

**KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,
KUMASI
COLLEGE OF ARCHITECTURE AND PLANNING
DEPARTMENT OF BUILDING TECHNOLOGY**

**COMPETENCY-BASED EVALUATION OF PROJECT MANAGERS’
PERFORMANCE IN MASS HOUSE BUILDING PROJECTS IN
GHANA – THE FUZZY SET THEORY APPROACH**

BY

OSMAN ABDUL MANAAN (BSc. Hons)

**A Thesis submitted to the Department of Building Technology, College
of Architecture and Planning, in partial fulfillment of the requirement
for the**

award of

Master of Science (MSc) in Construction Management

NOVEMBER, 2013

DECLARATION

I hereby declare that this submission is my own work towards the MSc. and that, to the best of my knowledge, it contains no material previously published by another person or material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

Osman Abdul Manaan

(PG 5402411)

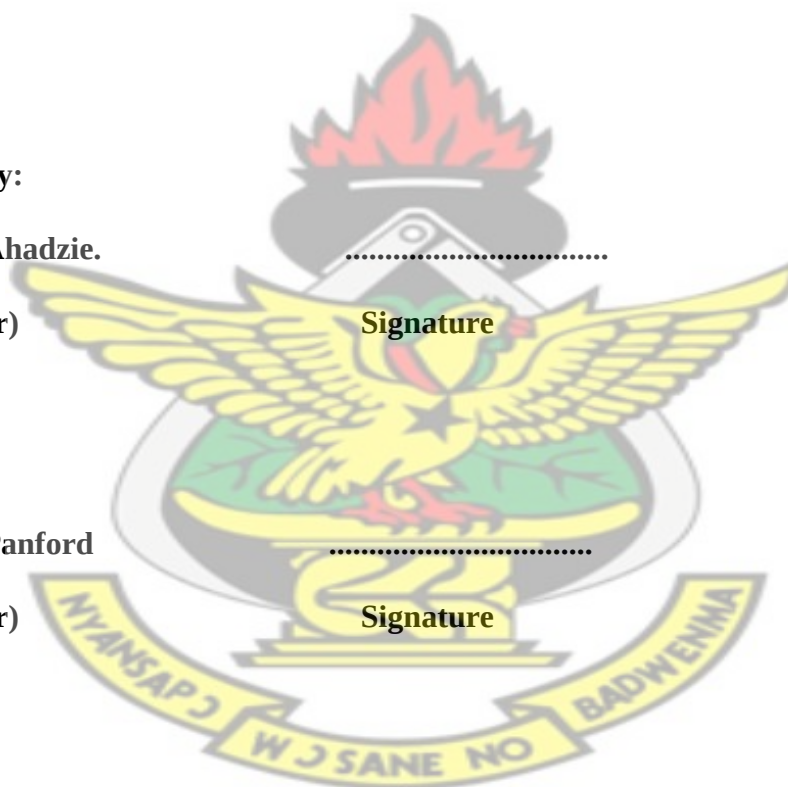
.....
Signature

.....
Date

Certified by:

Dr. D. K. Ahadzie.

(Supervisor)



.....
Signature

.....
Date

Mr. J. K. Panford

(Supervisor)

.....
Signature

.....
Date

Certified by:

Prof. J. Ayarkwa

(Head of Department)

.....
Signature

.....
Date

ABSTRACT

The fundamental concept on which project management is based is that a single individual-the project manager- is accountable for the success of the project. This involves project managers (PM) possessing a variety of skills relating to the standard objectives of project completion within a set specification, under time, cost and quality constraints. Admittedly, projects may fail due to external factors that are beyond the control of the project manager, however the competence of the project manager, "constitute a critical parameter among the many variables that directly affect the outcome of the project".

Furthermore, PM competencies have been identified to be project specific and the relative importance of success criteria differs significantly over the various phases of the project lifecycle. Subsequently, seven (7) key competency profiles have been developed for the management of mass house building projects in a previous study. However, there is no empirical understanding of how these competencies are being used in practice towards entrenching the reliability and validity of the seven (7) core competencies, especially where human decisions are involved.

Therefore, the main aim of this study is to establish a method for evaluating the performance of a PM in mass house building projects based on the seven (7) core competencies as defined by senior managers. Subsequently, a structured interview was conducted to elicit the views of senior managers regarding the antecedents or measure indicators (MIs) to the seven (7) key competency factors (KCFs) required in mass house building projects (MHBPs). Due to ill-defined and ambiguous nature of the competencies required in MHBPs, appropriate qualitative and linguistic terms were developed for senior managers to rate the performance of their PM handling a current project. The data

was taken through fuzzy arithmetic and results showed that the level of performance of the PM in the eyes of senior managers was average.

The study confirmed an earlier finding that the performance of PMs in Ghana is average.

Industrial contributions of the study involve developing a model that provides insight in to and sub-themes to the seven (7) key competencies that engender superior performance in MHBPs. The fuzzy technique used in this research has proven to be a useful tool for evaluation of competencies, which are quite difficult to measure and quantify in our present situation and with the existing tools in the construction industry if any.



ACKNOWLEDGEMENT

All thanks and praises be to Allah, Lord of the worlds and may His peace and blessings be on those whose love causes the love of Allah on the beloved. My sincerest thanks go to my supervisor, Dr. D. K. Ahadzie, a Senior Research Fellow at the Center for Settlement Studies, College of Architecture and Planning, for his constant guidance and encouragement during the entire period of writing this dissertation. You have been a great source of inspiration to me. God bless you.

To Mr. J. K. Panford of the Department of Computer Science, I say a big thank you for the support and invaluable input you have made as a co-supervisor to this dissertation. Your co-operative spirit and constant guidance saw me through the complicated Fuzzy set theory. God bless you.

I also wish to thank my Uncle, Dr. Tanimu Osman of Associated Beaver Consult for his constant will and support in seeing me through my entire educational life. I know I can not quantify my indebtedness to you. May Allah shower His mercy and blessings on you and your family.

I am grateful to my landlord Br. Baba, and his wife Ameriya, Abdulai Sulemana, and Umar Mohammed for hosting me throughout my stay in Kumasi. May Allah bless you all.

I also wish to thank the staff of Regimanuel Grey Estate limited for their co-operation.

Finally, I wish to thank Prof. J. Ayarkwa and the entire staff of the Department of Building Technology, KNUST.

DEDICATION

This work is dedicated to my entire family, especially the memory of my late mother

Hassana Ali

KNUST



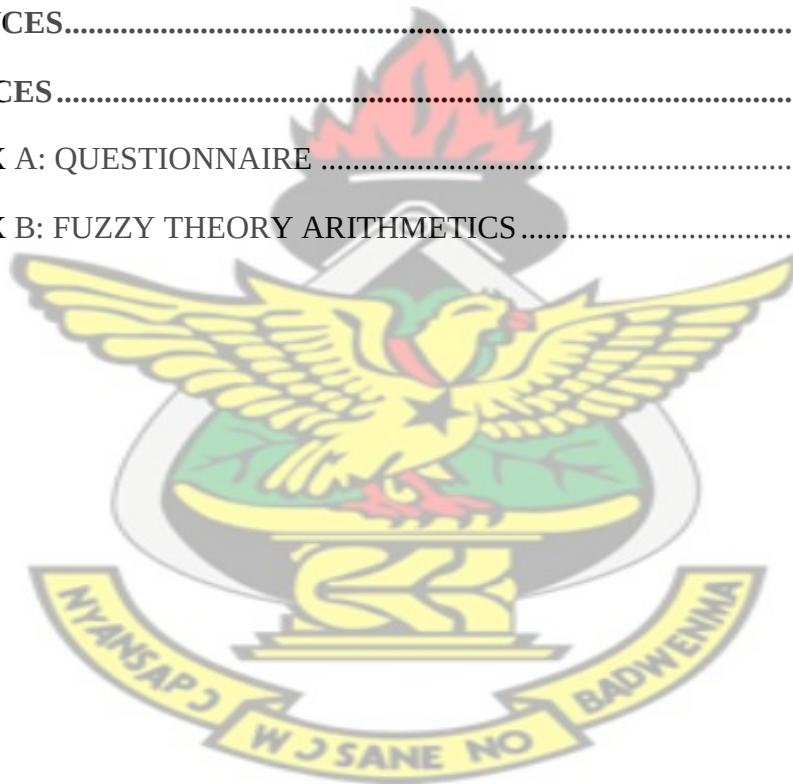
TABLE OF CONTENTS

DECLARATION	ii
ABSTRACT.....	iii
ACKNOWLEDGEMENT.....	v
DEDICATION	vi
TABLE OF CONTENTS	vii
LIST OF TABLES	xi
LIST OF FIGURES	xii
CHAPTER ONE	1
GENERAL INTRODUCTION.....	1
1.0 Introduction to the Study	1
1.1 Problem Statement	4
1.2 Research Questions.....	5
1.3 Significance of Study	6
1.4 Aim of Research	6
1.6 Scope of Study	7
1.8 Findings and Benefits	7
1.9 Organisation of chapters	8
CHAPTER TWO.....	9
LITERATURE REVIEW	9
2.0 Introduction.....	9
2.1 Emergence of Competencies.....	10
2.2 Towards a Definition of Competency	10
2.2.1 Individuals' Perspective on Competency.....	12
2.2.2 Organizational Perspective on Competency	12
2.2.3 Approaches to Competencies.....	13
2.3 Why Competency-Based Employee Evaluation?	16

2.3.1	Project Management Competence	18
2.3.2	Project Manager Competency Development Framework (PMCD).....	19
2.3.2.1	Background, Concept and Overview	19
2.3.2.2	Structure of the PMCD	20
2.3.3	AIPM Professional Competency Standard	21
2.3.3.1	Background, Concept and Overview	21
2.3.3.2	Structure of the AIPM Competency Standard	22
2.3.3.3	Certification and Assessment of Project Manager.....	23
2.3.4	IPMA Competence Baseline 3.0.....	24
2.3.4.1	Background, Concept and Overview	24
2.3.4.2	Structure of the IPMA Competence Baseline 3.0	24
2.3.4.3	Certification and Assessment of PM.....	25
2.3.5	APM Competence Framework	26
2.3.5.1	Background, Concept and Overview	26
2.3.5.2	Structure of the APM Competence Framework.....	26
2.3.5.3	Certification and Assessment.....	27
2.3.6	Comparing and Critiquing the Standards.....	27
2.3.6.1	PMs Certification Level.....	27
2.3.6.2	Competencies required for different Project Phases	28
2.3.6.3	Basic Competencies in each Standard	28
2.3.7	Towards Competencies of Construction Project Managers.....	30
2.3.7.1	What is Mass House Building Projects (MHBPs)?	31
2.3.7.1	PMs Competencies Required in MHBPs	31
2.3.7.2	Practical Applications of Competencies in MHBPs	34
2.3.8	Evaluation of Competencies of PMs in MHBPs.....	35
2.3.8.1	Elementary Matching.....	36
2.3.8.2	Absolute Rating Scales	36

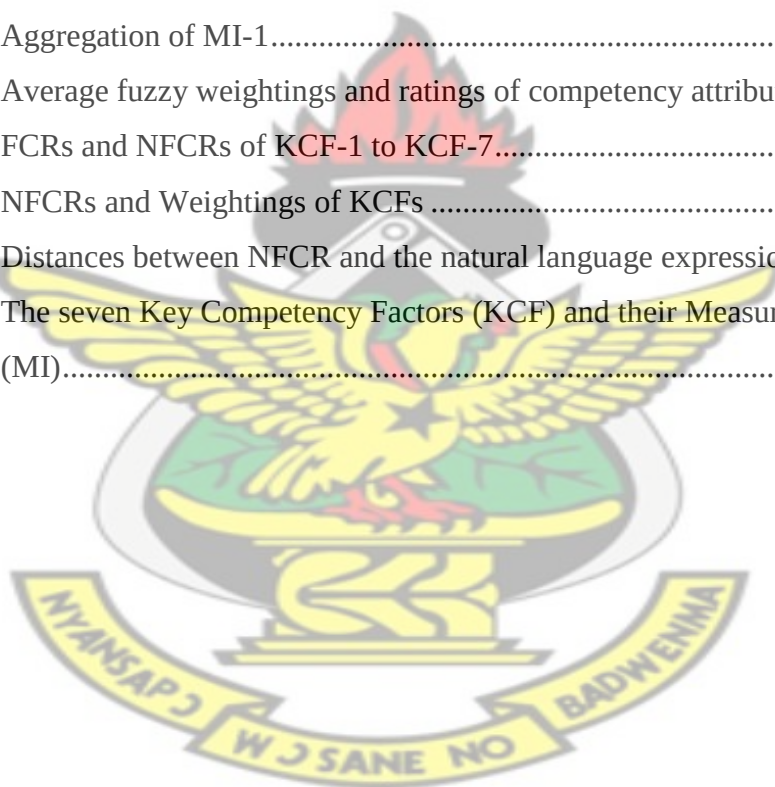
2.3.8.3	Forced-distribution Rating Scales.....	37
2.3.8.4	Analytic Hierarchy Process (AHP) and Fuzzy Approach.....	38
CHAPTER THREE.....		41
METHODOLOGY/RESEARCH DESIGN.....		41
3.0	Introduction.....	41
3.1	Theoretical Framework.....	41
3.2	Case Study	43
3.3	Data Collection	44
3.3.1	Interview process	44
3.3.2	Questionnaire Development.....	44
3.4	Fuzzy Set.....	45
3.5	Evaluation Process	45
3.6	Summary	49
CHAPTER FOUR.....		50
DATA ANALYSIS, RESULTS AND DISCUSSION		50
4.0	Introduction.....	50
4.1	The Project Manager (PM) Under Assessment.....	50
4.2	Evaluation and Decision Making Process.....	51
4.2.1	Assessing the Weightings and the Ratings	51
4.2.2	Aggregating the Opinions of the Assessors	54
4.2.3	Calculating the Fuzzy Competency Rating (FCR) and Normalized Fuzzy Competency Rating (NFCR) for the KCFs.....	57
4.2.4	Calculating the FCR and NFCR of the PMs Total Competency level	59
4.2.5	Matching the NFCR to linguistic terms	60
4.3	Discussion of competency levels	61
4.3.1	NFCR-0 - The Overall Competency of the Project Manager	62
4.4	Summary	64

CHAPTER FIVE	65
CONCLUSIONS AND RECOMMENDATIONS	65
5.0 Introduction.....	65
5.1 Review of Objective 1	65
5.2 Review of Objective Two	68
5.3 Review of Objective Three	68
5.4 Potential uses of the framework.....	68
5.4 Conclusion	69
5.4 Recommendation	69
REFERENCES.....	71
APPENDICES	76
APPENDIX A: QUESTIONNAIRE	76
APPENDIX B: FUZZY THEORY ARITHMETICS	84



LIST OF TABLES

Table 2.1:	Typologies of meaning and purpose of “Competency”	11
Table 2.2:	Differences in definition of competencies: the UK versus the US approach.....	15
Table 2.3	Some common definitions of competency found in the literature.....	16
Table 2.4:	Illustrating Absolute Rating Scales in Competency Assessment	36
Table 3.1	Likert Scale for Weighting and Rating the PM and their Corresponding Fuzzy Numbers.....	43
Table 3.2:	Natural language expression set and their corresponding Fuzzy Numbers..	49
Table 4.1:	Assessing the Weightings and Ratings on KCFs and MIs	52
Table 4.2:	Assessment of PM with respect to KCF-1 and MI-1 to MI-4 by senior managers.....	54
Table 4.3:	Aggregation of MI-1.....	55
Table 4.4:	Average fuzzy weightings and ratings of competency attributes	56
Table 4.5:	FCRs and NFCRs of KCF-1 to KCF-7.....	58
Table 4.6:	NFCRs and Weightings of KCFs	59
Table 4.7:	Distances between NFCR and the natural language expression set	61
Table 5.1:	The seven Key Competency Factors (KCF) and their Measure Indicators (MI).....	66



LIST OF FIGURES

Figure 2.1	Competency-based model for the project lifecycle	33
Figure 2.2:	Graphical analysis of competence (adapted from Chen 2009).....	37
Figure 3.1:	Project Manager Competency Assessment and Decision Making Framework	46
Figure 4.1:	Graph of NFCR-0 (in red) superimposed on Membership function plots....	63



CHAPTER ONE

GENERAL INTRODUCTION

1.0 Introduction to the Study

The fundamental concept on which project management is based is that a single individual -the project manager- is accountable for the success of the project (Goodwin 1993). This involves project managers (PM) possessing a variety of skills relating to the standard objectives of project completion within a set specification, under time, cost and quality constraints (Lei and Skitmore, 2004). Admittedly, projects may fail due to external factors that are beyond the control of the project manager, however the competence of the project manager "constitute a critical parameter among the many variables that directly affect the outcome of the project" (Goodwin 1993pp 217).

To this end, two significant streams of project management competencies have been identified in the literature;

- a) Competence standards developed and periodically revised by a number of national and international project management organisations (Global Performance Based Standards for Project Management, 2003 cited in (Brill et al. 2006)) and
- b) Reports on empirical studies in to project management competencies which usually relate to a specific discipline and are diverse in focus. (Crawford 2004)

Examples of the first stream include; "APM Competence Framework" by the Association of Project Management in 2008, "AIPM Professional Competency standards for Project Management developed by the Australian Institute of Project Management also in 2008," "IPMA Competence Baseline Version 3.0" by International Project Management Association in 2006 and "Project Manager Competency Framework" by the Project Management Institute in 2002. (G. Omidvar et al 2011).

Having recognised the efforts of these bodies in the development of standards for project management knowledge and practice, (Crawford 2004) criticized them for being largely qualitative and drawn from the collective opinions of experienced practitioners as to the knowledge and practices that a PM must possess in order to be considered competent. Further Crawford,(2004) questioned the assumption that acts as the ‘spring board’ for the development of these standards; that those who satisfy the requirements of these standards will perform effectively or at least perceived to be effective performers than those whose performance are at variance to the requirements of these standards. Indeed, data from (Crawford 2004) research indicates that senior management’s perception of PMs competence is different from what these project management bodies promulgate as competence that engenders superior performance .

