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RESEARCH PAPER

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

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ABSTRACT
A fuzzy-based method for assessing the performance level of a Project Manager (PM) at the construction phase of Mass House Building Projects (MHBPs) is presented. Based on seven key competencies previously developed for the Ghanaian housing industry, structured interviews involving a leading Ghanaian property developer was undertaken to explore the Measured Indicators (MIs) of the Key Competency Factors (KCFs) in evaluating the performance of PMs at the construction phase of MHBPs. Using a set of linguistic expressions and the Fuzzy Competency Rating approach, the performance levels of practicing PMs were assessed based on the empirical results extracted from the interview transcripts. The study provides insight into the sub-themes to the seven key competencies that engender superior performance in MHBPs, and provides evidence to suggest that the performance of PMs in Ghana is in need of improvement to bring it to acceptable levels of excellence.

Keywords: *Project Manager, Performance, Mass House Building Projects, Fuzzy, Competency*

INTRODUCTION

The project management concept is founded on the premise that a single individual-the project manager (PM) - is accountable for the success of the project (Goodwin, 1993). Being accountable for the success of the project requires that the PM must possess a variety of skills and competencies relating to achieving the standard project objectives of time, cost and quality (Lei and Skitmore, 2004). Admittedly, projects may fail due to factors outside the control of PMs. However the competence of the PM is a critical parameter that affects the outcome of the project (Goodwin, 1993). PM competencies have been found to be project specific hence the requirement that competency development should be aligned to specific project types (Morris, 2001; Omidvar, 2011). Pinto and Prescott (1998) have also established that the relative importance of success criteria differs significantly over the various phases of the project lifecycle (see also Lim and Mohammed, 1999; Omidvar, 2011). This suggests that PM competencies are likely to differ significantly

over the various project phases.

Thus, linking PM competencies to specific project types and also project lifecycle is now currently receiving considerable attention. For instance Jing-min *et al*., (2010) have recently looked at establishing success criteria for real estate projects. Brill *et al*., (2006) using a web-based Delphi technique investigated competencies required by PMs in instructional design. In a survey in south-east Queensland, Seng-Lei and Skitmore (2004) investigated the most important project management skills and any additional skills that a PM must possess in the twenty-first century. Fraser and Zarkada-Fraser (2003) investigated effectiveness of project managers by stakeholder perceptions. Ogunlana *et al.* (2002) looked into factors and procedures used in matching PMs to construction projects in Bangkok.

Ahadzie *et al.*, (2009a) investigated competencies required by PMs at the construction phase of MHBPs in Ghana. This study identified seven core competencies that senior managers can use to evaluate and assess the competency of PMs, namely: job knowledge in site layout techniques for repetitive construction works; dedication in helping contractors to achieve work programmes; job knowledge of appropriate technology transfer for repetitive construction works; effective time management practices on the house-unit; ability to provide effective solutions to conflicts while maintaining good relationships; ease with which the PM is approachable by works contractors; and PM volunteering to help works contractors solve personal problems. The authors contend that these competencies could be used in Competency-Based Interview (CBT), PM job matching and succession planning (Ahadzie *et al.*, 2009b). Subsequently, fuzzy set- theory is used to establish an empirical understanding of the practical application of the core competencies by real estate companies in Ghana.

THE SIGNIFICANCE OF COMPETENCY BASED MEASURES

Competency-based evaluative criteria can be used in a variety of ways including: 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).

However, in using the competency-based methods, one needs be to guided by some form of decision making framework (DMF). Accordingly, Torfi and Rashidi (2011) emphasized the need for a method that can select the most suitable candidate for the post of PM based on their qualifications, competencies and the opinions of senior managers. "Fuzzy logic gives the means by which judgments that characterize ones mode of reasoning can be formalised without choosing an artificial process of making these judgments exact" (Golec and Kahya, 2007). The fuzzy evaluative method presents a prima facie case in performance management of the construction workforce including the project manager and has been used extensively in construction engineering and management (Poveda and Fayek, 2009). However, while the literature is replete with fuzzy performance evaluation of the construction workforces including the PM in the generic sense, specific project types such as MHBPs are yet to be explored.

