Model for Predicting the Performance of Project Managers at the Construction Phase of Mass House Building Projects

D. K. Ahadzie[1]; D. G. Proverbs[2]; and P. O. Olomolaiye[3]

Abstract: The need to match project managers' (PMs) performance measures onto projects of both unique and similar characteristics has long since been acknowledged by researchers. The need for these measures to reflect the various phases of the project life cycle has also been contended in the recent past. Here, a competency-based multidimensional conceptual model is proposed for mass house building projects (MHBPs). The model reflects both performance behaviors and outcome in predicting the PMs' performances at the conceptual, planning, design, tender, construction, and operational phases of the project life cycle. Adopting a positivist approach, data elicited for the construction phase is analyzed using multiple regression techniques (stepwise selection). Out of a broad range of behavioral metrics identified as the independent variables, the findings suggest the best predictors of PMs' performances in MHBPs at the construction phase are: job knowledge in site layout techniques for repetitive construction works; dedication in helping works contractors achieve works schedule; job knowledge of appropriate technology transfer for repetitive construction works; effective time management practices on house units; ability to provide effective solution to conflicts, simultaneously maintaining good relationships; ease with which works contractors are able to approach the PM and volunteering to help works contractors solve personal problems. ANOVA, multicollineriality, Durbin–Watson, and residual analysis, confirm the goodness of fit. Validation of the model also reflected reasonably high predictive accuracy suggesting the findings could be generalized. These results indicate that the model can be a reliable tool for predicting the performance of PMs in MHBPs.

DOI: 10.1061/(ASCE)0733-9364(2008)134:8(618)

CE Database subject headings: Construction management; Housing; Professional development; Managers; Regression models; Buildings, residential.

Introduction

Presently, there is a renewed interest in the human resource management (HRM) including the construction management discipline that performance measures are the most viable option for validating the managerial "excellence" of project managers (PMs) (cf. Conway 1999; Dainty et al. 2003; Cheng et al. 2005). It is also being increasingly affirmed that the development of appropriate predictive models is of significant value in the identification and development of potentially robust measures (see, e.g., Dainty et al. 2004; 2005). Indeed, performance measures are useful for a number of purposes including administrative, research and development (Scullen et al. 2003). Above all, these measures have the potential of providing managers the relevant information they need toward engendering their continuing professional development (Scullen et al. 2003; Fraser and Zakrada-Fraser 2003). However, the inherently unique nature of many construction projects often influences how effective these measures would be in practice (cf. Holloway 1997; Clark 1999; Maylor 1999; Dainty et al. 2003). The corollary is for these measures to be designed so as to reflect the characteristics of the different project types involved (Ogunlana et al. 2002). This has recently been executed by developing a competency-based multidimensional conceptual model for PMs' performance measures in mass house buildings projects (MHBPs) (see Ahadzie et al. 2006b). Granted, it is now established that factors relating to management support are significantly related to project success at the various project phases of the project life cycle (Belout and Gauvreau 2004), this evidence has also been factored into the conceptual model in predicting the PMs' performances at the conception, planning, design, tender, construction, and operational phases. Subsequently, the substantive model for the construction phase has been developed which is reported here. The significance of the findings toward best practice in the management of MHBPs is discussed.

This paper first commences by placing the definition of MHBPs into context. Thereafter, a discussion is presented on the generic relevance of mapping performance measures onto different project types including MHBPs. Next, the underlying theoretical framework is presented followed immediately by the conceptual model. The research methodology including the method for data collection is then presented followed by a de-

[1]Research Fellow, Center for Settlement Studies, Kwame Nkrumah Univ. of Science and Technology, Kumasi, Ghanan; formerly, Ph.D. Candidate, School of Engineering and the Built Environment, Univ. of Wolverhampton, Wolverhampton, WV1, 1SB, U.K. (corresponding author). E-mail: divinedka10@yahoo.com

[2]Professor of Project Management and Head of Construction and Infrastructure, School of Engineering and the Built Environment, Univ. of Wolverhampton, Wolverhampton, WV1 1SB, U.K. E-mail: D.Proverbs@wlv.ac.uk

[3]Professor of Project Management and Dean, School of Engineering and the Built Environment, Univ. of Wolverhampton, Wolverhampton, WV1 1SB, U.K. E-mail: P.Olomolaiye@wlv.ac.uk