Further ,Omidvar et al (2011) admitted that ,these competence frameworks provide the basis for transportability of project management competences across different industries and organisations from different countries, however they criticized them for failing to consider factors such as project size, complexity, nature and organisational specific needs.

Other researchers such as Morris (2001) also outlined some shortfalls of these competence standards, noting that, the existence of different Knowledge Guides-which serve as the basis for these competence frameworks for the various PM bodies-“ implies confusion at the highest level on what the content and the philosophy of the profession is”(Morris 2001pp 22).

Morris, (2001) therefore recommended that one begins with a clean sheet and by empirical techniques discover competence requirements of PMs.

In line with Morris's recommendation of a clean sheet, (Brill et al. 2006) using a web-based delphi technique investigated competencies required by PMs in instructional design. (Crawford 2004) on her part, looked in to senior managers' perceptions of competencies required by project managers, whilst (Ahadzie et al. 2009) investigated the competencies required by PMs in mass house building projects in Ghana. (Fraser, C., & Zarkada-fraser 2003) investigated effectiveness of project managers by stakeholder perceptions. (Lei and Skitmore, 2004) in a survey in South East Queensland investigated the most important project management skills and any additional skills that a PM must possess in the twenty-first century.

From the forgoing, the difficulty in evaluating project manager's performance is not just in identifying the competencies suitable for performance evaluation but also in determining the relationship between these variables (Poveda & Fayek 2009), the uniqueness of the project in involve (Ahadzie et al. 2008), the perception of those responsible for the evaluation vis-à-vis the criteria outlined (Crawford 2004) and the subject in question- the PM- (Fraser, C., & Zarkada-fraser 2003).

It seems plausible therefore to adopt the findings of (Ahadzie et al 2009a) for;

- being competency-based, which resonates well with current trends in the human resource management process and construction management genre (Dainty et al. 2003),
- concentrating on MHBPs which differ significantly from the usual off-the -cuff projects usually encountered in construction,
- The fact that, competencies discovered by Ahadzie et al (2009a) are those perceived by top management who are responsible for decision making in the organisation.

Therefore having recognized the suitability of the findings of Ahadzie et al.(2009a) for this research, it implies a cursory look in to the findings is worthwhile.

According to (Ahadzie et al. 2009a) seven critical competencies that senior managers expect PMs to have in mass housing projects are:

- Site layout techniques for repetitive construction works
- Appropriate technology transfer for repetitive construction works
- Dedication in helping works contractors and /or artisans achieve works schedule
- Effective time management practices on house units
- Ability to provide solutions to conflicts while maintaining good relationships
- Ease of approachability of the PM by works contractors
- Volunteering to help work contractors and/or artisans to solve personal problems

They contend that these findings could be further developed for continuing professional development, a check list for senior managers to ascertain and predict the performance of prospective PMs in their organisations and a tool for practicing PMs to align themselves to in their efforts to be effective PMs.

However, there is no empirical understanding of the usage of these competencies in practice. Besides, the seven (7) competence criteria outlined above are at best vague and imprecise. Therefore any method employed in the assessment of any PM should accommodate the multiplicity of meanings and vagueness of these competencies.

1.1 Problem Statement

Ahadzie et al,(2009a), proposed that these seven (7) key competency factors could be used

- as a checklist for competency based interviewing (CBI) and recruitment,

- for deployment of PM and job matching,
- for curriculum development etc

However, since the development of the competencies by Ahadzie et al,(2009a), there is no empirical evidence to suggest that the findings are being used in practice. Besides, for PM deployment and succession planning, there is the need to evaluate the performance of the potential candidate with respect to the Competencies required in the management of MHBPs. Considering the qualitative and linguistic nature of the competencies, any method used for the evaluation and subsequent decision making should reflect the vagueness and multiplicity of meanings of competencies. The proposed method should also be in line with the natural disposition and cognitive perspective of the evaluators (Tan et al. 2011). Kahraman et al. (2003) opined that fuzzy set theory resembles the human reasoning style in using imprecise information and uncertainty to make decisions. Therefore, due to the ill-defined and ambiguous nature of the competencies in MHBPs, conventional deterministic “crisp” approach may not be suitable for evaluating performance. Accordingly, linguistic variables, such as “good”, “very good” etc, are a critical component of fuzzy set analysis and are each used to capture a range of numerical values. It is against this background that the study sought to use the findings of Ahadzie et al,(2009a)to evaluate the competency level of a practicing project manager and establish a decision making framework using the fuzzy set theory approach.

1.2 Research Questions

The specific questions studied include:

- In evaluating the performance of a PM, what makes up the meanings of the seven (7) key competencies required in managing mass house building projects (MHBPs)?

- How will the competencies and their meanings be evaluated in the performance of a PM?
- How are decisions arrived at in the evaluation of a PM based on the seven (7) key competencies required in MHBPs?

1.3 Significance of Study

The outcome of this study will enable senior managers to use realistic qualitative and linguistic terms in evaluating the competence of PMs. This should improve decision making regarding succession planning, training needs, and promotions of project managers in MHBPs.

1.4 Aim of Research

The research was aimed at presenting an assessment method to evaluate the competence of PMs based on the seven key competency factors that PMs require at the construction phase of MHBPs using the fuzzy set theory approach. This should improve decision making regarding Job matching and succession planning, promotions and training needs of PMs in MHBPs.

1.5 Objectives

To achieve the above aim, the following objectives were proposed:

- Identify the antecedents of the seven(7) Key Competency Factors(KCFs) that engender superior PM performance in Mass House Building Projects,
- Evaluate and establish the competency level of an active PM based on the seven key competencies (KCFs) using a case study of one of the largest mass housing companies in Ghana.
- Ascertain the relevance of the seven (7) core competencies required by PMs in MHBPs.

1.6 Scope of Study

The research was limited to the competencies required at the construction phase of mass house building projects (MHBPs).

1.7 Research Methodology

The approach took two forms: data gathering and data analysis. For gathering the data, the preliminary approach was a structured interview where senior managers gave their views on the antecedents or Measure Indicators (MI) to the seven key competency factors (KCFs) required in managing MHBPs. The second approach took the form of questionnaire administration. With appropriate linguistic variables, senior managers were asked to evaluate the performance of a PM using the results of the interview. The linguistic variables were converted to triangular fuzzy numbers and subsequently taking through fuzzy arithmetic to get the total competency level of the PM.

1.8 Findings and Benefits

It is found that the performance of the project manager at the construction phase of MHBPs is average. Academically, a method has been developed for evaluating the performance of project managers using imprecise information. If accepted, this method could be employed on several case studies to actually see the trend of performance of project managers in the construction phase of MHBPs.

Industrial contributions involve developing a model that provides insight in to the seven (7) key competencies that engender superior performance in MHBPs. The fuzzy technique used in this research provides a tool for evaluation and prediction of competencies, which are quite difficult to measure and quantify in our present situation and with the existing tools in the industry.

1.9 Organisation of chapters

The study has been organized in to five (5) chapters. Chapter one gives a general introduction and background to the study. The aims, objectives and research questions and methods were reported briefly.

Chapter two dwells on literature concerning the term “Competencies/Competences”. The emergence of the competency movement and its numerous definitions are presented. Then competences required by PMs in mass house building projects are explored. A section is dedicated to personnel evaluation and selection. An outline of various decision support tools such as Traditional Methods, Elementary matching, Analytic Hierarchy Process (AHP) and fuzzy set theory ends this chapter.

Chapter three basically looked at the research method use in data gathering and analysis. The theory of fuzzy set and justification for its usage is presented.

Chapter four is dedicated to the systematic data analysis. An attempt is made to explain the result of the analysis.

Chapter five brings the curtains down on the research with conclusions, recommendations and the potential use of the evaluation and decision making framework in MHBPs.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

Technical resource optimization has long been considered important for effective industrial performance. Nowadays Technical resource optimization appears more human resource centered (Houé et al. 2011). Therefore many companies spend substantial amount of resources recruiting personnel who are well suited for vacant positions either temporary or on permanent basis or both (Golec & Kahya 2007). Consequently, competition in many industries has become a battle of talents.(P. Chen 2009)

Since the introduction of Competency testing and evaluation by (McClelland 1973), the acquired and required competences pattern has grown to be a widely accepted framework for personnel evaluation and selection in the Human Resource Management sphere (Hayes et al. 2000). This chapter tries to review literature on competencies, its numerous definitions and taxonomy. It will also outline the competencies in generic project management and particular findings of individual researchers in construction project management. Then competences required by PMs in mass house building projects will be explored. A section will be dedicated to personnel evaluation and selection. Various decision support tools in competency-based employee evaluation and selection such as Traditional Methods, Elementary matching, Analytic Hierarchy Process and Fuzzy Multi-Criteria Decision Methods will be brought to light. The chapter will end with justification for choosing the fuzzy theory in the evaluation of competencies required by PMs in mass house building projects.

2.1 Emergence of Competencies

Testing for competence rather than intelligence was proposed by David McClelland, a former

Harvard psychologist in the early 1970s. He was asked by the US Foreign Service to find new methods that could predict human performance and minimize the bias of traditional intelligence and aptitude testing. Hence the idea of measuring competence was born.

2.2 Towards a Definition of Competency

Rowe, (1995) believes it is necessary to distinguish between ‘competence’ and ‘competency’ as some dictionaries lump them together and use them interchangeably. He suggests that ‘competence’ means “a skill and the standard of performance reached” whilst ‘competency’ refers “to the behavior by which it is achieved”. Further, competence describes *what* people can do whilst competency refers to *how* they do it. Therefore for purposes of clarity, the plurals ‘competences’ focuses on a range of skills as a standard whilst ‘competencies’ refers to a range of behaviours that an individual needs to demonstrate. According to (Hoffmann 1999), the term “competency” has been used to connote behaviour whilst “competence” has been used to refer to the meaning expressed as standards. Strebler et al, (1997) in (Hoffmann 1999) notes that private organisations employ competency models whilst their counterparts in the public sector use competence models. Consequently our focus is on the word “competency”.

Technically however, the term ‘Competency’ has several definitions in the literature and so there is no universally accepted definition. This is succinctly put forth by (Jubb & Robotham 1997) “It still remains the case that a precise and widely-accepted definition of competences continues to elude both those researching in the field and trainers themselves”.

Thus, researchers and practitioners alike have advanced several meanings of this multi-faceted concept that provide an interest for them to use the competency approach to their work.

In fact, Hoffmann,(1999) believes that the definition given to competencies is determined by the rationale for its use and that the reason for the definition of competency is to improve human performance. In reviewing the literature, (Hoffmann, 1999) reveals three strands taking towards defining the term ‘competencies’:

- Observable performance (Boam and Sparrow,1992;Bowden and Masters,1993)
- The standard or quality of the outcome of the person's performance

(Rutherford, 1995; Hager et al., 1994); or

- The underlying attributes of a person (Boyatzis, 1982; Sternberg and Kolligian, 1990.)

To show that the term has several meanings depending on the purpose, (Hoffmann 1999) developed a typology of the meanings of competency. This is shown in the table below:

Table 2.1: Typologies of meaning and purpose of “Competency”

	Individual	Corporate	Purpose
Output	Performance Standards	Benchmarks	Performance based objectives (training)
Inputs	Knowledge, Skills and Abilities	Distinctive Strengths	Subject matter Content (Education)

Source:(Hoffmann, 1999)

2.2.1 Individuals' Perspective on Competency

(Spencer and Spencer, 1993) see (Garavan & Mcguire 2001) defines competency as “an underlying characteristics of an individual that is casually related to criterion-referenced effective and or superior performance in a job”. Thus the focus here is on whether an employee is competent in relation to documented standards. This definition is in tandem with the competencies of individuals related to output in the (Hoffmann 1999) typologies of competencies. According to (Wynne and Stringer,1997) see (Kiely & Brophy 2001) competencies “are the things people have to be, know and do, to achieve the outputs required in their job”. Here the focus is on inputs of employees required for competent performances. By defining the knowledge, skills and attitudes of competent performers, a cartography of input competencies can be attained for the development of a learning program. This in turn resonates with the individual input competencies in (Hoffmann 1999)’s typology.

2.2.2 Organizational Perspective on Competency

The other perspective to the definition of competences is in relation to the organization. The premise for this view is that employee competencies are one of the assets of the organization.(Garavan& Mcguire 2001).(Wynne and Stringer,1997) taking a holistic view in (Kiely & Brophy 2001) defines competencies “as the glue which binds an organisation together, taking a holistic look at the people, processes and performance they also enable organisations to understand and better measure performance”. This encompasses both the output and input competencies of the organisation. The organisational input competences is more like what (Stuart & Lindsay 1997) called the “semantic construct” that gives meaning to managerial competence.

This opinion therefore provides a contextual behaviour amenable for a learning program. In this instance, employees’ performances are described as competencies in order for

them to be observed and evaluated, and assessed to obtain accreditation as being competent.(Hoffmann 1999).Stuart & Lindsay (1997) proceeded to define it “as a statement of value accorded to another within a particular organisation – the value that is placed on a manager who is able to perform and be in ways that are highly valued and required by the organisation”. Consequently the focus of the organisation is on the distinctive attributes they have and how those attributes could be supported, enhanced and maintained.

Organisational competencies relating to output see competencies as standard of outcomes of the organisation. Organisational standard could mean, a) the minimum acceptable level of performance i.e threshold competences as by Jubb & Robotham (1997) b) new levels of acceptable performance than had previously existed, or c) the necessity to standardize performance across parts of a company (Hoffmann 1999). Consequently, a match between team or individual performance and corporate objectives or “benchmarks” may be the goal of such an approach. Thus competence will mean that documented standards have been reached and the relative strengths of the organisation (core competences) are maintained.

2.2.3 Approaches to Competencies

The literature reveals two main approaches to competencies. The UK and US perspectives. According to Garavan & McGuire (2001), the US perceives competencies to be related to the individual employee and whether they have the skills and knowledge to perform a job or take a particular position, whereas the UK perceives competencies not only in relation to the attributes of an individual but also to a range of guidelines required to get a job done.

Within the UK approach competencies are seen as standards for job performance and professions whilst by the US approach, the behaviour of superior performers forms the

basis for the development of test of relevant competencies. This appear to be in line with the views of Stuart & Lindsay (1997) who believe the US model is input oriented whilst the UK model is output oriented (where the underpinning attributes of an employee are assumed to exist if the standards are met). Though each view clearly has validity and by virtue of its emphasis, its strengths, they are both incomplete and lack a comprehensive frame for understanding and working with competence in the managerial domain (Stuart & Lindsay 1997). Therefore Hoffmann (1999) proposes that, instead of recognizing the different meanings of “competency” and setting up opposing camps to fight out the “true” meaning of the term, practitioners and researchers should choose how to use the term to achieve their goals. Tables 2.2 and 2.3 show some varied definitions and approaches of competency. Some of these definitions bear similarities to those presented above whilst others define competency from different perspectives.

Despite, the numerous and varied definitions of the term and the plurality of approaches in research and practice, Boon and Van der klink, (2001) suggest that the fuzziness of the term competenc(i)es does encourage discourse on the topic. They suggest that the strength of the concept lies in its complexity serving both research and practice and at the organisational level, embraces the interest of both employees and management.

Table 2.2: Differences in definition of competencies: the UK versus the US approach

BASIS FOR DIFFERENCE	UK APPROACH	US APPROACH
Purpose	Assessment and certification of employees	Development of competencies to enhance performance
Focus	Focus on job/individual characteristics and skill accumulation	Produce descriptions of excellent behaviour and attributes to define standards
Role of organisational context	Context is not as significant as professional area and specific job functions	Context defines the behaviour and skills required
Conceptualisation of work/individual	Characteristics of the work are the point of departure	Greater emphasis on the individual rather than specific task
Methodological	More multi-method and quantitative	Rationalistic and positivistic
Scope	Competencies are specific to professions and job functions	Competencies are specific to organisations
Measurement	Documentation of evidence of work activities and experiences denotes evidence of competency	Quantitative measurement and identification of a correlation between possession of attributes and work performance
Role of Assessor	Formally assessed by external to determine level	Assessment of performance by job supervisors and job incumbent
Perspective of learning advocated	Constructivistic perspective of learning	Cognitive perspective of learning

Source: Adapted from (Garavan & Mcguire 2001)

Table 2.3 Some common definitions of competency found in the literature

Worker-oriented definitions

- The behavioural characteristics of an individual that are casually related to effective and/or superior performance in a job. This means that there is evidence that indicates that possession of the characteristic precedes and leads to effective and/or superior performance on the job. (Boyatzis,1982)
- An underlying characteristic of an individual that is casually related to criterion referenced effective and /or superior performance in a job or situation. (Spencer and Spencer,1993)
- A high performance or H-competency is a relatively set of behaviours which produces superior work group performance in a more complex organisational environment. (Schroder,1989)

Work-oriented definitions

- Occupational competence (is).....the ability to perform activities within an occupation or function to the level of performance expected in employment.(Management Charter Initiative,1990)
- The ability to perform the activities within an occupation. (Nordhaug and Gronhaug,1994)
- An action, behaviour or outcome which the person should be able to demonstrate. (Training Standards agency,2000)

Multi-dimensional definitions

- The ability to apply knowledge, understanding, practical and thinking skills to achieve effective performance to the standards required in employment. This includes solving problems and being sufficiently flexible to meet changing demands.(NCVQ,1997)
- The skills, knowledge and understanding, qualities and attributes, sets of values, beliefs and attitudes which lead to effective managerial performance in a given context, situation or role. (Woodall and Winstanley, 1998).