Competency-based measures are geared towards making skills development context-based and geared towards unique project types (Brill *et al*, 2006; Crawford, 2004; Omidvar, *et al.*, 2011). In this respect, the seven core PM competences identified by Ahadzie, (2009a) for MHBPs were selected as the Key Competency Factors (KCF) for this study. While the contribution of PMs in the Ghanaian housing industry has gained recognition no major attempt has been made in isolating appropriate competen-

cies for PM assessment and professional development in the sector (see also Ahadzie *et al.*, 2009a; 2009b).

THE PROJECT MANAGEMENT ENVIRONMENT IN GHANA

Bredeilet *et al.*, (2009) argue that the level of project management development in a country is positively associated with Gross Domestic Product (GDP)/capita. In principle, economies with high GDP/capita are expected to have a more developed project management environment and vice versa. In Ghana, the project management environment albeit gradually gaining recognition is embedded with structural and organizational problems such as payment difficulties and delays, poor coordination and communication structures, fiscal constraints and extensive controls, an undeveloped and complex land tenure system and rampant disregard to building regulations (Amoah *et al.*, 2011).

Notwithstanding these challenges, there is a generally increasing awareness that the role of the PM is important in achieving project success. In the last decade, the PM title has become more widely recognized in the construction sector and acknowledged in the manuals of the Procurement Act (Act 663, 2003; Ahadzie *et al.*, 2012). The establishment of the Ghana Chapter of the Project Management Institute early this decade is also an important indication of the potentials that exist for accelerated project management advancement and deployment in future projects including those in the housing sector (Kissi, 2013).

This study builds on the work of a previous long term research project studying the performance of PM on MHBPs in Ghana, which developed a model of seven core competencies for aiding the selection and evaluation of PMs (Ahadzie *et al*., 2009a; 2009b). However, existence of the model does not rule out human judgments in coming to the right permutations on how to select the right PM and on how to undertake dependable evaluations. In order to help minimize errors in the judgment made by senior managers of property developers, there is the need to subject these competencies to some form of robust multi-criteria decision making model so that a more rigid competency toolkit could be established devoid of qualitative bias of the human mind.

METHODOLOGY

This section is mainly in three parts. First the theoretical framework underpinning the fuzzy evaluation is presented. This is followed by the case study approach and the assessment procedure. Subsequently the methodology for aggregating the opinion of the assessors, calculating and normalizing the ratings are reported.

The Theoretical framework

The theoretical framework presents the method used to assess the performance of a PM in MHBPs using the concept of fuzzy sets and it is based on structured interviews of senior managers. The performance assessment involved using linguistic expressions (Table 1) to attach weightings and ratings to the Key Competency Factors (KCFs) and Measured Indicators (MIs) by senior managers of a real estate company chosen for this study. The linguistic expressions used in Table 1 are modified versions of those used in previous studies by Lin and Chen (2004) and Torfi and Rashidi, (2011). The fuzzy triangular membership functions are favoured because of their simplicity (Torfi and 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 and Fayek 2009; Tan *et al*., 2011; Manaan, 2013). Subsequently the opinions of the assessors were aggregated using Fuzzy Competency Ratings (FCR). The Normalised Fuzzy Competency Rating (NFCR) for each KCF was calculated and matched to predefined linguistic expressions as in Table 7. The expression with the shortest distance to the NFCR defines the performance rating of the PM relative to the particular attribute. This is illustrated in fig. 1.

Table 1: Likert scale for rating/weighting 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)