Note. Discussion open until January 1, 2009. Separate discussions must be submitted for individual papers. To extend the closing date by one month, a written request must be filed with the ASCE Managing Editor. The manuscript for this paper was submitted for review and possible publication on October 12, 2006; approved on January 14, 2008. This paper is part of the ***Journal of Construction Engineering and Management***, Vol. 134, No. 8, August 1, 2008. ©ASCE, ISSN 0733-9364/2008/8-618–629/$25.00.

scription of analysis of the data. Thereafter, the significance of the findings viz. the theoretical framework adopted and project management practice in MHBPs is discussed. The penultimate section identifies the boundaries of the findings by addressing the limitations and the conclusion summarizes the discourse.

Relevance of This Paper to Industry

The relevance of this paper to practitioners and researchers are highlighted.

Relevance to Practitioners

It is well recognized that the skills and capabilities of PMs are influenced by the characteristics of different project types (cf. Ogunlana et al. 2002; Dainty et al. 2003: Crawford et al. 2006). The matching of skills to specific project-based sectors is important for developing the capabilities and prospects of PMs (see, e.g., Egbu 1999; Ogunlana 2002; Lyon 2003). At the practitioner level, the narrative presents a set of competency profiles that can be mapped and customized onto improving the current and projected future roles of PMs in MHBPs.

Equally relevant, this paper provides empirically based evidence for homebuilders, especially those in developing countries seeking to recruit, retain, and promote the services of PMs so that they (i.e., the homebuilders) can make informed and objective decision toward engaging those with the appropriate skills and competencies.

Relevance to Researchers

The methodology draws significantly on the well-acclaimed organizational psychology theory of job performance. The findings do suggest reasonably compelling convergence, indicating that the theory is relevant for application in the construction industry. Researchers who wish to replicate the study in other geographical locations will therefore find the methodology potentially useful. The conceptual model also provides a potentially rigorous approach for construction researchers who are interested in developing an understanding of the PMs' performance domains throughout the various phases of a project life cycle.

Definition of Mass House Building Projects

The term mass house building projects is used in the construction industry to describe mass production techniques of housing development projects. This definition, which has been used by many other researchers to date, is derived from the manufacturing sector (cf. Ashley 1980; Mahdi 2004). However, the definition fails to explicitly highlight some of the characteristics found in construction, such as the project environment; site conditions including topography; the weather; bulky materials; and design considerations. In an attempt to provide a definition encapsulating the true characteristics of the industry and for the purpose of this study, MHBPs are defined as "the design and construction of speculative standardized house units usually in the same location and executed within the same project scheme" (Ahadzie et al. 2007b). Such house units could include: terrace, multistory or tower blocks, maisonettes, semidetached, and/or detached residences or a combination of them.

Basic experience or learning curve theory suggests that each time the number of repetition doubles the cumulative production rate (man-hours per unit) declines by a consistent fixed percentage of the previous cumulative production rate (Schwartzkopf 1985). When this theory was replicated in the construction industry using 45 identical house units, it was confirmed that each time the house units doubled the cumulated production rate was 90% (Schwartzkopf 1985). This suggests that a minimum of two house units is sufficient to achieve a learning curve effect arising out of the repetition involved in MHBPs. This not withstanding, the United Nations Economic Commission for Africa had suggested that for developing countries to meet their present and future housing needs, they should aim at an annual production rate of 10 house units per 1000 population (cf. Edmonds and Miles 1984). Within this context, here, the threshold for the minimum quantity of house units is fixed at 10 house units.

Mapping Performance Measures onto Different Project Types

There is a general consensus that one of the key objectives of performance measures is to provide benchmarks toward engendering best practice improvement (Barber 2004). However, it is also acknowledged that the nature of projects executed in the construction industry can particularly impinge on how successful the benchmarking process would be in practice (Dainty et al. 2003). More importantly, the situation can be muddled if there is a lack of common basis for comparison. For instance, Holloway et al. (1997) has noted that, one of the main difficulties in undertaking benchmarking using performance measures is the lack of a suitable basis for comparing information. Others researchers, such as Clarke (1999) and Maylor (1999), have drawn attention to how unreliable benchmarking through performance measures can be, especially if the project types are not similar. Thus, although it is recognized that construction projects are unique in nature, it seems potentially necessary for performance measures to be categorized to reflect the characteristics of the different project types involved (Ahadzie et al. 2005b).