Source: Adapted from (Woodall and Winstanley,1998) and (Horton,2000) see (Garavan & McGuire 2001)

2.3 Why Competency-Based Employee Evaluation?

Surviving in a competitive market today requires organisations having competitive advantages. These “competitive advantages” is increasingly seen as having competent personnel(Omidvar et al. 2011). According to Boam and Sparrow,1992 see (Kiely &

Brophy 2001) among the factors that has created the need for competence personnel are ; new technology, the drive for quality, more flexible and responsive organisation, supply of resources, new competitive arrangements, the internationalization of businesses and the power of information. Accordingly, in reviewing the literature, Kiely& Brophy (2001) reveals that, the ascendancy in competency-based approaches is due to:

- A growing recognition that business performance and employee skills are linked, such that sustained business performance can only be achieved through improved management capability (Boam and Sparrow, 1992).
- The failure of large scale change programs to deliver the necessary changes in individual behaviour (Boam and Sparrow,1992)

Consequently, competency-based employee performance management is favoured because according to Kiely & Brophy (2001)

- It emphasizes behaviour of employees, what people actually do and not what they claim they do.
- It is sensitive to and chooses what general managers at the top of the organisation have to do.
- It suits pragmatists because it looks at the underlying nature of superior performance.

From the forgoing, project management researchers and practitioners have not been left out in these current trends in employee performance management. Performance measures such as time, cost and product/service quality have also been developed, however these outturn measures appear overly simplistic to be applied in evaluating project manager's performance(Dainty, et al. 2005). Besides they provide lagging measures which are not

particularly amenable for personal development of project managers (Ahadzie et al. 2008). According to (Crawford 2004), concern for project management competence have lead to the development of various standards for knowledge and practice of project management. The centrality of project manager to the success of projects has been recognised by numerous researchers and practitioners such as (Goodwin, 1993), (Brill et al. 2006), (Omidvar et al.2011) etc.

2.3.1 Project Management Competence

The fundamental concept on which project management is based is that a single individual-the project manager- is accountable for the success of the project (Goodwin 1993). This involves PM possessing a variety of skills relating to the standard objectives of project completion within a set specification, under time, cost and quality constraints (Lei and skitmore, 2004).Admittedly, projects may fail due to external factors that are beyond the control of the project manager, however the competence of the project manager "constitute a critical parameter among the many variables that directly affect the outcome of the project" (Goodwin 1993pp 217).

To this end, two significant streams of project management competencies have been identified in the literature;

- a) Competence standards developed and periodically revised by a number of national and international project management organisations (Global Performance Based Standards for Project Management, 2003 cited in (Brill et al. 2006)) and
- b) Reports on empirical studies in to project management competencies which usually relate to a specific discipline and are diverse in focus.(Crawford 2004)

Examples of the first stream include; “APM Competence Framework” by the Association of Project Management in 2008, “AIPM Professional Competency standards for Project Management developed by the Australian Institute of Project Management also in 2008,”IPMA Competence Baseline Version 3.0” by International Project Management Association in 2006 and “Project Manager Competency Framework” by the Project Management Institute in 2002.(Omidvar et al, 2011). A brief view of each of these standards is presented below.

2.3.2 Project Manager Competency Development Framework (PMCD)

2.3.2.1 Background, Concept and Overview

This framework was a project sponsored by Project Management Institute (PMI) in 1998. The input was collected from the frameworks published by PMI, National Competency Standard developed by the Australian Institute of Project Management, Competency Dictionary developed by Lyne and Signe Spencer (1993), Project Management Professional (PMP) Role Delineation Study, and Project Management Experience Knowledge Self-Assessment Manual and some other information from international organizations and industries. After some revisions, the draft was submitted to public for their comments and after reviewing the comments, the final version of the framework was issued in 2002.

According to (Pereira & Carvalho, 2009), the assumption that underlies the development of this standard is that competencies have direct impact on performance. The standard defines PM major competencies dimensions and delineates the competencies that have greater chance to impact on performance. Also its generic nature is to ensure

transportability across different organisations and industries (Omidvar et al. 2011; Pereira & Carvalho 2009)

Further the framework has been designed and developed to incorporate what it calls “the three dimensions of competence” (PMI 2002). These are:

- Project Management Knowledge Competencies- considers what individual project managers bring to a project or related activities of projects through their knowledge and understanding of project management.
- Project Management Performance Competencies- examines competencies that individual project managers are able to demonstrate in their capacity to successfully manage the project or complete a project related activities and
- Personal Competencies- the core attributes or personality characteristics underlying a person’s ability to carry out a project or project related activity.

Therefore through establishing criteria for performance evaluation, per area of knowledge and process group, the PMCD Framework helps in describing the necessary knowledge, performance and behaviour of a competent PM (Pereira & Carvalho 2009). Omidvar et al. (2011) holds a different view, thus the purpose of this standard is to primarily be a guide for individuals and organisations and not for selection or evaluation purposes.

2.3.2.2 Structure of the PMCD

The project management knowledge and performance are defined based on nine knowledge areas of PMBOK. These knowledge areas are scope, integration, cost, time, quality, risk, human resource, communication, and procurement management. These nine areas of project management knowledge are assessed in five clusters of project management process groups as outlined in PMBOK. These clusters are called initiating,

planning, executing, controlling, and closing. In addition to the Project Management Knowledge and performance competencies, the Personal competencies are also addressed in the PMCD framework. The project management performance competencies describe how a project manager is able to apply project management knowledge at the workplace. In assessing project management knowledge, mechanism such as Project Management Professional (PMP) exams can be used. In assessing the performance competencies, the project manager's actual work or outputs can be reviewed.

Based on these nine units of project management knowledge and the five clusters of the project process, a total of 45 competency components are defined. They are then classified into elements of competency and competence criteria. These elements and criteria are used in measuring the project management knowledge and performance in each unit of competency.

In addressing the personal competencies' structures, the PMCD framework is based on the competency dictionary by Lyne and Singe Spencer (1993). There are six units of competencies in this dictionary. They are achievement and action, helping and human service, impact and influence, and managerial competencies. Each unit is classified into clusters, which describe the required behavior in each unit.

2.3.3 AIPM Professional Competency Standard

2.3.3.1 Background, Concept and Overview

The Australian institute of project management (AIPM) which acts as the main project management body in Australia developed the “National Competency Standards for Project Management” in 1996, and based on “Registered Project Manager's program” it awarded certificates in three levels of the project director, project manager and project practitioner. In order to upgrade this standard and based on requirements of

professionalism in the project management, AIPM developed the “AIPM professional competency standards for project management” in 2008. Compared to the previous AIPM Competency Standard,(Omidvar et al. 2011) asserts that this standard has the three advantages. The first advantage is that it is a rigorous assessment method. Next, it can be used for the senior management level, and finally, it is able to meet industry needs. According to (Omidvar et al. 2011) the purpose of this standard to fulfill the requirement of the project management profession.

This standard is designed to cover most industries and most projects from the simple ones to the very complex ones. Assessment of nominees is based on the project managers’ workplace performance. This standard covers the higher level of management, which is the senior management level in organizations.

In this standard, being competent means to have the minimum predefined levels of knowledge and skills in project management and to be able to apply this knowledge and skills at the workplace. . From “Project Practitioner Level” to “Project Manager Level”, or from “Project Manager Level” to “Project Director Level”, the level of responsibility and minimum requirements for the knowledge, skills, and experience increase as well.

2.3.3.2 Structure of the AIPM Competency Standard

The knowledge and skills required in the Australian institute of project management (AIPM) standard are driven from the project management body of knowledge standard (PMBOK). Thus for this standard, the areas of project managements are defined according to scope, time, cost, quality, human resource, communication, risk, procurement, and integration management.

2.3.3.3 Certification and Assessment of Project Manager

Certification is in four levels, which are Project Practitioner, Project Manager, Project Director, and Executive Project Director, and based on these levels, the titles awarded to successful candidates are: Certified Practicing Project Practitioners (CPPP), Certified Practicing Project Manager (CPPM), Certified Practicing Project Director (CPPD), and Executive Project Director (Exec PD).

Responsibility increases from Project Practitioner level to Executive Project Director Level. Assessment is performance-based. This means project manager's application of knowledge and skills in the work place are evaluated. These competencies are defined based on units of competencies that explain the kinds of competency required for an effective performance in the workplace. Based on this standard, for a candidate to achieve certification, he or she needs to collect evidences based on his or her performance for assessors to evaluate and subsequently advise the AIPM on the candidate's certification level. AIPM has defined a guideline for assessors in order that the assessment is fair and follows AIPM policies.

An assessment can be carried out by one assessor who is chosen by a candidate through the list of candidates available on the AIPM website. All assessors are based in Australia and some of them are able to evaluate candidates from outside Australia. Usually, the candidate meets the assessor twice. In the first session, the assessor usually notifies the candidate on the necessary evidences and documents that the candidate needs to submit. In the second session, all the necessary documents and evidences should have been compiled by the candidate. If there is a need to have more sessions for a more rigorous assessment, the assessor will notify the candidate accordingly. The assessor will report to AIPM on the evaluation of the candidate and almost one month after that, the certificate will be issued by AIPM to the candidate.

2.3.4 IPMA Competence Baseline 3.0

2.3.4.1 Background, Concept and Overview

In the late 1990s IPMA developed IPMA Competence Baseline version 2.0. In order to improve this standard, IPMA undertook a revision project and based on the suggestions and directions from 40 association members, IPMA Competence Baseline 3.0 was published.

IPMA Competence Baseline 3.0 defines a common framework for the certification purpose. 50 members of IPMA worldwide can use IPMA Competence Baseline as a basis and add their own specific competencies and provide a National Competence Baseline. However, this National Standard should be validated by IPMA. According to (Omidvar et al. 2011) The main purpose of IPMA Competence Baseline is to define a standard to be used for the universal certification system. Another purpose of this standard is to develop personnel that are working in the project management area. For assessments, candidates need to submit evidence based on their performance at the workplace, and assessors evaluate candidates' knowledge and experience according to these submitted evidence. In considering cultural differences, IPMA allows members to have a "National Section" in each competency element by adding new competencies related to cultural differences.

2.3.4.2 Structure of the IPMA Competence Baseline 3.0

Within the International Project Management Association (IPMA) Baseline 3.0, competency is defined within the perimeter of technical, behavioral and contextual competencies, and based on these three, 46 competency elements are defined. They are 20 technical competency elements, 15 behavioral competency elements, and 11 contextual competency elements. Technical competencies dealing with project deliverables.

Behavioral competencies deal with the personal relation among all parties involved in a project, and contextual competencies deal with the interrelation of the project team within the context of a project. Each competency element, requirements of knowledge and experience in different IPMA levels are described. Besides this, there is also a section called “main relation” that describes the relation of each competency element with other competence elements (Omidvar et al 2011).

2.3.4.3 Certification and Assessment of PM

There are four levels for certification awarded to candidates based on this standard. These are: (IPMA Level A) Certified Project Director, (IPMA Level B) Certified Senior Project Manager (IPMA Level C) Certified Project Manager, and (IPMA Level D) Certified Project Associate. At the Project Director Level, members who have advanced knowledge and experience are able to direct program and portfolio. At the Senior Manager Level (Level B), members are able to manage complex projects. At the Project Manager Level (Level C), members are able to manage projects with limited complexity, and in the Project Association Level (Level D), members are able to apply project management knowledge at their workplace.

In the IPMA certification system, there are two assessors evaluating candidates. One of the assessors comes from same industry with the candidate, and the other assessor is from a different industry. Assessors are certified based on the IPMA certification and must be at least at the same level with the candidate.

For the assessment process, after submitting all necessary documents such as the curriculum Vitae, self-assessment, 360-degree assessment, projects, programs and portfolios of the candidate involved, an interview will be carried out by the assessors.

Assessors evaluate the candidate's knowledge and experience in each competency element, and the scale used is from 0 (no competence) to 10 (absolute maximum). Assessors only evaluate the candidate competency level and do not advise the candidate for any required courses. Assessment tools used are written exam, reports which the candidate writes about the projects, programs, and portfolios he or she is assigned to, workshops (optional) that are problem- solving nature and interviews. In order to achieve good marks for experience, candidates need to have worked in various types and sizes of projects. They also need to work in different organizations. In the IPMA certification system, the evaluation of candidates is based on all 46 competency elements.

2.3.5 APM Competence Framework

2.3.5.1 Background, Concept and Overview

This standard is linked to IPMA Competence Baseline and also the Association of Project Management (APM) Body of Knowledge, and is designed to assess knowledge and experience of candidates who want to attain a global recognized certification. For the development of the standard, worldwide competence frameworks are studied and project management practitioners' knowledge and experience inside UK industry has been used (Omidvar et al 2011).

2.3.5.2 Structure of the APM Competence Framework

In this standard, competence elements are defined within three domains: technical competencies, behavioral competencies, and contextual competencies. Technical competencies contain 30 functional project management competency elements. Behavioral Competencies contain personal project management competence elements, which cover attitudes and skills. These elements are related to project manager's interaction with parties involved in executing a project. Behavioral Competencies have

nine competency elements. Contextual Competencies describe the interrelationship between organization and project manager, and they include eight competency elements.

2.3.5.3 Certification and Assessment

Similar to the IPMA Competence Baseline 3.0, the APM Competence Framework has four levels. These are: Level A-Candidate can successfully execute all the indicators by directing the management of complex projects and / or programmes for an organisation or a functional unit. Level B -Has successfully executed most of the indicators by managing a complex project

Level C- Candidate has successfully executed at least some of the indicators by management of a project with limited complexity

Level D- Candidate has the knowledge required and may execute some of the indicators in supporting a project manager and / or project team.

2.3.6 Comparing and Critiquing the Standards

2.3.6.1 PMs Certification Level

By defining different competency levels for different management levels in IPMA, AIPM and the APM competency standards, there would be a sense of the competency requirements understanding among all organizations, otherwise organization expectations about project personnel competencies would be varied from one organization to another. This issue is not addressed in the PMCD. As noted earlier, certification levels provide motivation for project personnel to develop their competencies and enrich their experiences.

Accordingly, project personnel can undergo any Continuing Professional Development (CPD) program to upgrade their knowledge, skills and competencies. However, in PMCD this motivation diminishes.

2.3.6.2 Competencies required for different Project Phases

PMCD Framework acknowledges that competencies required for project managers in different project phases differ, thus project phases such as initiating, planning, execution, controlling, and closing- are highlighted. This issue is one of the advantages of PMCD Framework. It is not addressed in AIPM, IPMA and the APM competence frameworks.

2.3.6.3 Basic Competencies in each Standard

All the standards are generic in nature. This means all the standards are applicable to all industries and organisations. Consequently, project size, complexity, project nature, organisational specific needs, and cultural differences are not considered in these standards.(Omidvar et al. 2011) According to Brill et al. (2006), the advantage is that it forms the basis for transporting competencies across different industries, organisations and countries. However, Omidvar et al. (2011) posits that the fact that some competencies are related to project size, complexity, project nature, organisational specific needs, and cultural differences means these competencies will be missed.

Having recognised the efforts of these bodies in the development of standards for project management knowledge and practice, Crawford (2004) criticized them for being largely qualitative and drawn from the collective opinions of experienced practitioners as to the knowledge and practices that a PM must possess in order to be considered competent.

Further Crawford, (2004) questioned the assumption that acts as the ‘spring board’ for the development of these standards; that those who satisfy the requirements of these

standards will perform effectively or at least perceived to be effective performers than those whose performance are at variance to the requirements of these standards.

Indeed, data from Crawford, (2004) research indicates that senior management's perception of PMs competence is different from what these project management bodies promulgate as competence that engenders superior performance. Besides, other characteristics of projects such as technology, complexity, uncertainty, level of risk, urgency, nature of work force, degree of definition and repetition are all contextual variables that various authors consider to have influence over the outcome of any project. Other researchers such as Morris (2001) also outlined some shortfalls of these competence standards, noting that, the existence of different Knowledge Guides-which serve as the basis for these competence frameworks for the various PM bodies-, “implies confusion at the highest level on what the content and the philosophy of the profession is”(Morris 2001pp 22). He (Morris 2001) therefore recommended that one begins with a clean sheet and by empirical techniques discover competence requirements of PMs.

In line with Morris's recommendation of a clean sheet, Brill et al. (2006) using a web-based Delphi technique investigated competencies required by PMs in instructional design, Ahadzie et al. (2009a) investigated the competencies required by PMs in mass house building projects in Ghana. Fraser, & Zarkada-fraser,(2003) investigated effectiveness of project managers by stakeholder perceptions. Lei and Skitmore, (2004) in a survey in South East Queensland investigated the most important project management skills and any additional skills that a PM must possess in the twenty-first century. Ogunlana et al. (2002) looked in to factors and procedures use in matching PMs to construction projects in Bangkok.

2.3.7 Towards Competencies of Construction Project Managers

Recognizing that critical competencies of PMs could be missed if not developed in tandem with project size, complexity, nature, industry, etc, and the unpredictability that these factors bring in their wake in construction compared to other industries such as manufacturing, several researchers have tried to investigate competencies required of construction project managers. For instance, (Ogunlana et al. 2002) looked in to factors and procedures used in matching PMs to different construction projects in Thailand. He categorized construction projects in to residential and commercial, industrial projects and heavy engineering projects. Data obtained comprised 24 questionnaires for residential and commercial category, 22 and 27 for industrial and heavy engineering projects respectively.

Edum-Fotwe & McCaffer,(2000), conducted a survey in the UK to find out how construction PMs acquired and develop the necessary skills and knowledge for practice. The focus of this study was on general knowledge and skills. However, they contend that PMs may need different knowledge and skills in different sectors of the construction industry. Lei and Skitmore, (2004), in an effort to capture the “real world” experiences of practicing PMs carried out a competency survey in Australia. However, Ahadzie et al. (2009b) argues that operational measures used in eliciting the data should not only reflect the uniqueness of the projects involved but must be competency-based. That cannot be said of the listed studies above.

It is argued that competency-based measures is the only viable option for performance evaluation of employees in the HRM sector and the construction management sub-sector (Dainty et al. 2003; Ahadzie et al. 2009b).