***Source**: Adapted from Lin and Chen (2004) and Torfi and Rashidi, (2011)*

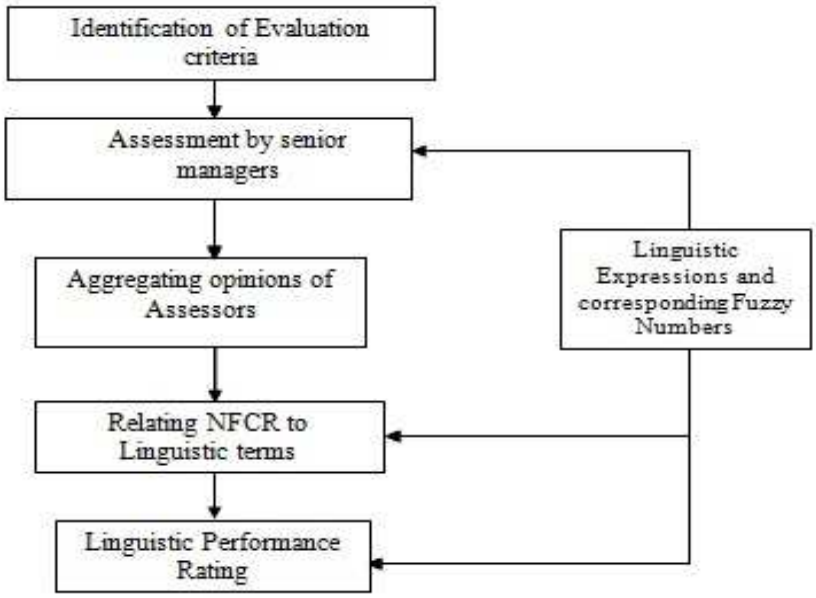

Fig.1: PMs' performance assessment framework
Source: Manaan (2013)

Case Study

Previous studies involving the concept of fuzzy set theory, required the use of real case scenario to establish reliability and validity of findings (Golec and Kahya, 2007; Nyugen *et al.*, 2008; Gregore *et al.* 2008; Tan *et al*. 2011; Torfi and Rashidi, 2011). Drawing on these experiences, this study also decided to adopt the case study approach involving a large Ghanaian Estate Development organisation. Case selection criteria included size, experience, market share, current project running and willingness to participate in the study. The case study company is the leading housing development company in Ghana incorporated in 1991 and currently controls approximately 50% of the total housing market (Bank of Ghana, 2007; Manaan, 2013).

Data analysis-assessment process

Data analysis

Two senior managers who participated in the preliminary interview assessed the performance of the PM using the seven competencies required for the management of MHBPs. A 5-point Likert scale was employed in assessing the performance of the project managers. However in Fuzzy language the terminology linguistic rating/weighting is preferred. The linguistic rating was used in rating the performance of the PM with respect to the KCFs while the linguistic weightings shows the weight that senior managers put on the KCFs with respect to their importance in achieving project success (shown by the corresponding fuzzy numbers). These are the scales shown in Table 1 above. Note that for a triangular fuzzy membership functions, $F=(x_1,x_m,x_u)$, where the parameters x_1,x_m,x_u denotes the smallest possible value, the most promising value and the largest possible value that describes the fuzzy event. Thus, unlike a deterministic situation where assessors use rigid Likert values to represent the level of performance of a PM, the fuzzy membership function converts assessors opinions using the range of values described above. Here, the triangular membership function by Lin and Chen, 2004 and Torfi and Rashidi, (2011) which are widely acclaimed for PM selection was adopted for this study. Thereafter, the managers were briefed on the KCFs and MIs and then asked 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 1. With the provided data, the two senior managers gave their judgments on the weightings and ratings of the competency attributes exhibited by the PM as shown in Table 2.

Aggregating the Opinions of the Assessors

According to Lin and Chen (2004), the average fuzzy ratings and average fuzzy weightings are used to pull he opinions of the assessors together. Thus:

$$r_i = \frac{1}{t}[r_i^1 \oplus r_i^2 \oplus \ldots . \oplus r_i^t] \quad \ldots\ldots\ldots (1)$$

$$w_i = \frac{1}{t}[w_i^1 \oplus w_i^2 \oplus \ldots .. \oplus w_i^t] \quad \ldots .. (2)$$

Where i = 1, 2,…..nth variable (in this case the KCFs), r = fuzzy value for ratings and w = fuzzy value for weightings. By using equations 1 and 2, Table 3 is obtained.