Albeit arguably, the above-presented scenario seems more plausible to contend with, in regards to choice of performance measures for MHBPs. This is because these projects, in particular, differ significantly from many of the one-off projects normally encountered in the construction industry in various ways. For example, these projects must be based on standardized design; there is the need to identify the stages in production at which control is to be exerted; there is the need for production time between stages, including delivery schedule of house units (cf. Burgess and White 1979; Muhleman et al. 1992). Further, because of its nature the setting up of the production system involves two associated problems; the minimizing of synchronizing loss and the maximizing of resource utilization (Muhleman et al. 1992). The implication of these unique attributes is for PMs to be able to evaluate available planning and scheduling tools in order to maintain a continuous flow of work for the repetitive task involved (cf. Ashley 1980; Mahdi 2004; Hyari and El-Rayes 2005).

Unfortunately, the literature lacks evidence of a very specific systematic study toward understanding the taxonomy of the PMs' performance profiles in MHBPs. To this effect, potential and experienced PMs lack the knowledge that can help engender and sustain their continuing professional development (CDP) toward best practices. Identification of appropriate performance profiles should therefore serve as an important step for developing the skills of potentially competent PMs who can promote the effec-

J. Constr. Eng. Manage., 2008, 134(8): 618-629

tive management of MHBPs in a dynamic but difficult business environment, such as those pertaining in many developing countries. Mapping performance measures onto specific project types, such as MHBPs will also help create some common basis for comparison; create familiarization in their use; make it easier for users to understand the performance dimensions involved better; and ultimately help engender better methodological systems for future improvement (Ahadzie et al. 2005a).

Equally important is the contention that performance measures should reflect various phases of the project life cycle. Given the often speculative nature of MHBPs, PMs are normally expected to assist and coordinate activities within the various phases of these projects from inception to completion including facilities management. However, it is evident that as a project progresses, there may be a set of different factors impeding on each of the various project phases (Lim and Mohammed 1999). Such factors may be inherent in proxies, such as feasibility studies, marketing research, and data of various kinds, site conditions, the weather, and so on (Lim and Mohammed 1999). Indeed, it has recently been affirmed that different personality factors may be significantly related to project success at the various phases of the project life cycle (Belout and Gauvreau 2004). It seems therefore logical to contend that PMs engaged in MHBPs will require different performance measures at the various phases of the project life cycle toward engendering their professional development and improvement.

Theoretical Framework

Traditionally, in mainstream project management practice, performance measurement of PMs has been conceptualized mainly on the premise that it is systems and processes that deliver projects (cf. Cooke-Davies 2002). It is therefore not surprising that the governing variables of interest have long since tended to focus on developing functional competences, such as time, cost, and quality. However, these functional competences are not particularly amenable for isolating the contributions of PMs from other team members and also the influence of extraneous effects. To this effect, practicing PMs find it potentially difficult to establish what exactly makes them effective in their managerial roles, so that they can learn lessons for their CPD and also strive for managerial excellence (Dainty et al. 2004, 2005; Cheng et al. 2005).

To this effect contemporary researchers in the HRM genre, including construction, are now increasingly relying on competency-based approaches as a viable option for validating superior performance (cf. Tett et al. 2000; Dainty et al. 2003; 2004; 2005; Skipper and Lansford 2006). These competency-based profiles founded on key behavioral measures circumvent many of the weaknesses of the traditional measures (Dainty et al. 2004). Again, these measures offer the psychological understanding needed for selecting and predicting human performance (Motowidlo et al. 1997). Further, these measures have the potential to assist PMs to contribute more effectively to their personal development by enabling effective understanding of the appropriate performance domain (Tett et al. 2000; Cheng et al. 2005). Thus, for organizations that are keen to support the professional development of their key managerial staff, the implication is to rather define what constitutes outstanding performance in explicit behavioral terms or in terms of what makes managers successful (Latham et al. 1979; Ahadzie et al. 2007a). The onus therefore is for organizations who want to achieve best practice in the performance of PMs to strive toward identifying the appropriate behavioral profiles.