This is because these measures are able to overcome many of the problems of traditional measures including identification and facilitation of the appropriate measures useful for developing predictive models (Dainty et al. 2005). Therefore to address the limitations of generic project management standards in its application to different industries, sectors, project-based and non-project-based sectors, geographic and culturally different project environments, etc, Ahadzie et al (2009a) investigated the competencies required by project managers in Mass Housing Projects in Ghana. Mass Housing Projects because, it does not only present one of the most establish project-based sectors in most developing countries but also evidentially characterize by uncertainties, crises and suspense which requires an examination of the PMs ability in coordinating and controlling a diverse selection of functional specialist (Ahadzie et al 2009b). Therefore identifying the requisite PM competencies could serve as a basis for developing the skills of potentially competent PMs, who can promote the effective management of MHBPs in a relatively unstable and increasingly difficult business setting (Ogunlana et al. 2002).

2.3.7.1 What is Mass House Building Projects (MHBPs)?

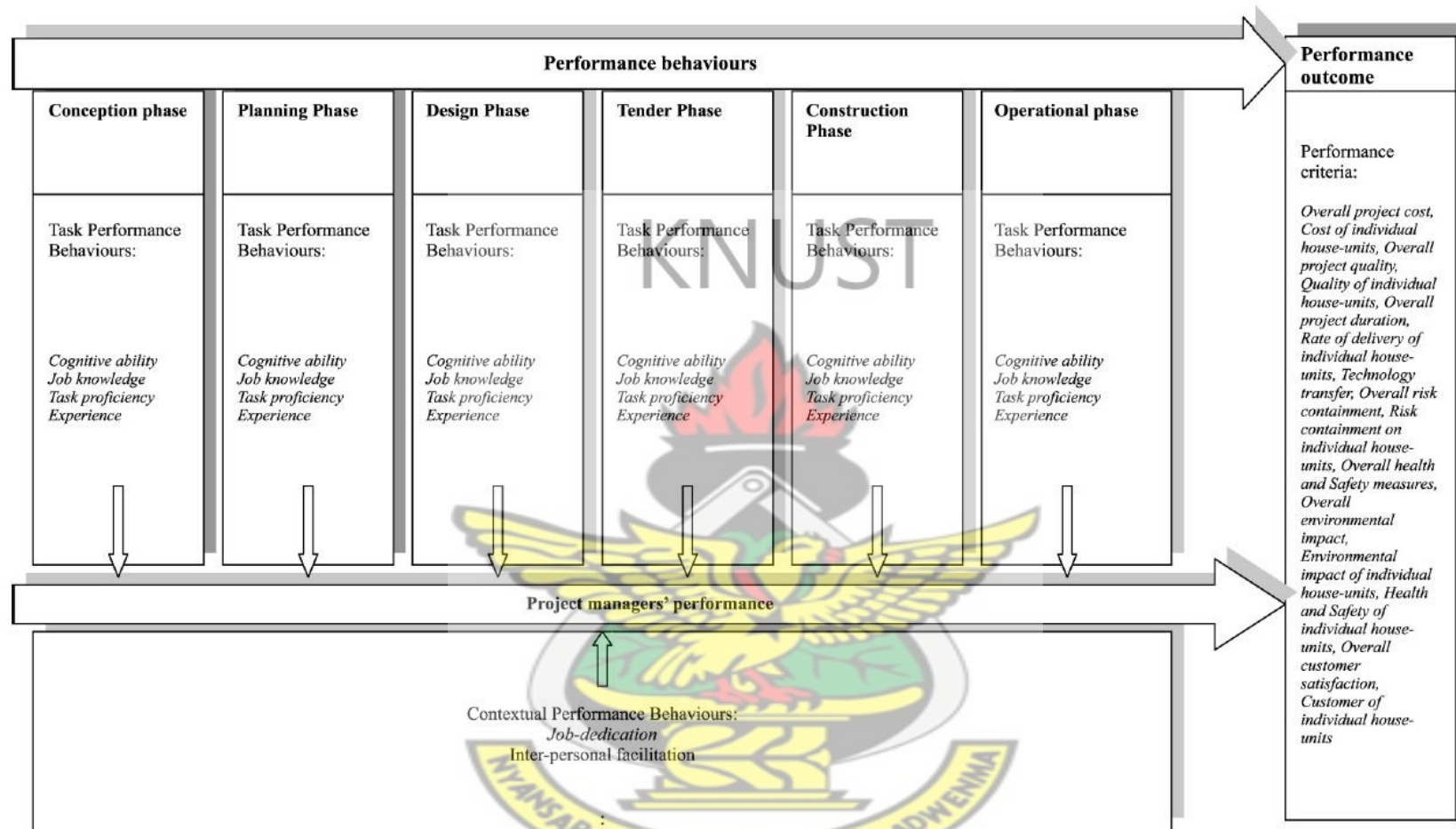
Ahadzie et al. (2008a) define MHBPs as “the design and construction of speculative and standardized house-units usually in the same location and executed within the same project scheme”. Examples include: multi-storey block of flats, semi-detached, detached, maisonettes, terrace and /or a combination of them. This is the definition adopted in this study.

2.3.7.1 PMs Competencies Required in MHBPs

According to (Roy and Cochrane, 1991), MHBPs are speculative in nature. Thus, acquisition of land, design and construction of house units are done without any known customer in mind. Therefore, design process management and construction process

management of these projects become the responsibility of a single organisation-the Property Developer (Ahadzie et al. 2007). According to (Ahadzie et al 2004) the practice in Ghana is to appoint the PM at an early stage to oversee the concept, planning, tender, procurement, construction and operational phases of the project. Consequently, the PM is defined “ as the individual that has the authority and responsibility for the management of MHBPs throughout the project life cycle and who works in the interest of the key stakeholder (the homebuilder)”(Ahadzie et al. 2009b pp 90)

Drawing on the significance of MHBPs and their contribution to the Gross Fixed Capital Formation(GFCF) of developing economies(Ahadzie et al 2009b), and the crucial role the PM plays in the delivery of mass housing,(Ahadzie et al 2009a) underscored the need for a more rigorous competency-based performance model that can be used to evaluate, match and select PMs for MHBPs, predict their performance and engender PMs Continuing Professional Development. By adopting the well-acclaimed organisational psychology theory of job performance (Borman and Motowidlo 1993), they developed a conceptual model that sought to measure PMs performance based on both behavioural and output measures. Subsequently, Ahadzie, et al. (2009a) developed a multi-dimensional competency-based framework that can be used to isolate the competency of PMs from inception to completion. See figure 2.1



Source: Ahadzie et al. (2009a)

Figure 2.1 Competency-based model for the project lifecycle

By collecting data from members of the Ghana Real Estate Developers Association, Ahadzie et al. (2009a) discovered that seven critical competencies account for managerial excellence during the construction phase of MHBPs. These are Knowledge of appropriate site layout techniques for repetitive construction works, Dedication in helping works contractors to achieve works schedule, Knowledge of appropriate technology transfer for repetitive construction works, Effective time management practices on all project sites, Ability to provide effective solutions to conflicts while maintaining good relationships, Ease with which works contractors are able to approach the project manager with their problem and Volunteering to help works contractors solve external difficulties.

2.3.7.2 Practical Applications of Competencies in MHBPs

According to Ahadzie et al.(2009a)the seven (7) key competencies could be used a) as a checklist for competency based interviewing (CBI) and recruitment, b) for deployment of PM and job matching, c) for curriculum development etc. The primary question that arises is how you arrive at a decision based on the multiple criteria outlined above? How will each of these criteria be assessed and measured in an individual? How will each of this criterion combine with the rest to come out with a decision? Admittedly, several authors have reservations about the possibility of measuring managerial performance. For instance (Rowe 1995) believes the process remains to some extent subjective especially where there a lot of assessors, but at least there is a general consensus as to what is to be tested and how it should be measured. The other problem is the form the assessment should take. According to (Jubb & Robotham 1997), several researchers have examined the performance of managers and concluded that there is no single measure that was capable by itself of assessing managerial performance.

They contend that managerial performance domain is not easily adaptable to say X number of units produce in Y units of time, to measure managerial effectiveness. Besides, managerial effectiveness in itself is a vague concept with no real measurable output (Tsui and Ohlott, 1988).

2.3.8 Evaluation of Competencies of PMs in MHBPs

However and perhaps in line with the competency catch cry (Rowe 1995), “if you can’t measure it, you can’t manage it” several researchers have proposed different methods in overcoming these challenges. Hence to be able to manage the PM in mass housing, there is the need to institute a criterion that is understood by those responsible for the evaluation and a method that sits well with the nature of the competencies at the construction phase of MHBPs. Recognising the uncertainty and vagueness inherent in managerial domain as emphasized by Tsui and Ohlott, (1988), a method that aligns with the imprecision in the seven (7) key competencies at the construction phase of MHBPs is indeed welcomed. Fuzzy linguistic approach is favoured for the performance evaluation of the PM in MHBPs because; it allows senior managers to use every day language to assess their PMs performance.

Among the various decision making tools are Elementary Matching (Houé et al. 2011), Absolute Rating Scales and Forced distribution rating scales (Mirabile 1997), Analytic Hierarchy Process (AHP) and other methods based on fuzzy logic (Houé et al. 2011; Chen 2009; Poveda & Fayek 2009; Golec & Kahya 2007; Pe’piot et al. 2008).

2.3.8.1 Elementary Matching

Consider the following:

Let the set of competencies required in MHBPs be $R_c = [C_j] \ j = 1, 2, \dots, n$ and the set of acquired or possessed competencies of the PM be $P_c = \{C_k\} \ k = 1, 2, \dots, n$. Theoretically an elementary matching is successful when a given element of P_c belongs to R_c . According to (Houé et al. 2011), such a method is so rough that it does not consider the level with which either a competence is required or acquired.

2.3.8.2 Absolute Rating Scales

These use a range of ratings- for instance, 1-3, means the associated competence is not necessarily needed, 3-5 meaning it is necessary for the worker to have some elementary notions and 5-7 means the worker should master it. According to Mirabile (1997), scales help define the importance of a particular competency for a job, the proficiency level for each competency and the competency grade of an individual. To illustrate this concept, consider the Table 2.4 below

Table 2.4: Illustrating Absolute Rating Scales in Competency Assessment

Competence	Required level	Acquired level
Knowledge of appropriate site layout techniques for repetitive construction works,	3	3
Dedication in helping works contractors to achieve works schedule	3	2
Knowledge of appropriate technology transfer for repetitive construction work	3	1

Given a bundle of competences required to occupy the PM's position in MHBPs , two sets of measures are defined, referring to what is needed and to what extent it is needed on one hand and to what extent the employees skills / knowledge / abilities comply with the requirements on the other. With these two sets of measures, it becomes easy to gauge the state of competence of the PM by comparing the levels of required/acquired

competence. Using a graphical tool such as the radar graph (see figure 2.2), the displacement between the required/acquired competences indicate the competency level of the PM. Though it would be difficult to evaluate the whole adequacy of the PM's background based on the graph, such assessment has been satisfactorily implemented in an industrial context (Houé et al. 2011). Based on the gap between the required/acquires levels in an elementary competence, such companies have defined that as “need for training”. However, they tend to produce ratings that cluster around the middle or above the middle of the range known as the *central tendency error*. The power of this method to predict competency is weak to moderate (Mirabile 1997).

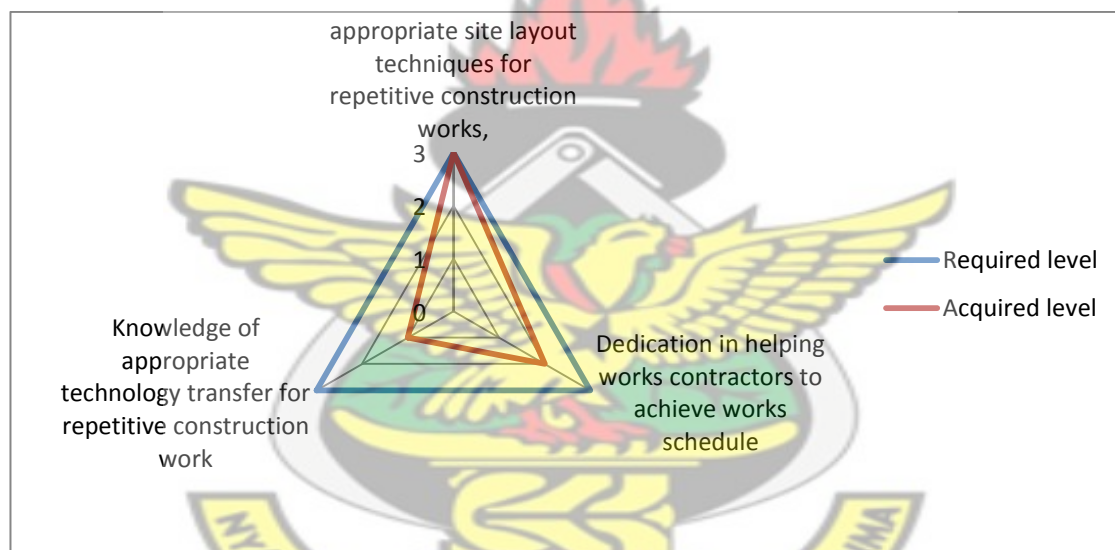


Figure 2.2: Graphical analysis of competence (adapted from Chen 2009)

2.3.8.3 Forced-distribution Rating Scales

These scales have descriptions for each level and are used for the same reasons as the absolute rating scales. The only difference is that forced-distribution scales are restricted in how many times a particular rating can be used for job or an employee. For instance with a seven-point scale, a restriction might be that rating 7 can only be used twice and so on down the scale. According to (Mirabile 1997) such scales are good for establishing

accurate difference in performance levels of workers but only in relative terms. The predictive power is moderate to strong.

2.3.8.4 Analytic Hierarchy Process (AHP) and Fuzzy Approach

This in general is a multi-objective decision making framework developed by Saaty in 1971. According to Chen, (2009), it is mainly used in uncertainty in decision-making issues with multiple criteria. By this approach, all required competences are ranked against each other until all possible pairs are ranked. The results yields one competency consistently ranked highest, one next highest, and so on until all of the competencies are ranked in terms of their criticality to the position of PM in MHBPs.

Similarly, the PM's ratings are ranked against each other until all possible pairs are ranked. The result is a rank order listing of the most competent PM to the least competent using some measure of competence as the criterion for comparison. According to Mirabile (1997), the merit of this method is a solid outcome. The shortfall is that it is difficult if not impossible to compare job outcome against employee outcome when the number of possible pairs become extremely large.

Also the method allows consistency testing of the Eigen-values and eigenvectors. If the consistency of the matrix developed from the paired-comparison does not meet the requirements, it shows inconsistencies in the decision making process.

However, the Traditional AHP has some shortcomings. Chen, (2009) believes it is unable to cope with the subjective, fuzzy and imprecise properties in the human decision-making process. That is, "it takes assessors vague ideas as specific value to output, thus neglecting inter-numerical and linguistic plausibility". This short fall has lead to a lot of researchers advocating for integration between AHP and Fuzzy theory.

For example, Fong & Choi (2000) used analytical hierarchy process to select contractors. Liang (2003) using a case study, evaluated a project and used the AHP to decide whether to terminate the project or not.

Due to the obvious shortfall of the inability of the AHP to mimic the human thinking style and the fuzziness that pervade the human reasoning style, most authors have advocated an integration of AHP with fuzzy logic. Thus Kahraman et al.(2003) used the fuzzy AHP to select suppliers whilst Koul & Verma (2011) used the fuzzy AHP in vendor selection. Other researchers such as Golec & Kahya (2007) used the fuzzy approach in competency-based employee evaluation and selection. Nguyen et al. (2008) used fuzzy sets to select an architecture-engineering team based on imprecise measures such as financial soundness, experience, expertise, availability and compatibility of personality, Poveda and Fayek (2009) used fuzzy logic to evaluate the performance of construction trades foremen.

The model developed assist in measuring the effectiveness of a foreman, monitoring improvements in effectiveness over time and revealing areas where there is need for training and mentoring to improve performance.

Lately, Tan et al, (2011) used the fuzzy approach to evaluate and decide whether to bid or not to bid for a project using ambiguous and multi-faceted concepts such as operational systems, related future work, technical approach and competition for the project.

Finally, integrating fuzzy sets with AHP, Torfi and Rashidi, (2011) selected the best candidate for the post of project manager. The data used for this study included the background of the candidate, experience and demographic features such as gender, age and mental and physical health. Others were managerial capability, decision making ability and communication and human resource management ability etc.

Therefore, given that the seven key competency factors (KCFs) can be used for the evaluation of PMs performance at the construction phase of MHBPs, fuzzy approach can be said to be appropriate for competency based evaluation of project managers in Mass House Building Projects.

KNUST



CHAPTER THREE

METHODOLOGY/RESEARCH DESIGN

3.0 Introduction

Recognizing the centrality of the PM to the success of MHBPs, the competencies required of them in MHBPs and the absence of a decision making framework (DMF) for assessing the performance of a PM, a method that encourage, simplifies and conforms to the natural human thinking and decision making process is indeed welcomed. The chapter begins with the profile of the case study company and the PM, outlines the method of evaluation and how decisions are made in such a fuzzy environment. A brief introduction to the theory of Fuzzy sets is explored and an attempt is made to justify the adoption of this theory for this study. Then the method to be adopted for the collection of data and analysis is presented. The chapter ends with a summary of all what has been discussed.

3.1 Theoretical Framework

In general, as a consequence of performance management in most organisations, any competency-based evaluative criteria can be used in a variety of ways: to measure managers' performance and to provide a basis for reward; to identify superior performers from whom competency profiles can be derived which encourage more effective performance from other managers within an organization (Spencer and Spencer, 1993 in (Dainty et al. 2003)); to determine training and development needs; to provide a basis for personnel actions; to motivate workers by providing feedback and perhaps most significantly, to facilitate goal setting(Dainty et al. 2003).

