organizations in Croatia. *Proceedings of the 8th International Conference on Telecommunications ConTEL 2005*, *2*, pp. 647-653. Zagreb.

Torp, O., Austeng, K., & Jekale, W. (n.d.). Critical sucess factors for project performance: A study from fron-end assessment of large public projects in Norway.

Voropajev, V. I. (1998). Project management development for transitional economies(Russian case study). *International Journal of Project Management, 16*(5), 283-292.

Wang, S. Q., Dulaimi, M. F., & Aguria, M. Y. (2004). Risk management framework for construction projects in developing countries. *Journal of Construction Management and Economics*, 237-252.

Wheatley, M. (n.d.). *The importance of project management:New research into the role of project management in a modern developed economy like the UK*. Retrieved March 17, 2010, from Project Smart. co.uk: http://www.projectsmart.co.uk/the-importance-of-project-management.html

Wysocki, R. K. (2004). *Project management process improvement.* Boston: Artech House, Inc.