Calculating the Fuzzy Competency Rating (FCR)

Referring to previous studies (Tan *et al.*, 2011; Lin and Chen 2004) a Fuzzy Competency Rating (FCR) is introduced to assess the PM competency relative to each criterion (KCF). The formula for FCR is derived thus:

Let Rj and Wj, j = 1,2,…..n respectively be the fuzzy rating and fuzzy weighting given to factor j by the assessors, according to the standard fuzzy operation (Lin and Chen 2004) the fuzzy competitiveness rating FCR can be obtained from:

$$FCR = \sum_{j=1}^{n} (Wj \otimes Rj) \ldots \ldots \quad \ldots\ldots\ldots (3)$$

Refer to second column of table 3 for the FCRs of all the KCFs.

Normalized Fuzzy Competency Rating (NFCR) for the KCFs

The value of the FCR is also a triangular fuzzy number denoted as FCR= $(\varkappa_1,\varkappa_m, \varkappa_u)$. To keep the value of FCR within the range {0, 1}, normalization method is needed. The most common method is to use the maximum a_u denoted as a_u* to divide FCR= $(\varkappa_1,\varkappa_m, \varkappa_u)$. According to Tan *et al*. (2011), where there is only one subject as in the case of the PM, the maximum

Table 4: 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	***Knowledge of appropriate sitelayout techniques for repetitive construction works***	**VI**		**EI**	
MI-1	Knowledge of site restrictions both vertical and horizontal and choosing appropriate method for moving materials and components. Ability to relate the volume of work and volume of material that need to be kept on site and spacial requirements for such materials	I	S	VI	P
MI-2	Knowledge of spacial requirements of maneuverability of construction plants and equipments	VI	G	I	G
MI-3	Ability to plan the layout of individual house units in such way that there is no double handling of materials and components	VI	O	VI	S
MI-4		I	G	I	O
KCF-2	***Dedication in helping works contractors achieve works schedule***	**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 target	I	P	UI	VP
KCF-3	***Knowledge of appropriate technology transfer for repetitive construction works.***	**VI**		**EI**	
MI-9	Willingness to implement new technology and the ability 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
KCF-4	***Effective time management practices on all project sites***	**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

Table 2 cont'

Indicators (MIs)		Senior Manager-1 LW	Senior Manager-1 LR	Senior Manager-2 LW	Senior Manager-2 LR
	Ability to forecast and identify delays and offer alternative	VI	S	VI	O
MI-15	solutions so that work proceeds as schedule	VI	O	EI	G
MI-16	Ability to acquire permits on time				
KCF-5	***Ability to provide effective solutions to conflicts while maintaining good relationships***	**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	***Ease with which works contractors are able to approach the PM with their problem***	**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	***Volunteering to help works contractors to solve personal problems***	**UI**		**LI**	
MI-25	Ability to appreciate problems of work contractors and their effects all 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

*Note: **KCF**= Key Competenties Factors, **MI**= Measured Indicators, **UI**= Unimportant, **LI**= Less important, **I**= Important, **VI**= Very Important, **EI**= Extremely important, **VP**= Very poor, **P**= Poor, **S**= Satisfactory **G**= Good, **O**= Outstanding, **LW**= Linguistic weighting, **LR**= Likert rating*

Source: Manaan (2013)

Table 3: Average fuzzy weightings and ratings of competency attributes

	Key Competency Factors(KCFs) and Measure Indicators(MIs)	Average Fuzzy Weightings	Average Fuzzy Ratings
KCF-1	*Knowledge of appropraite sitelayout techniques for repetitive construction works*	**(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	*Knowledge of appropraite technology transfer for repetitive construction works.*	**(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	*Dedication in helping works contractors achieve work schedule*	**(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	*Effective site management practices on all project sites*	**(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	*Ability to provide effective solutions to conflicts while maintaining good relationships*	**(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	*Ease with which works contractors are able to approach the PM with their problem*	**(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	*Volunteering to help works contractors to solve personal problems*	**(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)

*Note: **KCF**= Key Competencies' Factors, **MI**= Measured Indicators, **UI**= Unimportant, **LI**=Less important, **I**= Important, **VI**= Very important, **EI**= Extremely important, **VP**= Very poor, **P**= Poor, **S**= Satisfactory **G**= Good, **O**= Outstanding, **LW**= Linguistic weighting, **LR**= Likert rating*

Source: Manaan (2013)

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

$$NFCR = \frac{FCR}{a^*_u} = \left[\frac{x_1}{a^*_u}, \frac{x_m}{a^*_u}, \frac{x_u}{a^*_u} \right] \quad (4)$$

(NFCR) can be calculated by equation 4.