Indeed Ahadzie,et al(2009a),confirms that, with the support of an appropriate decision making framework (DMF), the competencies discovered for PMs in MHBPs can be used effectively for Competency-Based Interviewing (CBI), PM job matching and

deployment, Succession planning etc. However, in using the competency-based methods, there will be the need for human decision especially in evaluating the performance of a PM. The fact that human decisions are prone to error means results may not be dependable. Accordingly, Torfi & Rashidi (2011) emphasizes the need for a method that can select the most suitable candidate for the post of PM base on his qualifications, competencies and the opinions of senior managers. Thus such a situation requires a method such as the fuzzy technique to help select the most suitable candidate for the job. According to Golec & Kahya (2007,pp144) “fuzzy logic gives the means by which judgments that characterize our mode of reasoning can be formulized without choosing an artificial process of making these judgments exact”. It is our opinion that a fuzzy evaluative method for assessing the performance of PM presents a prima facie case in performance management of the construction workforce including the project manager. Indeed, according to Poveda & Fayek (2009), though fuzzy logic has been used extensively in construction engineering and management, it has not been employed thoroughly in performance evaluation of the construction workforce. Therefore the seven (7) competences required by PMs in the management of MHBPs identified by (Ahadzie et al,2009a) and their antecedents (sub-attributes) were selected as the Key Competency Factors(KCF) and Measure Indicators (of the KCFs) respectively for measuring the competency of practicing PMs at the construction phase of mass housing.

Using appropriate linguistic terms as shown in Table 3.1 assessors were asked to rate the performance of the PM with respect to KCFs and MIs and attached weights to the various KCFs and their corresponding MIs.

Table 3.1 Likert Scale for Weighting and Rating the PM and their Corresponding Fuzzy Numbers

LINGUISTIC RATING	LINGUISTIC WEIGHTING	Fuzzy Numbers
Very Poor(VP)	Unimportant(UI)	(0.00, 0.00, 0.20)
Poor(P)	Less Important(LI)	(0.10, 0.25, 0.40)
Satisfactory(S)	Important(I)	(0.30, 0.50, 0.70)
Good(G)	Very Important(VI)	(0.60, 0.75, 0.90)
Outstanding(O)	Extremely Important(EI)	(0.80, 1.00, 1.00)

3.2 Case Study

In a study of assessing the competitiveness of construction firms using the concept of fuzzy set theory, a major limitation as pointed out by Tan et al. (2011) was that the study was not validated by using real case scenario. Also previous studies such as those by (Nguyen et al. 2008; Torfi & Rashidi 2011; Gregoire 2008; Golec & Kahya 2007) that employed the concept of fuzzy sets have always tended to use real case study scenarios or at least recognises that validity depends on case study. Therefore, for the purpose of this research, the methodological approach adopted was a case study performed in a large Ghanaian Estate Development organisation. Case selection criteria included size, experience, market share, current project running and willingness to participate in the study. Indeed, Regimanuel Gray Limited was chosen because it has consistently provided approximately 50% of the total housing units built by real estate providers since 2000(Bank of Ghana Report, 2007). The company was established in 1991 as an international joint venture between a Regimanuel Limited of Ghana and Gray construction of Houston, USA. It has provided over 2500 satisfied houses in its catchment area. It has and is still undertaking different types of MHBPs in various areas within

Accra. Types of houses developed include Detached and Semi-detached, Multi-storey flats, etc.

3.3 Data Collection

Data collection technique involved interviews and questionnaire administration at two levels aimed at

1. Identifying the antecedents (measure indicators) of the seven (7) Key Competency factors(KCFs) required by PMs in the management of MHBPs and
2. Assessing the performance of a PM on a current mass housing project using linguistic terms respectively.

3.3.1 Interview process

The interview process took a structured format where senior managers of the case study company gave their opinions regarding the antecedents or measure indicators of the KCFs. To augment and enrich the content of the outcome of this interview, a detail literature search was carried out by the researcher on the Measure Indicators of each KCF. The outcome of this interview and literature search formed the basis of the next round of questionnaire administering.

3.3.2 Questionnaire Development

For this study, a 5-point Likert scale was employed in assessing the performance of PMs. One set was on the weighting senior managers put on the MIs and their KCFs and the other on how the subject PM fared with respect to the MIs and the KCFs. The scales are shown in Table 3.1. Note that for a triangular membership functions, $F = (\kappa_1, \kappa_m, \kappa_u)$, the parameters $\kappa_1, \kappa_m, \kappa_u$ denote the smallest possible value, the most promising value and the largest possible value that describe the fuzzy event. Thus, unlike a deterministic situation where assessors use crisp figures to represent the level of performance of a PM, fuzzy

membership functions converts assessors opinions using a range of values described above. Therefore, triangular membership functions adapted for evaluation are those used by Torfi & Rashidi, (2011) largely because it was used for the selection of PMs for a construction company and the criterion used in that evaluation process closely related to our variables.

3.4 Fuzzy Set

Fuzzy set was originally introduced by Zadeh in 1965. A major contribution of fuzzy set theory is its ability to represents vague and imprecise information (Kahraman et al. 2003). A fuzzy set, according to (Zadeh 1965) is a class of objects with a continuum of grades of membership. A fuzzy set (class) A in X is characterize by a membership function (characteristic) function $f_A(x)$ or $\mu_A(x)$ which relates with each point in X a real number in the interval $[0,1]$ with the value of $f_A(x)$ or $\mu_A(x)$ representing the “ strength of belongingness” or grade of membership of x in A . An alphabet with a tilde “ $\sim$ ” on top represents a fuzzy set. Therefore $\tilde{a}$ and $\tilde{v}$ are both fuzzy sets. The value of $\mu_A(x)$ represents the grade of membership of the element x in the fuzzy subset A for each x in X . that is , the element x is said to be in A if $\mu_A(x) = 1$, x does not belong to A when $\mu_A(x) = 0$ and x belongs to A with a membership $\mu_A(x)$ if $0 < \mu_A(x) < 1$. Types of Membership functions in fuzzy sets have been discussed in (Verkuilen 2005; Golec & Kahya 2007). However, Fuzzy triangular membership is favoured in this study because of its simplicity (Torfi& Rashidi 2011; Nguyen et al. 2008), ease of interpretation and application in the view of construction personnel and widespread usage in fuzzy logic modeling (Poveda& Fayek 2009; Tan et al. 2011).

3.5 Evaluation Process

It important that, a method that outlines the process for the evaluation of the competence of a PM is devised. This approach considers the uncertainty, ambiguity and plurality of

the meanings of the KCFs and MIs in construction PM competence assessment. The framework for the Evaluation is shown in figure 3.10

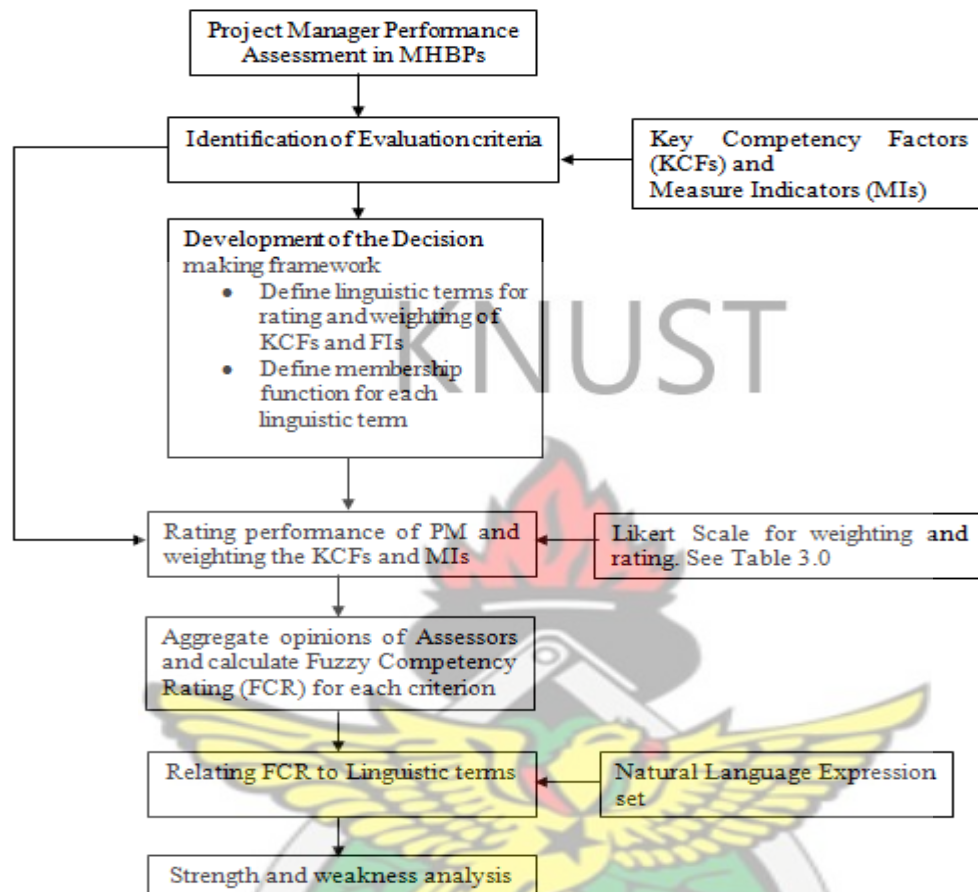


Figure 3.1: Project Manager Competency Assessment and Decision Making Framework

- Determining the appropriate preference scale for measuring the merit ratings and weighting of the KCFs and MIs. Using off-the-cuff linguistic variables and their corresponding membership functions have been criticized by fuzzy logic (Lin & Y. Chen 2004). However, for linguistic evaluation such as this, many common linguistic expressions and related membership functions have been proposed for linguistic assessment (Golec& Kahya 2007; Nguyen et al. 2008; Pe´piot, et al 2008).

Therefore, Lin & Chen (2004) proposed that instead of eliciting linguistic terms and corresponding membership functions from assessors(Senior Managers), they could be obtained from past data or basic models could be modified to accommodate specific situations and the expectations of different participants. Therefore the linguistic expressions and the membership functions used for this study are modified versions of those used in previous studies in the milieu of construction management.

- Senior managers measure KCFs and MIs using linguistic terms listed in table 3.10.
- Aggregating the opinions of senior managers relative to each KCF and MI using average fuzzy weightings and ratings.(Lin & Y. Chen 2004) believes that, in order to pull the opinions of the assessors(Senior Managers) together, average fuzzy ratings and average fuzzy weightings can be obtained using the following formulae

$$r_i = \frac{1}{t} [r_i^1 \oplus r_i^2 \oplus \dots \oplus r_i^t] \dots \text{Equation (1)}$$

$$w_i = \frac{1}{t} [w_i^1 \oplus w_i^2 \oplus \dots \oplus w_i^t] \dots \text{Equation (2)}$$

Where $i = 1, 2, \dots, n$, r = fuzzy value for ratings and w = fuzzy value for weightings.

- Referring to previous studies (Tan et al. 2011; Lin & Chen 2004) a Fuzzy Competency Rating (FCR) is introduced to assess the PM competency.

The formulae for FCR is

Let R_j and W_j , $j = 1, 2, \dots, n$ respectively be the fuzzy rating and fuzzy weighting given to factor j by the assessors, according to the standard fuzzy operation (Lin & Chen 2004) the fuzzy competitiveness rating FCR can be obtained from

$$FCR = \sum_{j=1}^n (W_j \otimes R_j) \dots \dots \text{equation (3)}$$

- According to equation (3), the value of the FCR is also a triangular fuzzy number denoted as $FCR = (\kappa_1, \kappa_m, \kappa_u)$. To keep the value of FCR within the range $\{0, 1\}$, a normalization method is needed. The most common method is to use the maximum a_u denoted as a_u^* to divide $FCR = (\kappa_1, \kappa_m, \kappa_u)$. According to Tan et al. (2011), where there is only one subject as in the case of the PM, the maximum a_u^* is ascertained by setting all attributes rating as the maximum rating (0.80, 1.00, 1.00) and keeping the weightings unchanged. By using equation (3), the FCR with the maximum a_u^* will be obtained as $FCR^* = (a_1^*, a_m^*, a_u^*)$ and the normalised fuzzy competency rating (NFCR) can be calculated by the following equation

$$NFCR = \frac{FCR}{a_u^*} = \left(\frac{\kappa_1}{a_u^*}, \frac{\kappa_m}{a_u^*}, \frac{\kappa_u}{a_u^*} \right) \dots \dots \text{equation (4)}$$

- Matching the NFCR to a linguistic term from the natural language expression set. Once the NFCR for the performance of the PM has been obtained, it (NFCR) can be matched to a natural language expression set using the Euclidean distance (Lin & Chen 2004; Tan et al. 2011). The natural language expression set is in Table 3.2.

Table 3.2: Natural language expression set and their corresponding Fuzzy Numbers

Linguistic Variables	Fuzzy Numbers
Very Low(VL)	(0.00, 0.10, 0.25)
Low(L)	(0.15, 0.30, 0.45)
Average(A)	(0.35, 0.50, 0.65)
High(H)	(0.55, 0.70, 0.85)
Very High(VH)	(0.75, 0.90, 1.00)

Source: adapted from Torfi & Rashidi (2011)

Consider two triangular fuzzy sets $\tilde{x} = [x_1, x_m, x_u]$ and $\tilde{y} = [y_1, y_m, y_u]$ the Euclidean distance between $\tilde{x}$ and $\tilde{y}$ is:

$$d(\tilde{x}, \tilde{y}) = \sqrt{\left[\frac{1}{3} (x_1 - y_1)^2 + (x_m - y_m)^2 + (x_u - y_u)^2 \right]} \dots \dots \dots \text{equation (5)}$$

This expression will be used to match the results of the FCR to the language expression set shown in Table 3.2 Then the linguistic term from the natural language set which has the minimum distance to the NFCR becomes the competency level of the PM with respect to that factor.

3.6 Summary

This chapter basically outlined the method adopted for data gathering and proposed analysis of data of the research. Reason for adopting case study research and the case study company were presented. A brief look at the theory of fuzzy sets was also presented. The chapter ended with the theoretical framework alongside step by step explanation of the framework.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.0 Introduction

In this chapter, the data gathered and results of the analysis on the performance evaluation of the PM in the construction phase of an ongoing Mass Housing Project is reported. The fuzzy set theory approach was employed to analyze the data and a decision was reached on the competency level of the project manager (PM) with respect to the key competency factors (KCFs). The step by step processes included aggregating the weightings and ratings of the two Senior Managers on the measure indicators (MIs) of the KCFs using averages. Then using equation (4), the Fuzzy Competency Rating (FCR) of each main criterion (KCF) was obtained. To keep the values of the FCR within $[0, 1]$, a normalization method was employed to convert the FCRs to Normalised Fuzzy Competency Rating (NFCR). Using the Euclidean Distance between two fuzzy sets – equation (4) - the NFCRs were matched to a natural Language expression set and the Competency rating of the PM vis-a-vis the KCFs were obtained. To start with, the chapter begins with the profile of the Case study Company.

4.1 The Project Manager (PM) Under Assessment

The PM under assessment was responsible for the construction of over ten (10), four-storey residential flats in Dome Kwabenya near Accra for the company. Data gathered revealed that he has worked with the company for over ten (10) years and has handled different projects on different sites. Therefore, there is some considerable interaction between the PM and the Senior Managers responsible for recruitment.