The evidence suggests that to have a better understanding of the behavioral performance domain, the measures involved should be separated into contextual and task performance behaviors (Borman and Motowidlo 1997). Task performance behaviors are job-specific, prescribed and rewarded, alternatively contextual performance behaviors relate to those discretionary job-related acts that are not formally recognized as part of the job and therefore not rewarded (Organ and Piane 1999). Thus, although task performance behaviors will arise from job descriptions and work assigned to individuals, contextual performance behaviors arise out of volition and predisposition (Borman and Motowidlo 1997; Motowidlo et al. 1997; Conway 1999).

The implication for the distinction of the performance domain into contextual and task performance behaviors suggest that in a any job situation, the reasons why contextual performance behaviors are desirable or undesirable may be different from the reason why contextual performance behaviors are desirable (Borman and Motowidlo 1997; Motowidlo et al. 1997). The knowledge, skills, and habits associated with task performance behaviors would therefore normally be different from those associated with contextual performance behaviors (Motowidlo et al. 1997). Subsequently the contextual task distinction should be useful for distinguishing the determinants of generic and specific competency profiles for specific project-based sectors and/or industries (Tett et al. 2000). Mainly because of its multidimensional perspective there is also the potential to use this framework to identify and develop a detailed analysis of the PMs' performance dimensions so that an appropriate and rigorous training programmes can be developed for specific industries and/or project based sectors (Motowidlo et al. 1997; Tett et al. 2000; Scullen et al. 2003).

Conceptual Model

Fig. 1 presents the conceptual framework underlying this discourse. This represents an abridged version of a much more comprehensive conceptual model linked to the project life cycle, namely: conception, planning, design, tender, construction, and operational phases (see the Appendix). Drawing on the theoretical framework, Fig. 1 purports to evaluate the PMs' performances by establishing the behavioral attributes that best contributes to predicting performance outcome in MHBPs at the construction phase. The model takes the view that, to establish the PMs' performance domains from a multidimensional perspective it should conceptually be based on: contextual performance behaviors, task performance behaviors and the performance outcome (see Fig. 1). Further, the multidimensional methodology takes the view that performance is not only a function of the PMs' attributes but also a function of the expected outcome (see also Cheng et al. 2005).

Task performance behaviors as evidenced in the literature are best predicted by individual differences in the constructs cognitive ability (Campbell 1993), job-specific knowledge, task proficiency, and experience (Hunter 1983; Schmidt et al. 1986; Van Scotter and Motowildlo 1996: Gelattly and Irving 2001), whereas contextual performance behaviors are best predicted by job dedication and interpersonal facilitation (see Conway 1999). These attributes were adopted as the constructs of the behavioral measures as shown in Fig. 1 and subsequently operationalized as the independent variables. Drawing from Pinto and Slevin (1988), the

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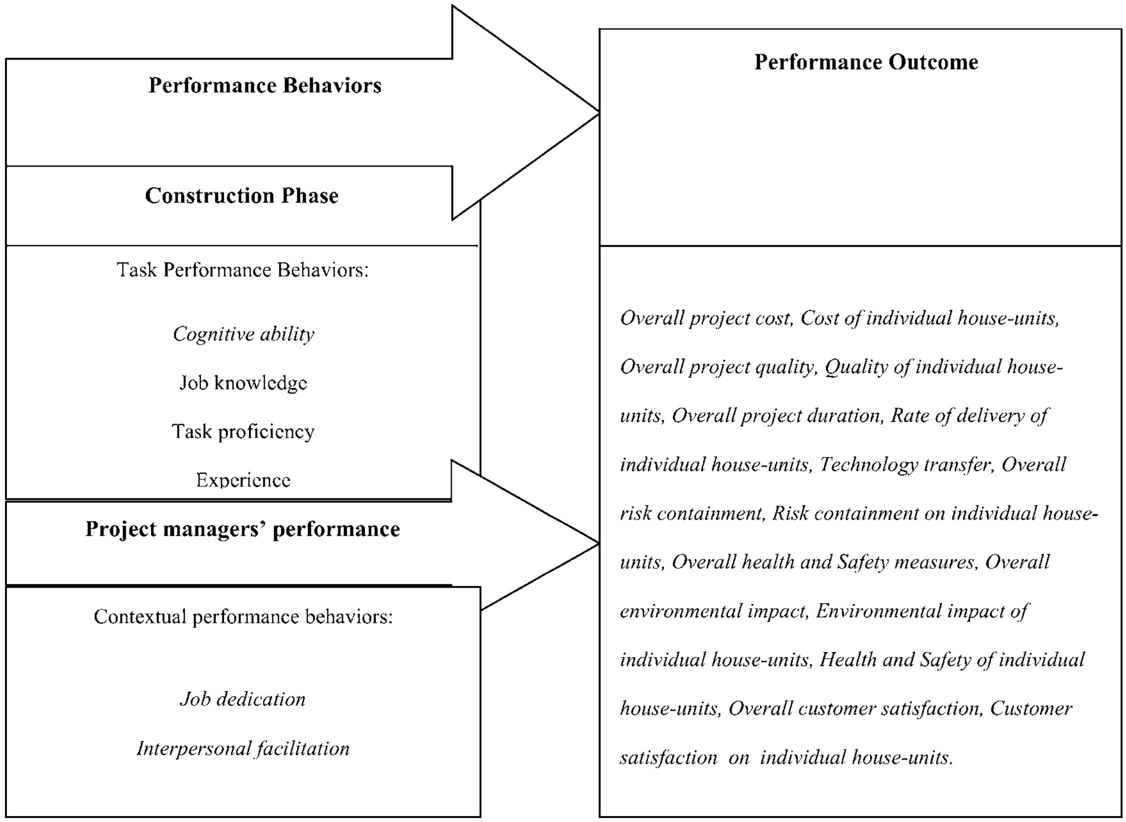