The process is repeated for the rest of the main attributes (KCFs) and the results are shown in Table 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 (Table 5) are multiplied by the weighting of the seven key competency factors and added to give the total FCR. The maximum a_u method (equation 4) is used to keep the values of FCR between {0,1}. The calculation process is shown below.

Total FCR is given as:

$$[(0.33,0.61,0.89)\otimes(0.68,0.89,0.95)] \oplus [(0.24,0.45,0.71) \otimes (0.55,0.75,0.85)]$$

$$\oplus [(0.34,0.62,0.89) \otimes (0.70,0.88,0.95)]$$

$$\oplus [(0.37,0.65,0.87) \otimes (0.55,0.75,0.85)]$$

$$\oplus [(0.27,0.52,0.79) \otimes (0.20,0.38,0.55)]$$

$$\oplus [(0.16,0.34,0.61) \otimes (0.45,0.63,0.80)]$$

$$\oplus [(0.16,0.38,0.72) \otimes (0.05,0.13,0.30)] = (0.93,2.38,4.14)$$

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. Thus, the maximum a_u = 5.25.

Therefore the normalized fuzzy competency

Table 4: 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)

Source: Manaan (2013)

Table 5: 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)

rating ($NFCR_O$)

= FCR/5.25 = ($^{0.93}$/5.25, $^{2.38}$/5.25, $^{4.14}$/5.25)

= (0.18,0.45,0.79)

RESULTS

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 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 PM. The natural language expression set and their corresponding fuzzy membership functions used for this study is in Table 6 (Torfi and Rashidi 2011).

$\tilde{x} = [x_1, x_m, x_u]$ and $\tilde{y} = [y_1, y_m, y_u]$

Table 6: 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)

The Euclidean distance between $\tilde{x}$ and ỹ is:

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

The Euclidean distance between the total competency level -$NFCR_O$- and the expression "Very low" of the natural language set is illustrated below:

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

$= [(0.0324 + 0.1225 + 0.2916/3)] = (0.148)^{\frac{1}{2}} = 0.39$ …… (6)

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 are shown in Table 7 below.

Interpretation of competency levels

With the results in Table 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 tech-

Table 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

Source: Manaan (2013)

niques 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".

An aggregation of the above gives the opportunity to establish the overall competency level of the PM and here, 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. From fig. 2 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.

DISCUSSION

The fact that the role of the PM is now a recognized hierarchy in the construction sector need not be over-emphasized (Ogunlana, 2002; Ling, 2004). It is also true that the PM is indeed an established part of key decision making in today's competitive construction environment

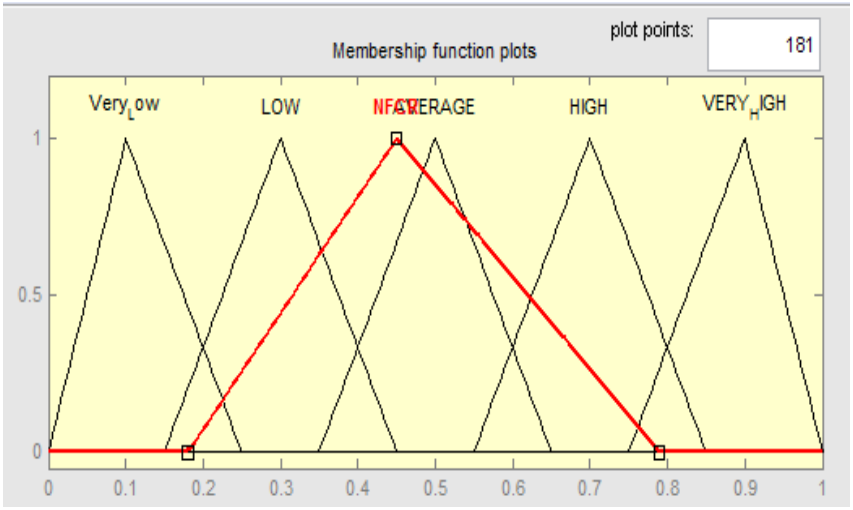

Fig. 2:Graph of NFCR-0 (in red) superimposed on Membership function plots

Source: Manaan (2013)