4.2 Evaluation and Decision Making Process

4.2.1 Assessing the Weightings and the Ratings

Two senior Managers who participated in the first Preliminary interview assessed the performance of the PM using the seven (7) competencies required for the management of MHBPs. The Managers were briefed on the KCFs and MIs. The second set of questions was given to them to assess the weightings and ratings of the KCFs and MIs based on their understanding of the KCFs and the MIs and the modus operandi of their company. The weightings and ratings of the attributes (KCFs and MIs) were expressed using the linguistic terms proposed in table 3.1(see chapter 3). With the provided data, the two Senior Managers gave their judgments on the weightings and ratings of the competency attributes that are exhibited by the subject PM as shown in Table 4.1

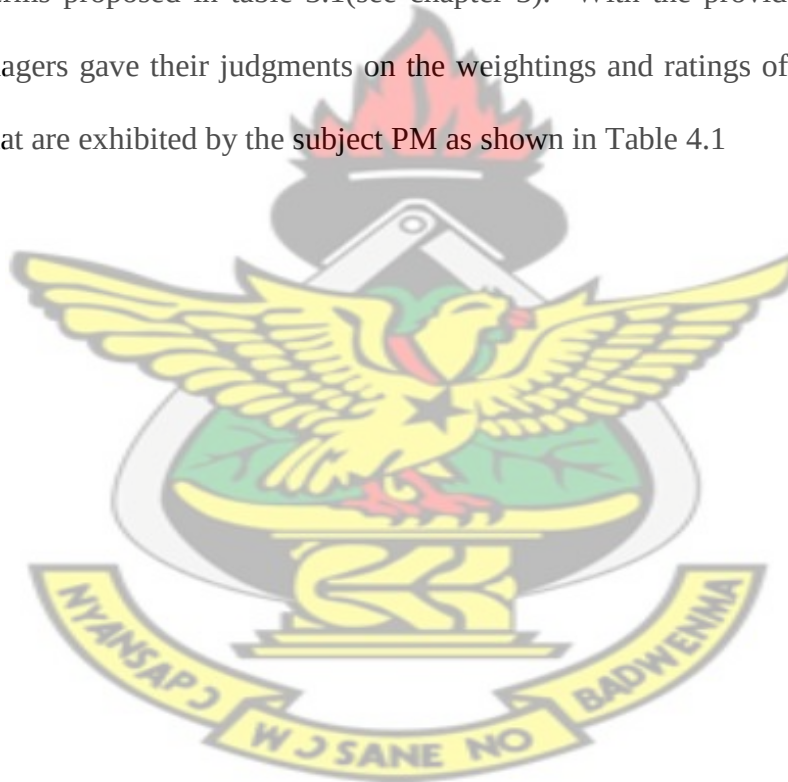


Table 4.1: Assessing the Weightings and Ratings on KCFs and MIs

Key Competency Factors(KCFs) and Measure Indicators(MIs)		Senior Manager-1		Senior Manager-2	
		LW	LR	LW	LR
KCF-1	<i>Knowledge of appropriate sitelayout techniques for repetitive construction works</i>	VI		EI	
MI-1	Knowledge of site restrictions both vertical and horizontal and choosing appropriate method for moving materials and components.	I	S	VI	P
MI-2	Ability to relate the volume of work and volume of material that need to be kept on site and spacial requirements for such materials	VI	G	I	G
MI-3	Knowledge of spacial requirements of manouverability of construction plants and equipments	VI	O	VI	S
MI-4	Ability to plan the layout of individual house units in such a way that there is no double handling of materials and components	I	G	I	O
KCF-2	<i>Dedication in helping works contractors achieve works schedule</i>	I		EI	
MI-5	Ability to predict,identify and clear road blocks to production schedule of work contractors	VI	S	EI	G
MI-6	Ability to plan, schedule,organise and communicate scope of works to work contractors	I	O	VI	S
MI-7	Assisting work contractors to review and adjust specific work place activities to meet production schedule	LI	G	LI	P
MI-8	Commitment to drive works contractors to meet set targets	I	P	UI	VP
KCF-3	<i>Knowledge of appropriate technology transfer for repetitive construction works.</i>	VI		EI	
MI-9	Willingness to implement new technology and the ability to manage people through change	EI	G	VI	G
MI-10	Ability to assess the impact of the adoption of appropriate technology on financial,schedule and quality performance of all housing units	VI	O	I	S
MI-11	Knowledge of organisational policy regarding the adoption of appropriate technology for repetitive construction	I	O	I	O
MI-12	Ability to identify and assess cultural backgrounds of work contractors and settings that may influence the adoption of appropriate technology for repetitive construction	I	S	VI	G

*Linguistic Ratings: VP = Very Poor, P = Poor, S = Satisfactory, G = Good and O = Outstanding

Table 4.1: continued

Indicators(MIs)		Senior Manager-1		Senior Manager-2	
		LW	LR	LW	LR
KCF-4	<i>Effective time management practices on all project sites</i>	EI		I	
MI-13	Timely requisition of project resources such as materials and components	EI	O	I	S
MI-14	Knowledge of programming tools for repetitive construction such as line of balance	VI	G	I	S
MI-15	Ability to forecast and identify delays and offer alternative solutions so that work proceeds as schedule	VI	S	VI	O
MI-16	Ability to acquire permits on time	VI	O	EI	G
KCF-5	<i>Ability to provide effective solutions to conflicts while maintaining good relationships</i>	LI		I	
MI-17	Ability to predict and anticipate conflicts and quick to diffuse tensions	VI	G	I	O
MI-18	Ability to listen and gather information concerning conflicting parties	I	P	VI	G
MI-19	Ability to deal with peoples' prejudices and feelings or emotions and knowledge of team integration techniques	LI	O	VI	S
MI-20	Ability to maintain fairness between conflicting parties, good work ethics , integrity and honesty	LI	G	LI	P
KCF-6	<i>Ease with which works contractors are able to approach the PM with their problem</i>	I		VI	
MI-21	Ability to offer effective solutions to problems of work contractors	VI	G	VI	VP
MI-22	Trustworthiness and confidential	EI	S	I	P
MI-23	Ability to promote pride and workmanship among work contractors	I	P	LI	S
MI-24	Down to earth and approachable	I	G	UI	O
KCF-7	<i>Volunteering to help works contractors to solve personal problems</i>	UI		LI	
MI-25	Ability to appreciate problems of work contractors and their effects on output	I	G	I	VP
MI-26	Accommodating and altruistic in approach to problems of work contractors	I	G	VI	S
MI-27	Honest and resourceful	LI	S	LI	G
MI-28	Patient and sympathetic	LI	P	UI	O

Linguistic Weighting: UI = Unimportant, LI = Less Important, I = Important, VI = Very

Important and EI = Extremely Important.

4.2.2 Aggregating the Opinions of the Assessors

In accordance with Table 3.1 (chapter 3), the opinions of the senior managers in Table 4.1 can be transformed to triangular fuzzy numbers and aggregated using equation (1) (see chapter 3). The average fuzzy ratings and fuzzy weightings of the competency levels are obtained as shown in Table 4.4.

For instance, Table 4.2 shows the opinions of the senior managers on “Knowledge of appropriate site layout techniques for repetitive construction”; KCF-1 and MI-1 to MI-4.

Table 4.2: Assessment of PM with respect to KCF-1 and MI-1 to MI-4 by senior managers

Key Competency Factors(KCFs) and Measure Indicators(MIs)		Senior Manager-1		Senior Manager-2	
		LW	LR	LW	LR
KCF-1	<i>Knowledge of appropriate sitelayout techniques for repetitive construction works</i>	VI		EI	
MI-1	Knowledge of site restrictions both vertical and horizontal and choosing appropriate method for moving materials and components.	I	S	VI	P
MI-2	Ability to relate the volume of work and volume of material that need to be kept on site and spacial requirements for such materials	VI	G	I	G
MI-3	Knowledge of spacial requirements of manouverability of construction plants and equipments	VI	O	VI	S
MI-4	Ability to plan the layout of individual house units in such a way that there is no double handling of materials and components	I	G	I	O

Table 4.3: Aggregation of MI-1

MI-1	Senior Manager-	
	1	2
Linguistic Weighting	(0.30,0.50,0.70)	(0.60,0.75,0.90)
Linguistic Rating	(0.30,0.50,0.70)	(0.80,1.00,1.00)

Using equation(1) and (2) (see chapter 3)

Average linguistic weighting (Avw) is

$$Avw = \left(\frac{1}{2} (0.30 \oplus 0.60), \frac{1}{2} (0.50 \oplus 0.75), \frac{1}{2} (0.70 \oplus 0.90) \right)$$

$$Avw = (0.45, 0.63, 0.80)$$

Also, the Average linguistic rating (Avr) is

$$Avr = \left(\frac{1}{2} (0.30 \oplus 0.80), \frac{1}{2} (0.50 \oplus 1.00), \frac{1}{2} (0.70 \oplus 1.00) \right)$$

$$Avr = (0.55, 0.75, 0.85)$$

This process is repeated for all linguistic weightings and ratings from MI-1 to MI-28 including the weightings on the KCFs. Note that the average fuzzy weightings and the average fuzzy ratings are used to pull the opinions of the two senior managers together. The figures in bold represent the average weightings of the seven key competency factors (KCFs) needed in managing the construction phase of MHBPs.

Table 4.4: Average fuzzy weightings and ratings of competency attributes

Key Competency Factors(KCFs) and Measure Indicators(MIs)		Average Fuzzy Weightings	Average Fuzzy Ratings
KCF-1	<i>Knowledge of appropriate sitelayout techniques for repetitive construction works</i>	(0.68, 0.89, 0.95)	
MI-1		(0.45, 0.63, 0.80)	(0.55, 0.75, 0.85)
MI-2		(0.45, 0.63, 0.80)	(0.60, 0.75, 0.90)
MI-3		(0.60, 0.75, 0.90)	(0.55, 0.75, 0.85)
MI-4		(0.30, 0.50, 0.70)	(0.70, 0.88, 0.95)
KCF-2	<i>Knowledge of appropriate technology transfer for repetitive construction works.</i>	(0.55, 0.75, 0.85)	
MI-5		(0.70, 0.88, 0.95)	(0.45, 0.63, 0.80)
MI-6		(0.45, 0.63, 0.80)	(0.55, 0.75, 0.85)
MI-7		(0.10, 0.25, 0.40)	(0.35, 0.50, 0.65)
MI-8		(0.15, 0.25, 0.45)	(0.05, 0.13, 0.30)
KCF-3	<i>Dedication in helping works contractors achieve work schedule</i>	(0.70, 0.88, 0.95)	
MI-9		(0.70, 0.88, 0.95)	(0.60, 0.75, 0.90)
MI-10		(0.45, 0.63, 0.80)	(0.55, 0.75, 0.85)
MI-11		(0.30, 0.50, 0.70)	(0.80, 1.00, 1.00)
MI-12		(0.45, 0.63, 0.80)	(0.45, 0.63, 0.80)
KCF-4	<i>Effective site management practices on all project sites</i>	(0.55, 0.75, 0.85,)	
MI-13		(0.55, 0.75, 0.85)	(0.55, 0.75, 0.85)
MI-14		(0.45, 0.63, 0.80)	(0.45, 0.63, 0.80)
MI-15		(0.60, 0.75, 0.90)	(0.55, 0.75, 0.85)
MI-16		(0.70, 0.88, 0.95)	(0.70, 0.88, 0.95)
KCF-5	<i>Ability to provide effective solutions to conflicts while maintaining good relationships</i>	(0.20, 0.38, 0.55)	
MI-17		(0.45, 0.63, 0.80)	(0.70, 0.88, 0.95)
MI-18		(0.45, 0.63, 0.80)	(0.35, 0.50, 0.65)
MI-19		(0.35, 0.50, 0.65)	(0.55, 0.75, 0.85)
MI-20		(0.10, 0.25, 0.40)	(0.35, 0.50, 0.65)
KCF-6	<i>Ease with which works contractors are able to approach the PM with their problem</i>	(0.45, 0.63, 0.80)	
MI-21		(0.60, 0.75, 0.90)	(0.30, 0.38, 0.55)
MI-22		(0.55, 0.75, 0.85)	(0.20, 0.38, 0.55)
MI-23		(0.20, 0.38, 0.55)	(0.20, 0.38, 0.55)
MI-24		(0.15, 0.25, 0.45)	(0.70, 0.88, 0.95)
KCF-7	<i>Volunteering to help works contractors to solve personal problems</i>	(0.05, 0.13, 0.30)	
MI-25		(0.30, 0.50, 0.70)	(0.30, 0.38, 0.55)
MI-26		(0.45, 0.63, 0.80)	(0.45, 0.63, 0.80)
MI-27		(0.10, 0.25, 0.40)	(0.45, 0.63, 0.80)
MI-28		(0.05, 0.13, 0.30)	(0.45, 0.63, 0.80)

4.2.3 Calculating the Fuzzy Competency Rating (FCR) and Normalized Fuzzy Competency Rating (NFCR) for the KCFs

According to equation (3) and (4), the FCR and NFCR for each main criterion can be calculated. For the main criterion “Knowledge of appropriate site layout techniques for repetitive construction works”, the calculation process is shown below;

Calculating the Fuzzy Competency Rating (FCR) for the KCF-1

KCF 1.

$$(0.45, 0.63, 0.80) \otimes (0.55, 0.75, 0.85) = (0.25, 0.47, 0.68)$$

$$\oplus (0.45, 0.63, 0.80) \otimes (0.60, 0.75, 0.90) = (0.27, 0.47, 0.72)$$

$$\oplus (0.60, 0.75, 0.90) \otimes (0.55, 0.75, 0.55) = (0.33, 0.56, 0.78)$$

$$\oplus (0.30, 0.50, 0.70) \otimes (0.70, 0.88, 0.95) = (0.21, 0.44, 0.68)$$

$$FCR_1 = (1.06, 1.94, 2.85)$$

The value of the FCR_1 is also a triangular fuzzy number denoted as $FCR = (\kappa_1, \kappa_m, \kappa_u)$. To keep the value of FCR within the range $\{0, 1\}$, a normalization method is needed. The most common method is to use the maximum a_u denoted as a_u^* to divide $FCR = (\kappa_1, \kappa_m, \kappa_u)$. According to Tan et al. (2011), where there is only one subject as in the case of the PM, the maximum a_u^* is ascertained by setting all attributes rating as the maximum rating (0.80, 1.00, 1.00) and keeping the weightings unchanged. By using equation (3), the FCR with the maximum a_u^* will be obtained as $FCR^* = (a_1^*, a_m^*, a_u^*)$ and the normalised fuzzy competency rating (NFCR) can be calculated by the following equation

$$NFCR = \frac{FCR}{a_u^*} = \left(\frac{\kappa_1}{a_u^*}, \frac{\kappa_m}{a_u^*}, \frac{\kappa_u}{a_u^*} \right) \dots \dots \text{equation (4)}$$

Calculating FCR* whilst keeping weightings constant and ratings maximum (0.80, 1.00, 1.00) for

KCF – 1

$$(0.45, 0.63, 0.80) \otimes (0.80, 1.00, 1.00) = (0.36, 0.63, 0.80)$$

$$\oplus (0.45, 0.63, 0.80) \otimes (0.80, 1.00, 1.00) = (0.36, 0.63, 0.80)$$

$$\oplus (0.60, 0.75, 0.90) \otimes (0.80, 1.00, 1.00) = (0.48, 0.75, 0.90)$$

$$\oplus (0.30, 0.50, 0.70) \otimes (0.80, 1.00, 1.00) = (0.24, 0.50, 0.70)$$

$$FCR_1^* = (1.44, 2.51, 3.20)$$

$$a_u^* = 3.20$$

The process is repeated for the rest of the main attributes (KCFs).see appendix B. The results are shown in Table 4.5.

Table 4.5: FCRs and NFCRs of KCF-1 to KCF-7

Key Competency Factor (KCF)	Fuzzy Competency Rating (FCR)	a_u	Normalized Fuzzy Competency Rating (NFCR)
KCF - 1	(1.06, 1.94, 2.85)	3.20	(0.33, 0.61, 0.89)
KCF - 2	(0.62, 1.18, 1.84)	2.60	(0.24, 0.45, 0.71)
KCF - 3	(1.11, 2.03, 2.88)	3.25	(0.34, 0.62, 0.89)
KCF - 4	(1.32, 2.29, 3.03)	3.50	(0.37, 0.65, 0.87)
KCF - 5	(0.71, 1.38, 2.09)	2.65	(0.27, 0.52, 0.79)
KCF - 6	(0.44, 0.94, 1.69)	2.75	(0.16, 0.34, 0.61)
KCF - 7	(0.36, 0.83, 1.59)	2.20	(0.16, 0.38, 0.72)

4.2.4 Calculating the FCR and NFCR of the PMs Total Competency level

With the results of the seven main attributes (KCFs), the FCR and the NFCR of the PMs total competency level can be calculated. Here, the NFCRs of the seven main attributes (see Table 4.5) are multiplied by the weighting of the seven key competency factors and added to give the total FCR. The maximum a_u method (see equation (4)) is used to keep the values of FCR between $\{0,1\}$. The calculation process is shown below.

Table 4.6 NFCRs and Weightings of KCFs

Key Competency Factor (KCF)	Normalized Fuzzy Competency	
	Rating (NFCR)	Average Weightings
KCF - 1	(0.33, 0.61, 0.89)	(0.68, 0.89, 0.95)
KCF - 2	(0.24, 0.45, 0.71)	(0.55, 0.75, 0.85)
KCF - 3	(0.34, 0.62, 0.89)	(0.70, 0.88, 0.95)
KCF - 4	(0.37, 0.65, 0.87)	(0.55, 0.75, 0.85,)
KCF - 5	(0.27, 0.52, 0.79)	(0.20, 0.38, 0.55)
KCF - 6	(0.16, 0.34, 0.61)	(0.45, 0.63, 0.80)
KCF - 7	(0.16, 0.38, 0.72)	(0.05, 0.13, 0.30)

Total FCR is given as

$$\begin{aligned}
 & [(0.33, 0.61, 0.89) \otimes (0.68, 0.89, 0.95)] \oplus [(0.24, 0.45, 0.71) \otimes (0.55, 0.75, 0.85)] \\
 & \oplus [(0.34, 0.62, 0.89) \otimes (0.70, 0.88, 0.95)] \\
 & \oplus [(0.37, 0.65, 0.87) \otimes (0.55, 0.75, 0.85)] \\
 & \oplus [(0.27, 0.52, 0.79) \otimes (0.20, 0.38, 0.55)] \\
 & \oplus [(0.16, 0.34, 0.61) \otimes (0.45, 0.63, 0.80)] \\
 & \oplus [(0.16, 0.38, 0.72) \otimes (0.05, 0.13, 0.30)] = (0.93, 2.38, 4.14)
 \end{aligned}$$

Therefore the Total $FCR = (0.93, 2.38, 4.14)$

To keep the values of the total FCR between $\{0,1\}$, the average weightings of the main attributes (KCFs) are multiplied again by the maximum rating (0.80,1.00,1.00) and added to get the maximum a_u .