Fig. 1. Abridged version of conceptual model at the construction phase (adapted from Ahadzie et al. 2007b)

success model and also the notion that in MHBPs, PMs have to exhibit the relevant knowledge in repetitive construction works, a success framework was developed for MHBPs to represent the constructs for the performance outcome and subsequently the dependent variables (Ahadzie et al. 2007b). Against the background that PMs should have management intuition in repetitive techniques to be successful in MHBPs, the dependent variables (numbering a total of 15) distinguished between success criteria in the overall project context and success criteria in the context of individual house units (cf. Ahadzie 2007).

Research Methodology

Based on the conceptual model, an appropriate research instrument (RI) was designed to help elicit the relevant data (Ahadzie et al. 2006a). Details of the design of the RI is already published and can be found in Ahadzie et al. (2006a). What is interesting about the RI in this context is that, where possible, the key wording, repetitive technique was used in the wording of the various questions. The intention was to help the potential respondents to reflect on this concept of repetition, which is generally acknowledged to be the key associated with achieving better managerial performance in MHBPs.

Pickett (1998) has noted that the "current and future success of an enterprise is a reflection of the effectiveness of the senior team, their vision and leadership, and combined knowledge and skills of the organizations workforce." This suggests that the identification of the appropriate competencies and success criteria that will enable an organization to meet the demands of the future can be assumed to be the key responsibilities of senior managers, such as senior business executives or managing directors (MDs). Here, MDs of house building companies in Ghana were chosen as the unit of analysis as they are responsible for decision making regarding corporate and project objectives. As major stakeholders in the property industry in the Ghanaian construction industry, the perceptions of these senior managers should help other interested stakeholders especially PMs to have a clearer understanding of what their superiors, who are also their potential employers, expects of them in defining managerial excellence. Using random sampling techniques the targeted respondents for this study (herein called homebuilders) were drawn from the registered list of the Ghana Real Estate Developers Association (GREDA). The GREDA is the umbrella body of house-building companies in the Ghanaian construction industry for which they are recognized by the Government of Ghana.

Following a pilot survey in April/May 2006 (Ahadzie et al. 2006a), 153 structured questionnaires were administered to the homebuilders to elicit their perceived ratings on both independent and dependent variables identified. Respondents were invited to indicate the degree of importance of each of the operational measures identified based on a five-point Likert rating scale (very important=5, important=4, neutral=3, unimportant=2 and, not very important=1). Sixty-nine completed questionnaires were received representing approximately a 45% response rate. As per conventional statistical convention (Good and Hardin 2003), approximately 20% of the questionnaires received (i.e., 12 in number) were retained for validation purposes. The demographic background of the respondents indicated that they were all active

J. Constr. Eng. Manage., 2008, 134(8): 618-629

members of the GREDA, had a minimum of 5 years experience in the implementation of MHBPs in Ghana, and were active in business.

Data Analysis and Discussions

The data was analyzed using SPSS (SPSS Inc., USA). Three statistical analyses were undertaken, namely, scale ranking, factor analysis, and multiple regression. However, only details of the regression analysis are reported here.