(Bredellit *et al*, 2011). However, the complexity of projects makes it difficult for stakeholders to identify and to select the right PM to specific project demands (Ogunlana, 2002; Bredellit *et al.*, 2009). While there is the recognized potential for project management advancement and deployment in the Ghanaian housing sector, the crucial issue of developing a robust methodology for their selection, recruitment and performance evaluation is still evolving. At best, the seven core competencies identified by Ahadzie *et al.* (2009a; 2009b) provide an important platform for some objective decisions to be made. However, the seven core competencies are still broad opening the avenue for subjective judgment and hence creating more room for error. Multi-criteria decision making tools such as fuzzy offer the opportunity to minimize potential error arising out of qualitative judgment by making sure that all feasible alternatives are considered in the presence of multiple and usually conflicting interests (Tan *et al.*, 2011).

Typically PMs' performance is seen as a function of behavior with evaluative components (Borman and Motowidlo, 1997; Cheng *et al.*, 2005). Behavioral competencies do not operate in a vacuum but are essentially performance outcome related. An important fact to recognize here is that this philosophy was robustly embedded in the earlier study that helped in the development of the seven core competencies where the emerging competency profiles were matched to an expected performance outcome (Ahadzie *et al.*, 2009a). As part of previous study also by Ahadzie (2007), an exploratory questionnaire survey was undertaken to establish the perception of property developers in Ghana on the performance level of PMs generally in the housing sector. The data analyzed by descriptive statistics suggested that the overall performance of the PMs in the housing sector is at best average, averaging between 50% – 69%.

Here, when senior managers in the case study company started putting weightings and ratings on the KCFs and MIs, their impression about the competency level of the PM under assess-

ment was "High". However, after the rigorous analysis involving fuzzy logic (Fig. 2) the findings indicate that the PMs Competency level is actually "Average". Drawing from Bredillet *et al.* (2009) position that the project management development in a country is positively associated with the country's GDP/capita, it could be argued that the average performance level established by the fuzzy method is realistic and a reflection of the relatively undeveloped project management environment in Ghana. The findings suggest that while PM could be making some important contribution to the management of MHBPs in Ghana, there is more room for improving upon their managerial skills and competencies. The findings also suggest that the seven core competencies are relevant and have the potential for further use in performance evaluation of PMs in the Ghanaian mass house building sector.

An important contribution of this study includes the development of measured 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 so that training programmes can then be instituted to overcome these gaps.

CONCLUSION

Project management has now become an established distinctive managerial process that requires specialist skills and distinctive organizational competencies in both academia and practice (Winch, 2002; Omidvar, 2011). In Ghana, the housing sector is one example of a project – based industry which has received reasonable attention in project management research especially in developing appropriate competency profiles. Subsequently the core competency profiles developed by Ahadzie *et al.,* (2009a) have become the foundation for addressing the required distinctive organizational competencies.

Here, the seven core competencies were subjected to fuzzy methodology to help establish their relevance as tools for evaluating the performance of PMs, devoid of error of judgment normally associated with using only human decisions. The Fuzzy technique has revealed that the core competencies have industrial relevance for application in the Ghanaian housing sector and could be useful in assessing the performance of PMs devoid of human error. More importantly the study results have revealed that the performance of PMs operating on MHBPs could be described as "low-average" performance, suggesting that there is the need for improvement to bring it to acceptable levels of excellence. It is acknowledged that the results of this research are based on the view of one property developer and cannot be claimed to be representative of the wider body of such firms. However, the case study company controls approximately 50% of the market share in the housing industry in Ghana and is therefore a good indicator of the sector. There is therefore the need for further studies using many more case studies to help affirm the results and propose appropriate management solutions .

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