The calculation of the maximum a_u is shown below

$$\begin{aligned}
 & [(0.80, 1.00, 1.00) \otimes (0.68, 0.89, 0.95)] \oplus [(0.80, 1.00, 1.00) \otimes (0.55, 0.75, 0.85)] \\
 & \oplus [(0.80, 1.00, 1.00) \otimes (0.70, 0.88, 0.95)] \\
 & \oplus [(0.80, 1.00, 1.00) \otimes (0.55, 0.75, 0.85)] \\
 & \oplus [(0.80, 1.00, 1.00) \otimes (0.20, 0.38, 0.55)] \\
 & \oplus [(0.80, 1.00, 1.00) \otimes (0.45, 0.63, 0.80)] \\
 & \oplus [(0.80, 1.00, 1.00) \otimes (0.05, 0.13, 0.30)] = (2.54, 4.41, 5.25)
 \end{aligned}$$

Hence the maximum $a_u = 5.25$

Therefore the Normalized fuzzy competency rating ($NFCR_o$) = $FCR / 5.25 =$

$$\begin{aligned}
 & (0.93/5.25, 2.38/5.25, 4.14/5.25) \\
 & = (0.18, 0.45, 0.79)
 \end{aligned}$$

4.2.5 Matching the NFCR to linguistic terms

With the results from the previous step, each NFCR can be matched to an appropriate linguistic expression in the natural language set (table 3.20) using the Euclidean distance formula of equation (5). This is done for all the main competencies and the total competency level of the PM. It is noted that, the expression with the least distance to the NFCR describes naturally the competency level of the subject PM. The Euclidean distance between the total competency level - $NFCR_o$ - and the expression “Very low” of the natural language set is illustrated below:

$$d(NFCR_o, VL) = \left\{ \frac{1}{3} [(0.18 - 0.00)^2 + (0.45 - 0.10)^2 + (0.79 - 0.25)^2] \right\}^{1/2}$$

$$= \left[\frac{(0.0324 + 0.1225 + 0.2916)}{3} \right]^{1/2} = (0.148)^{1/2} = 0.39$$

Similarly, all the NFCRs of all individual attributes (KCF-1 to KCF-7) are matched to all the expressions of the natural language set. The results is summarized in Table 4.7

Table 4.7: Distances between NFCR and the natural language expression set

Normalized Fuzzy Competency Ratings(NFCR)								
Natural Language Competency Levels	NFCR-0	NFCR1	NFCR-2	NFCR-3	NFCR-4	NFCR-5	NFCR-6	NFCR-7
Very Low(VL)	0.39	0.51	0.62	0.51	0.52	0.39	0.27	0.33
Low(L)	0.22	0.32	0.18	0.33	0.34	0.24	0.10	0.16
Average(A)	0.13	0.15	0.08	0.16	0.15	0.20	0.15	0.13
High(H)	0.26	0.13	0.24	0.13	0.11	0.18	0.34	0.30
Very High(VH)	0.44	0.52	0.42	0.29	0.27	0.37	0.52	0.48

4.3 Discussion of competency levels

With the results in Table 4.7, the level of competency exhibited by the PM on the seven KCFs can be expressed as:

- with Euclidean distance of **0.13**,NFCR-1 is closer to “**High**” therefore the PMs performance in the eyes of the senior managers with respect to “Knowledge of site layout techniques for repetitive construction” is high.
- with Euclidean distance of **0.08**,NFCR-2 is closer to “**Average**”, therefore the PM’s competency in Knowledge of appropriate technology transfer for repetitive construction is “Average”

- With Euclidean distance of **0.13**, NFCR-3 is closer to **“High”**, therefore in the opinion of senior managers, the PM is average in his “dedication in helping works contractors or artisans achieve works schedule”.
- with Euclidean distance of **0.11**,NFCR-4 is closer to **“High”** meaning that the PM’s level of competency with regards to “Effective time management practices on house units is “High”
- with Euclidean distance of **0.18**,NFCR-5 is closer to **“High”** hence the PM’s ability to provide solutions to conflicts while maintaining good relationships is “High”
- with Euclidean distance of **0.10**,NFCR-6 is closer to **“Low”**, therefore the PM’s competency with respect to “Ease with which works contractors and/or artisans are able to approach the PM with their problems is “Low”
- with Euclidean distance of **0.13**,NFCR-7 is closer to **“Average”**, thus the PM’s level of competency with respect to “Volunteering to help works contractors and/or artisans solve personal problems is “Average”

4.3.1 NFCR-0 - The Overall Competency of the Project Manager

With Euclidean distance of **0.13**, **NFRC-0** is closer to “Average”. This means the total competency level of the project manager at the time that this evaluation was done is average. Consider figure 4.1.

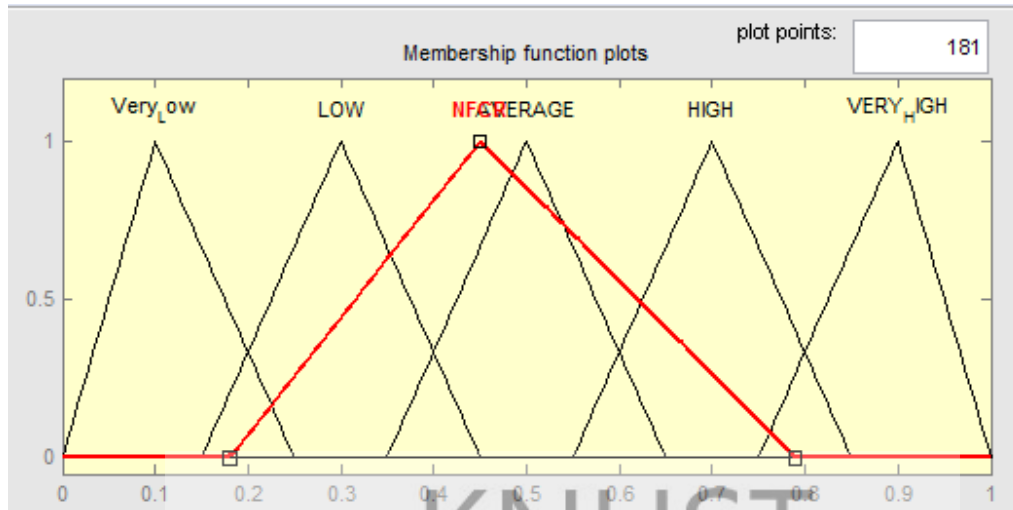


Figure 4.1: Graph of NFCR-0 (in red) superimposed on Membership function plots

From figure 4.1 above, one can understand that, the three linguistic terms “Low”, “Average” and “High” are the adjacent terms of NFCR-0, which denotes the total competency level of the project manager. Clearly, “Average” is over 95% immersed in the function plot of NFCR-0. Therefore in the eyes of senior managers, the performance of the project manager during the construction phase of the over (10) four-storey residential flats is average. This is a confirmation of the fact that performance of project managers at the construction phase of Mass housing Building Projects (MHBPs) is average in Ghana (Ahadzie 2007). Therefore there is the need for performance improvement.

Further, the analysis has revealed the usefulness of fuzzy sets in multi-criteria decision making. In fact, according to Kahraman et al.(2003), humans are uncertain in given crisp scores in any evaluation, therefore senior managers are allowed to express their opinions about the performance of their PM using more realistic, qualitative and linguistic terms appropriate for the evaluation.

Besides, the NFCR-0 generated by the analysis which is expressed in a range of values paints an overall picture and thereby offers flexibility for senior managers in decision making. Decisions regarding promotions, need for training, bonus, PM Job matching and deployment can easily be made after evaluations.

4.4 Summary

Basically this chapter concentrated on the analysis of the data gathered and inferences made about the competency level of the PM relative to the seven key competences that engenders superior performance. Some merits of using the fuzzy approach were also highlighted. Overall the PM is adjudged average.



CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

The aim of this study has been to come out with an evaluation and decision making framework for evaluating the performance of project managers (PMs) at the construction phase of mass house building projects (MHBPs). The study employed the seven (7) key competencies required by PMs during the construction phase of MHBPs as outlined by Ahadzie et al. (2009a). The research questions guided the formation of the objectives. This chapter outlines the objectives of the study and how each has been achieved. Lessons drawn from the research and potential application of the findings are also discussed. The chapter ends with recommendations on further studies on the measure indicators or antecedents to the seven (7) key competency factors (KCFs).

5.1 Review of Objective 1

Identify the antecedents of the seven (7) Key Competency Factors (KCFs) that engender superior PM performance at the construction phase of Mass House Building Projects

The preliminary interview and literature review revealed four (4) antecedents to each key competency factor, making a total of thirty five (35) variables used in the evaluation of the competency level of the project manager. The antecedents used in this study provide insight to the key competencies that are required in the management of MHBPs. However, we want to state that the twenty eight (28) measure indicators or antecedents are by no means exhaustive; therefore new factors may be added and the old ones amended to reflect the peculiar characteristic and situations of the company involved. Table 5.1 shows the KCFs and MIs.

Table 5.1: The seven Key Competency Factors (KCF) and their Measure Indicators (MI)

Key Competency Factors(KCFs) and Measure Indicators(MIs)	
KCF-1	<i>Knowledge of appropriate site layout techniques for repetitive construction works</i>
MI-1	Knowledge of site restrictions both vertical and horizontal and choosing appropriate method for moving materials and components.
MI-2	Ability to relate the volume of work and volume of material that need to be kept on site and spacial requirements for such materials
MI-3	Knowledge of spacial requirements of maneuverability of construction plants and equipment
MI-4	Ability to plan the layout of individual house units in such a way that there is no double handling of materials and components
KCF-2	<i>Knowledge of appropriate technology transfer for repetitive construction works.</i>
MI-5	Willingness to implement new technology and the ability to manage people through change
MI-6	Ability to assess the impact of the adoption of appropriate technology on financial, schedule and quality performance of all housing units
MI-7	Knowledge of organisational policy regarding the adoption of appropriate technology for repetitive construction
MI-8	Ability to identify and assess cultural backgrounds of work contractors and settings that may influence the adoption of appropriate technology for repetitive construction
KCF-3	<i>Dedication in helping works contractors achieve works schedule</i>
MI-9	Ability to predict, identify and clear road blocks to production schedule of work contractors
MI-10	Ability to plan, schedule, organise and communicate scope of works to work contractors
MI-11	Assisting work contractors to review and adjust specific work place activities to meet production schedule
MI-12	Commitment to drive works contractors to meet set targets

Table 5.1: The Seven (7) Key Competency Factors and Measure Indicators (MI)
cont'

Key Competency Factors(KCFs) and Measure Indicators(MIs)	
KCF-4	<i>Effective time management practices on all project sites</i>
MI-13	Timely requisition of project resources such as materials and components
MI-14	Knowledge of programming tools for repetitive construction such as line of balance
MI-15	Ability to forecast and identify delays and offer alternative solutions so that work proceeds as schedule
MI-16	Ability to acquire permits on time
KCF-5	<i>Ability to provide effective solutions to conflicts while maintaining good relationships</i>
MI-17	Ability to predict and anticipate conflicts and quick to diffuse tensions
MI-18	Ability to listen and gather information concerning conflicting parties
MI-19	Ability to deal with peoples' prejudices and feelings or emotions and knowledge of team integration techniques
MI-20	Ability to maintain fairness between conflicting parties, good work ethics , integrity and honesty
KCF-6	<i>Ease with which works contractors are able to approach the PM with their problem</i>
MI-21	Ability to offer effective solutions to problems of work contractors
MI-22	Trustworthiness and confidential
MI-23	Ability to promote pride and workmanship among work contractors
MI-24	Down to earth and approachable
KCF-7	<i>Volunteering to help works contractors to solve personal problems</i>
MI-25	Ability to appreciate problems of work contractors and their effects on output
MI-26	Accommodating and altruistic in approach to problems of work contractors
MI-27	Honest and resourceful
MI-28	Patient and sympathetic

5.2 Review of Objective Two

Evaluate and establish the competency level of an active PM based on the seven key competencies (KCFs) using a case study of a mass housing company in Ghana.

A decision making framework has been developed for the evaluation of competencies required in the management of MHBPs. In coming out with this framework, linguistic terms involved were a modification of previously used versions in project management and construction in general. The competency level of the PM at the construction phase of mass house building project is in the eyes of senior managers is average. However, it is acknowledged that linguistic expressions and membership functions used in any subsequent case study should reflect the cognitive perspective of the evaluators. Further, competitive strategies of companies vary and so, companies must establish their own membership functions suitable to their own situation.

5.3 Review of Objective Three

Ascertain the relevance of the seven (7) core competencies required by PMs at the construction phase of mass house building projects.

The study revealed that the seven (7) core competencies required by PMs at the construction phase of MHBPs are relevant in the performance evaluation of PMs.

5.4 Potential uses of the framework

Industrial contributions of this study include the development of measure indicators which provides insight to the seven key competencies required by Project Managers in MHBPs. The fuzzy approach provides a practical and easy method for the evaluation and prediction of the competency of a PM at any time. The main advantage of this model is its ability to allow senior managers to express their impressions about the performance of a PM using every day language.

If this approach is adopted by a number of mass housing companies over time, the collective results can be used to identify industry wide gaps in the competencies of PM at the construction phase of MHBPs. Training programs can then be instituted to overcome these gaps.

Academically, the contribution of this study includes the development of a framework for evaluating the competencies of PMs based on profiles defined by decision makers. The strength of this approach lies in its ability to use human language and reasoning style in decision making.

5.4 Conclusion

It is interesting to note that there is a little deviation from the expected results. Before senior managers started putting weightings and ratings on the KCFs and MIs, their impression about the competency level of the PM under assessment was “High”. The results after the rigorous analysis show that the PMs Competency level is actually “Average”. This confirms an earlier study that the performance of PMs in Ghana is average and therefore the fuzzy technique is proven to be an important decision tool in performance evaluation of the PM. The findings also suggest that the seven (7) core competencies have relevance in the Ghanaian mass house building sector and have the potential for further use in performance evaluation of the PM.

5.4 Recommendation

Regarding the measure indicators of the competencies required at the construction phase of mass house building projects, it is recommended that an industry wide research is done to come out with a collective set of measure indicators. This will create a common platform for evaluating PMs and perhaps develop training manuals for potential and practicing project managers.

According to Lin & Chen (2004), the calculation of Fuzzy Competency rating (FCR) is quite complicated and not easily appreciated by managers, therefore we recommend that further studies concentrate on a computerizing the calculation of FCR so as to reduce time and avoid errors.

Finally, it is suggested that the fuzzy approach is applied in the performance evaluation of PMs at the procurement, design and operational phases of mass housing project development.



REFERENCES

- Ahadzie, D K, Proverbs, D G & Olomolaiye, P.O., 2008a. Critical success criteria for mass house building projects in developing countries. *International Journal of Project Management*, 26(6), pp.675–687.
- Ahadzie, D K, Proverbs, D G & Olomolaiye, P.O., 2008b. Model for Predicting the Performance of Project Managers at Construction Phase of Mass House Building Projects. *Journal of Construction Engineering and Management*, 134(8), pp.618–629.
- Ahadzie, Divine Kwaku, 2007. A Model for Predicting the Performance of Project Managers in Mass House Building Projects in Ghana. PhD. Thesis, University of Wolverhampton, UK.
- Ahadzie, Divine Kwaku, Proverbs, David Gavin & Olomolaiye, P., 2008c. Towards developing competency-based measures for construction project managers : Should contextual behaviours be distinguished from task behaviours ? *International Journal of Project Management*, 26(6), pp.631–645.
- Ahadzie, D.K., Proverbs, D.G. and Olomolaiye, P. (2004) Meeting housing delivery targets in developing countries: the contribution of project managers in Ghana, in Ogunlana, S. (eds) *Globalization and Construction in Developing Countries*, AIT Conference Centre, Bangkok, Thailand, 17–19 November, pp. 620–30.
- Ahadzie, D.K., D.G. Proverbs, P.O. Olomolaiye, and N.A. Ankrah., 2009a. Towards developing competency - based measures for project managers in mass house building projects in developing countries. *Construction Management and Economics*, 27(1), pp.89–102.
- Ahadzie, D.K., Proverbs , D.G., Olomolaiye, P.O., and Ankrah, N.A., 2009b. Competencies required by project managers for housing construction in Ghana: Implications for CPD agenda. *Engineering, Construction and Architectural Management*, 16(4), pp.353–375. Available at: <http://www.emeraldinsight.com/10.1108/09699980910970842> [Accessed December 10, 2011].
- Brill, J.M., Bishop, M.J. & Walker, A.E., 2006. The Competencies and Characteristics Required of an Effective Project Manager: A Web-Based Delphi Study. *Educational Technology Research and Development*, 54(2), pp.115–140. Available at: <http://www.springerlink.com/index/10.1007/s11423-006-8251-y>.
- Buckley, J and Eslami, E. (2002), *An introduction to Fuzzy Logic and Fuzzy sets: Advances in soft Computing*, Physica-Verlag, Heilderlberg, NY, USA.
- Chen, P., 2009. A Fuzzy Multiple Criteria Decision Making Model in Employee Recruitment. *Journal of Computer Science*, 9(7), pp.113–117.

- Cheng, M.I., Dainty, A.R.J. and Moore, D.R. (2003) The differing faces of managerial competency in Britain and America. *Journal of Management Development*, 22(6), 527–37
- Crawford, L., 2004. Senior management perceptions of project management competence. *International Journal of Project Management*, 23(1), pp.7–16.
- Dainty, A.R.J., Cheng, M. & Moore, D.R., 2003. Redefining performance measures for construction project managers : an empirical evaluation. *Construction Management and Economics*, 21(2), pp.209–218.
- Dainty, Andrew R J, M., Cheng, M. & Moore, D.R., 2005. Competency-Based Model for Predicting Construction Project Managers ' Performance. *Journal of Management in Engineering*, 21(January), pp.2–9.
- Edum-Fotwe, F.T & McCaffer, R., 2000. Developing project management competency : perspectives from the construction industry. *International Journal of Project Management*, 18, pp.111–124.
- El-Saaba, S. (2001) The skills and career path of an effective project manager. *International Journal of Project Management*, 19, 1–7
- Fellows, R and Liu, A. (2008) *Research Methods for Construction*, Wiley-Blackwell, UK
- Fong, P. S.W and Choi, S.K.-Y. (2000), “Final contractor selection using Analytical Hierarchy Process”, *Construction Management and Economics*., Vol. 18, pp 547-57
- Fraser, C., & Zarkada-fraser, A., 2003. Investigating the effectiveness of managers through an analysis of stakeholder perceptions. *Journal of Management Development*, 22(9), pp.762–783.
- G.Omidvar, S.D.Z.B.A.S.& S.F.Z., 2011. Critical Evaluation of Project Manager's Competency Standards for Proposing a Comprehensive Model. *1er Congrès International en Management et Gestion des projets, Gatineau, (Québec), Canada*.,
- Garavan, T.N. & McGuire, D., 2001. Competencies and workplace learning : some reflections on the rhetoric and the reality. *Journal of Workplace Learning*, 13(4), pp.144–164.
- George,D,1993.Finding Your Way through Conflict, *Journal of Management in Engineering*, 9(2),pp.142-147
- Golec, A. & Kahya, E., 2007. A fuzzy model for competency-based employee evaluation and selection. *Computers & Industrial Engineering*, 52(1), pp.143–161.