Performance Outcome

The one-sample *t*-test was used to rank the mean importance of the 15 dependent variables. Thereafter, factor analysis was used to reduce the variables into a manageable set of data (see Ahadzie et al. 2007b). In this analysis (i.e., the factor analysis), the Kaizer–Meyer–Olkin's measure of sampling adequacy achieved a high value of 0.75; after extraction, average communalities values of all variables were above 0.60; factor loadings of more than four variables were also above 0.60. Similarly, the Bartlett test of sphericity proved significant indicating that the population matrix is not an identity matrix. Thus, irrespective of the fact that the ratio of sample size to the variables identified for the performance outcome is relatively low (i.e., 3.8), these preliminary test proved favorable for the factors analysis to proceed (cf. Gaudagnoli and Velicar 1988; Field 2005). A Cronbach's alpha also achieved a high value of 0.8966 suggesting the reliability of the RI. Hence, the rotated component matrix (not shown here), was used to extract four components with eigenvalues greater than 1.0, considering a factor loading of 0.50 as the cutoff point. The scree plot (also not shown here) confirmed the four components. The components, which represent different aspects of success criteria in MHBPs, were defined as: environmental safety, customer satisfaction, quality, and cost-time criteria. Details of the discussion of these clusters can be found in Ahadzie et al. (2007b)

Using the composite variable method (cf. Blaikie 2003; Meyers et al. 2005), the four clusters extracted from that factor analysis were weighted as shown here. Thus, performance outcome "*y*" was computed as

$$\text{Weighted composite, } y = w_1x_1 + w_2x_2 + w_3x_3 + w_4x_4 \qquad (1)$$

where x_1, x_2, x_3, and x_4=potential scores of the respondents for the appropriate variates and w_1, w_2, w_3, and w_4=appropriate weightings (including the respective factor loadings). For this purpose, equal weightings were assumed for the four components as it would be expected that each performance criteria should not be achieved at the expense of each other. Subsequently the final equation for determining the score for the performance outcome came up to:

$$y = 0.25[\text{environmental safety}] + 0.25[\text{customer satisfaction}] + 0.25[\text{quality}] + 0.25[\text{cost time}] \qquad (2)$$

Where environmental safety comprised overall environmental impact, environmental impact on individual house units, overall health and safety, health and safety on individual house units; customer satisfaction on house units comprised customer satisfaction on individual house units, technology transfer, overall customer satisfaction, risk containment on individual house units, and rate of delivery of individual house units; quality of house units comprised quality of individual house units, cost of individual house units, overall project quality; overall cost time comprised overall project cost and overall project duration. Note that the factor loadings associated with each variable including the ratings or scores provided by each respondent was factored, respectively, into the four clusters (Bailey 1987; Baikie 2003; Meyers et al. 2006)

The *y* output that emanated from the previous methodology was used as the dependent variable for the regression analysis.

Stepwise Selection

The stepwise selection procedure was used here because of the large number of independent variables involved. According to Walliman (2001), one important advantage of stepwise is that it results in the most parsimonious model (see also Chan and Kumaraswamy 1999). Thus, where a large number of independent variables are involved stepwise is quite appropriate for establishing in a hierarchy, the minimum number of variables needed to predict the criterion variable (Brace et al. 2003). In this case, the writers were trying to predict the performance outcome using the contextual and task performance behaviors identified. Table 1 is a summary of the model results. Table 1 suggests that Model No. 7, which accounted for the largest adjusted R^2 is the parsimonious model (adjusted R^2, 74.4; $F_{7,49}=24.30$, $p<0.0005$).

Table 1 also shows that the Durbin–Watson test recorded a value of 2.095 suggesting that the residuals errors are not correlated (cf. Field 2005). Further, the regression equation was significant at $p<0.0005$ (Table 2) and the coefficients were all significant at $p<0.0005$ (Table 3). Subsequently using the coefficients provided in Table 3, the following equation is extracted:

$$Y = 0.702 + 0.356(\text{Knstlrep}) + 0.277(\text{Dediprog}) + 0.259(\text{Kntchrep}) + 0.267(\text{Timemgmt}) + (-0.366)(\text{Abilcon}) + 0.203(\text{Easeproj}) + 0.192(\text{Volhelp})(R^2\text{adjusted} = 74.4) \qquad (3)$$

where Y=performance outcome; Knstlrep=job knowledge in site layout techniques for repetitive construction works; Dediprog =dedication in helping to achieve works schedule; Kntchrep=job knowledge in technology transfer for repetitive construction works; Timemgmt=time management on house units; Abilcon =ability to solve conflicts, simultaneously, maintaining good working relationships; Easeproj=ease with which works contractors can approach PM; and Volhelp=volunteering to help works contractors solve personal problems.