- Goodwin, R.S.C, 1993, Skills Required of Effective Project Managers, *Journal of Management in Engineering*, 9(3), pp.217-226
- Gre´ goire Pe´ piot, Naoufel Cheikhrouhou, Jean-Marie Fu¨ rbringer, R.G., 2008. A fuzzy approach for the evaluation of competences ´. *International Journal of Production Economics*, 112(1), pp.336–353.
- Hayes, J., Rose-Quirie, A. & Allinson, C.W., 2000. Senior managers’ perceptions of the competencies they require for effective performance: implications for training and development. *Personnel Review*, 29(1), pp.92–105. Available at: <http://www.emeraldinsight.com/10.1108/00483480010295835>.
- Hoffmann, T., 1999. The meanings of competency. *Journal of European Industrial Training*, 23(6), pp.275–286.
- Houé, R., Grabot, B. & Tchuente, G., 2011. Fuzzy logic in competence management. *EUSFLAT-LFA*, (July 2011), pp.651–656.
- Jubb, R. & Robotham, D., 1997. Competences in management development : challenging the myths. *Journal of European Industrial Training*, 21(5), pp.171–175.
- Kahraman, C., Cebeci, U. & Ulukan, Z., 2003. Multi-criteria supplier selection using fuzzy AHP. *Logistics Information Management*, 16(6), pp.382–394.
- Kiely, T. & Brophy, M., 2001. Competencies ; A New Sector ; Developing a Competency Model for Three Star Hotels. , pp.0–32.
- Koul, S. & Verma, R., 2011. Dynamic vendor selection based on fuzzy AHP. *Journal of Manufacturing Technology Management*, 22(8), pp.963–971. Available at: <http://www.emeraldinsight.com/journals.htm?articleid=1958469&show=abstract> [Accessed January 30, 2012].
- Lai-Kit, C. and S. Thomas Ng.(2005) Establishing a quantitative performance evaluation framework through fuzzy membership functions. *Proceedings, ARCOM 21st Annual Conference 2005 sept 7-9, SOAS London, Vol 2 pp 1015-1024*
- Liang, W.-Y., 2003. The analytic hierarchy process in project evaluation. *Benchmarking: An International Journal*, 10(5), pp.445–456.
- Lin, C. & Chen, Y., 2004. Bid / no-bid decision-making – a fuzzy linguistic approach. *International Journal of Project Management*, 22, pp.585–593.
- Martin S. and P. Barrett (2004), the role of technology transfer innovation within small construction firms. *Engineering, Construction and Architectural Management* , Vol. 11, No. 5 pp342-348.
- Mcclelland, D.C., 1973. Testing for Competence Rather Than for “ Intelligence .” *American Psychologist*, (January), pp.1–14.

- Morris, P.W., 2001. Updating the project management bodies of knowledge. *project management journal*, 32(3), pp.21–30.
- Nguyen, T.H., Shehab, T. & Gao, Z., 2008. Selecting an architecture-engineering team by using fuzzy set theory. *Engineering, Construction and Architectural Management*, 15(3), pp.282–298. Available at: <http://www.emeraldinsight.com/10.1108/09699980810867433> [Accessed September 25, 2011].
- Ogunlana, S. et al., 2002. Factors and procedures used in matching project managers to construction projects in Bangkok. *International Journal of Project Management*, 20(5), pp.385–400.
- Pereira, V.R. & Carvalho, M.M.D., 2009. Evaluating project manager performance : a case study. *Product: Management and Development*, 7(June), pp.65–70.
- Poveda, C.A. & Fayek, A.R., 2009. Predicting and Evaluating Construction Trades Foremen Performance: Fuzzy Logic Approach. *Journal of Construction Engineering and Management*, (September), pp.920–929.
- Richard J. Mirabile, 1997. everything you wanted to know about competency modelling. , pp.73–77.
- Rowe, C., 1995. Clarifying the use of competence and competency models in recruitment , assessment and staff development. *Industrial and Commercial training*, 27(11), pp.12–17.
- Stuart, R. & Lindsay, P., 1997. Beyond the frame of management competenc (i) es : towards a contextually embedded framework of managerial competence in organizations. *Journal of European Industrial Training*, 21(1), pp.26–33.
- Roy, C. and Cochrane, S.P. (1999) Development of customer focused strategy in speculative house building. *Construction Management and Economics*, 17, 777–87.
- Tan, Y., Shen, L. & Langston, C., 2011. A fuzzy approach for assessing contractors ' competitiveness. *Engineering, Construction and Architectural Management*, 18(3), pp.234–247.
- Torfi, F. & Rashidi, A., 2011. Selection of Project Managers in Construction Firms Using Analytic Hierarchy Process (AHP) and Fuzzy Topsis : A Case Study. *Construction in Developing Countries*, 16(1), pp.69–89.
- Tsui, A.S. and Ohlott, P. (1988), “Multiple assessment of managerial effectiveness: interrater agreement and consensus in effectiveness models”, *Personnel Psychology*, Vol. 41, pp. 779-803.
- Verkuilen, J.A.Y., 2005. Assigning Membership in a Fuzzy Set Analysis. *Sociological Methods and Research*, 33(4), pp.462–496.

- Walter C. Borman and Stephen J. Motowidlo, 1997. task and contextual performance: the meaning for personnel selection research. *Human Performance*, 10(2), pp.99–109.
- W. Wo Seng Lei and M. Skitmore, 2004, project management competencies: A survey of perspectives from project Managers in south east Queensland, *Journal of Building and Construction Management*, 9(1) pp.1-12

KNUST



APPENDICES

APPENDIX A: QUESTIONNAIRE

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ARCHITECTURE AND PLANNING

DEPARTMENT OF BUILDING TECHNOLOGY

TOPIC: COMPETENCY-BASED PROJECT MANAGERS EVALUATION IN MASS HOUSE BUILDING PROJECTS (MHBPs) -THE FUZZY SET THEORY APPROACH

This study aims at developing a method of assessment of the performance of a Project Manager for property developers. Your company has been identified as the largest estate development organisation and therefore chosen for this case study. Your view is therefore critical for this study.

Please be assured that, any information given will be treated confidentially.

SECTION A - kindly tick the appropriate answer where applicable.

1) How long has the company been in operation in Ghana?

☐ 5yrs - 10yrs ☐ 10yrs – 20yrs ☐ 20yrs and over

2) Approximately how many housing units have you worked on since you started operations in the country?.....

3) How many Housing units are you working on currently?

4) At what stage are the houses you are working on currently? (please tick)

- ☐ Inception ☐ construction ☐ completion ☐
- Operation

Other (Please specify).....

5) What type of housing units is your company developing currently?(please tick)

- ☐ Semi-detached ☐ Detached ☐ Multi-storey flats
- ☐ Mixed (Please specify)..... ☐ All of the above

Section B

Please indicate what attributes you will look for when evaluating a PM base on the seven (7) criteria outlined below:

1. Knowledge of appropriate site layout techniques for repetitive construction works

I.

II.

III.

IV.

Others.....

2. Dedication in helping works contractors to achieve works schedule

I.

II.

III.

IV.

Others.....

3. Knowledge of appropriate technology transfer for repetitive construction works

- I.
- II.
- III.
- IV.

Others.....

4. Effective time management practices on all project sites

- I.
- II.
- III.
- IV.

Others.....

5. Ability to provide effective solutions to conflicts while maintaining good relationships

- I.
- II.
- III.
- IV.

Others.....

6. Ease with which works contractors are able to approach the project manager with their problem

- I.
- II.
- III.
- IV.

Others.....

7. Volunteering to help work contractors and/or artisans to solve personal problems

I.

II.

III.

IV.

Others.....

8. Please, do you think the seven(7) key competencies outlined above is still relevant to performance management of PM in MHBPs?



KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ARCHITECTURE AND PLANNING

DEPARTMENT OF BUILDING TECHNOLOGY

TOPIC: COMPETENCY-BASED PROJECT MANAGERS EVALUATION IN MASS HOUSE BUILDING PROJECTS (MHBPs) -THE FUZZY SET THEORY APPROACH

This study aims at developing a method of assessment of the performance of a Project Manager for property developers. Your company has been identified as the largest estate development organisation and therefore chosen for this case study. Your view is therefore critical for this study.

Please be assured that, any information given will be treated confidentially

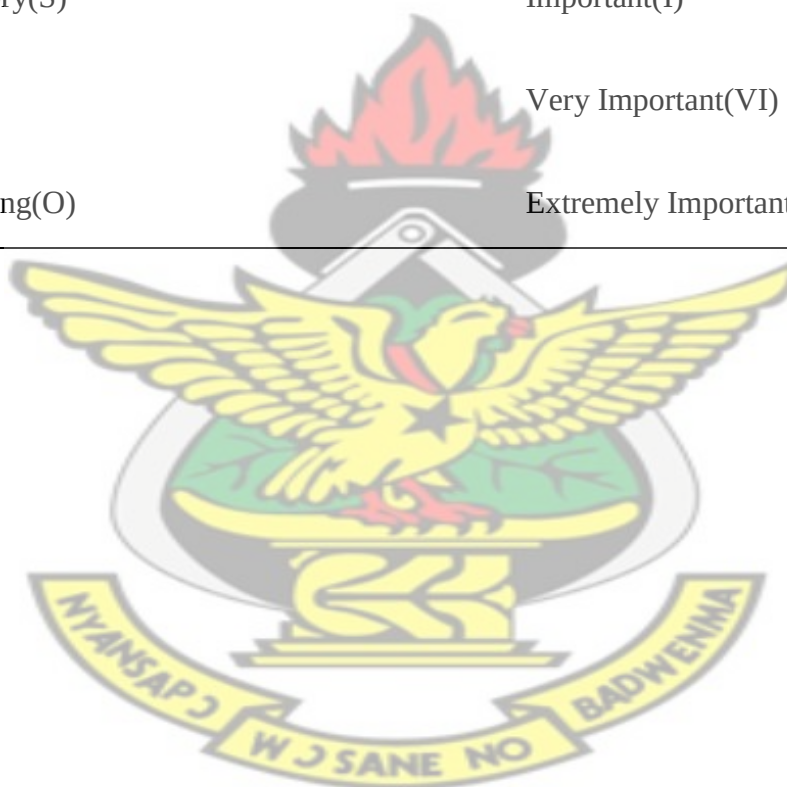
These set of questions are aimed at assessing the performance of the PM on your ongoing project.

SECTION A

- 1) How long has the PM worked with your company?.....
- 2) Which of the following housing units has your current PM worked on since his appointment? (You may choose **MORE THAN ONE** if applicable)
☐ Semi-detached ☐ Detached ☐ Multi-storey flats
- 3) Which of the following housing units is your PM working on presently? (You may choose **MORE THAN ONE** if applicable)
☐ Semi-detached ☐ Detached ☐ Multi-storey flats
- 4) How will you rate his/ her performance so far?(pick **ONE** only)
☐ Very Low (VL) ☐ Low (L) ☐ Average (A)
☐ High (H) ☐ Very High (VH)

The table below shows the linguistic terms to be used in evaluating the PM based on the seven (7) Key Competency Factors (KCF) and the Factor Indicators (FI)(of the KCF) in MHBPs. It should be used to answer the questions that follow. Please use the abbreviations provided.

LINGUISTIC RATING	LINGUISTIC WEIGHTING
Very Poor(VP)	Unimportant(UI)
Poor(P)	Less Important(LI)
Satisfactory(S)	Important(I)
Good(G)	Very Important(VI)
Outstanding(O)	Extremely Important(EI)



Key Competency Factors(KCFs) and Measure Indicators(MIs)		Senior Manager-1		Senior Manager-2	
		LW	LR	LW	LR
KCF-1	<i>Knowledge of appropriate sitelayout techniques for repetitive construction works</i>				
MI-1	Knowledge of site restrictions both vertical and horizontal and choosing appropriate method for moving materials and components.				
MI-2	Ability to relate the volume of work and volume of material that need to be kept on site and spacial requirements for such materials				
MI-3	Knowledge of spacial requirements of manouverability of construction plants and equipments				
MI-4	Ability to plan the layout of individual house units in such a way that there is no double handling of materials and components				
KCF-3	<i>Knowledge of appropriate technology transfer for repetitive construction works.</i>				
MI-5	Willingness to implement new technology and the ability to manage people through change				
MI-6	Ability to assess the impact of the adoption of appropriate technology on financial,schedule and quality performance of all housing units				
MI-7	Knowledge of organisational policy regarding the adoption of appropriate technology for repetitive construction				
MI-8	Ability to identify and assess cultural backgrounds of work contractors and settings that may influence the adoption of appropriate technology for repetitive construction				
KCF-3	<i>Dedication in helping works contractors achieve works schedule</i>				
MI-9	Ability to predict,identify and clear road blocks to production schedule of work contractors				
MI-10	Ability to plan, schedule,organise and communicate scope of works to work contractors				
MI-11	Assisting work contractors to review and adjust specific work place activities to meet production schedule				
MI-12	Commitment to drive works contractors to meet set targets				

		Senior Manager-1		Senior Manager-2	
	Indicators(MIs)	LW	LR	LW	LR
KCF-4	<i>Effective time management practices on all project sites</i>				
MI-13	Timely requisition of project resources such as materials and components				
MI-14	Knowledge of programming tools for repetitive construction such as line of balance				
MI-15	Ability to forecast and identify delays and offer alternative solutions so that work proceeds as schedule				
MI-16	Ability to acquire permits on time				
KCF-5	<i>Ability to provide effective solutions to conflicts while maintaining good relationships</i>				
MI-17	Ability to predict and anticipate conflicts and quick to diffuse tensions				
MI-18	Ability to listen and gather information concerning conflicting parties				
MI-19	Ability to deal with peoples' prejudices and feelings or emotions and knowledge of team integration techniques				
MI-20	Ability to maintain fairness between conflicting parties, good work ethics , integrity and honesty				
KCF-6	<i>Ease with which works contractors are able to approach the PM with their problem</i>				
MI-21	Ability to offer effective solutions to problems of work contractors				
MI-22	Trustworthiness and confidential				
MI-23	Ability to promote pride and workmanship among work contractors				
MI-24	Down to earth and approachable				
KCF-7	<i>Volunteering to help works contractors to solve personal problems</i>				
MI-25	Ability to appreciate problems of work contractors and their effects on output				
MI-26	Accommodating and altruistic in approach to problems of work contractors				
MI-27	Honest and resourceful				
MI-28	Patient and sympathetic				

APPENDIX B: FUZZY THEORY ARITHMETICS

Calculating the Fuzzy Competency Rating (FCR) for the KCF(s)

KCF 1.

$$(0.45, 0.63, 0.80) \otimes (0.55, 0.75, 0.85) = (0.25, 0.47, 0.68)$$

$$\oplus (0.45, 0.63, 0.80) \otimes (0.60, 0.75, 0.90) = (0.27, 0.47, 0.72)$$

$$\oplus (0.60, 0.75, 0.90) \otimes (0.55, 0.75, 0.55) = (0.33, 0.56, 0.78)$$

$$\oplus (0.30, 0.50, 0.70) \otimes (0.70, 0.88, 0.95) = (0.21, 0.44, 0.68)$$

$$FCR_1 = (1.06, 1.94, 2.85)$$

To keep the FCR(s) between the [0,a normalization method is needed. According to cheng (2000), Lietal (2007), the common method is to use the maximum a_u to divide FCR= (a, a_m , a_u). According to Tan etal (2010), where there is one subject-thePM - , the a_u can be obtained by setting all MI fuzzy ratings as the maximum (0.89, 1.00, 1.00) whilst weightings remain constant. Hence

Normalized Competency Rating NFCR

$$NFCR = FCR/Q_u = \left(\frac{q_1}{q_u} \frac{q_m}{q_u} \frac{q_u}{q_u} \right)$$

Calculating FCR* whilst keepy weightings constant and ratings maximum (0. 80, 1.00, 1.00) for

KCF – 1

$$(0.45, 0.63, 0.80) \otimes (0.80, 1.00, 1.00) = (0.36, 0.63, 0.80)$$

$$\oplus (0.45, 0.63, 0.80) \otimes (0.80, 1.00, 1.00) = (0.36, 0.63, 0.80)$$

$$\begin{aligned}
& \oplus (0.60, \quad 0.75, 0.90) \otimes (0.80, \quad 1.00, 1.00) \\
& = (0.48, \quad 0.75, \quad 0.90)(0.30, \quad 0.50, 0.70) \\
& \otimes (0.80, \quad 1.00, 1.00) = (0.24, \quad 0.50, \quad 0.70)
\end{aligned}$$

$$FCR_1^* = \underline{(1.44, 2.51, 3.20)}$$

$$q_u = \underline{3.20}$$

Calculating Normalized Fuzzy Competency Rating NFCR

KCF – 1

$$NFCR_1 = FCR_1 / 3.20 = (1.06/3.20, 1.94/3.20, 1.54/3.20)$$

$$NFCR_1 = (0.33, 0.61, 0.89)$$

Matching NFCR(s) of each Main KCF to the Natural Language Expression Set

Competency Level		Fuzzy Number
Very low	(VL)	(0.00, 0.10, 0.25)
Low	(L)	(0.15, 0.30, 0.45)
Average	(A)	(0.35, 0.50, 0.65)
High	(H)	(0.55, 0.70, 0.85)
Very high	(VH)	(0.75, 0.90, 1.00)

Matching NFCR, to Natural language set

NFCR₁, = (0.33, 0.61, 0.89)

d(NFCR₁, VL)

$$= \left\{ \frac{1}{3} [(0.33 - 0)^2 + (0.61 - 0.10)^2 + (0.89 - 0.25)^2] \right\}^{1/2}$$

$$\left[(0.1089 + 0.2601 + 0.4096) \frac{1}{3} \right]^{1/2}$$

$$= (0.2595)^{1/2} = 0.51$$

KNUST