Test of Goodness of Fit

In Table 1, R represents a measure of the correlation between the observed value and the predicted value of the criterion variable. R^2 is the square of this measure of correlation and indicates the proportion of the variance in the criterion variable, which is accounted for by the model. Further, it is a measure of how good the predictor variables can be used to predict the criterion variable (Brace et al. 2003). However R^2 tends to somewhat overestimate the success of the model when applied to the real-world situation, so an adjusted R^2 value is calculated which takes into account the number of variables in the models and the number of observations (participants) the model is based on.

The adjusted R^2 was found to equal 74.4 (Table 1) suggesting that about 70% of the variation in the performance outcome for MHBPs can be explained by the variability in the independent variables extracted. This suggests that to help achieve the managerial performance in MHBPs, PMs should have the potential of improving their knowledge and skills in these independent variables. Table 2 also shows the ANOVA undertaken as part of the regression. The findings show the regression equation is significant ($F_{7,56}=24.303$, $p<0.001$). Two diagnostics test, tolerance

J. Constr. Eng. Manage., 2008, 134(8): 618-629

Table 1. Model Summary (Adapted from Ahadzie et al. 2007a)

Model	R^2	Adjusted R^2	R^2 change	Standard error	Significance of F-statistic	Durbin–Watson
1	0.443	0.433	0.443	0.28475	0.000	
2	0.589	0.574	0.146	0.24678	0.000	
3	0.673	0.655	0.084	0.22212	0.001	
4	0.700	0.677	0.026	0.21501	0.037	
5	0.723	0.696	0.023	0.20854	0.044	
6	0.758	0.729	0.035	0.19703	0.010	
7[a]	0.776	0.744	0.019	0.19118	0.048	2.095

Note: The above is an indication of how the variables were added in the stepwise selection. That is, job knowledge of appropriate site layout techniques for repetitive construction works was added first followed by dedication in helping works contractors achieve work schedules and in that order.

[a]Predictors: (constant) Knowledge of appropriate site layout techniques for repetitive construction works, dedication in helping works contractors to achieve work schedules, knowledge of appropriate technology transfer for repetitive construction works, effective time management on all project sites, ability to provide effective solutions to conflicts, and simultaneously maintaining good relationships, ease with which small-scale contractors are able to approach project manager with their problems, and Volunteering to help small-scale contractors solve external difficulties.

[h]Dependent variable: overall performance outcome.

Table 2. Optimum Model's ANOVA Results—Model No. 7

Model	Sum of squares	Degrees of freedom	Mean square	F	Significance
Regression	6.218	7	0.888	24.303	0.000
Residual	1.791	49	0.037		
Total	8.009	56			

Note: Source: Ahadzie 2007.

Table 3. Optimum Regression Model's Result (Adapted from Ahadzie et al. 2007b)

Variable[a]	Variable description[b]	β^c	σ^d	β^e	t^f	Significance[g]	Tolerance ce[h]	VIF[i]
NA	(Constant)	0.702	0.238		2.949	0.005		
Knstlrep	Knowledge of appropriate site layout techniques for repetitive construction works	0.190	0.047	0.356	4.096	0.000	0.603	1.569
Dediprog	Dedication in helping works contractors to achieve work schedules	0.134	0.043	0.277	3.142	0.003	0.585	1.709
Kntchrep	Knowledge of appropriate technology transfer for repetitive construction works	0.125	0.040	0.259	3.098	0.003	0.652	1.533
Timemgmt	Effective time management on all project sites	0.165	0.050	0.267	3.321	0.002	0.707	1.413
Abilcon	Ability to provide effective solutions to conflicts, simultaneously maintaining good relationships	−1.80	0.047	−0.366	−3.811	0.000	0.495	2.020
Easeproj	Ease with which contractors are able to approach the project manager with their problems	0.087	0.039	0.203	2.225	0.031	0.546	1.831
Volhelp	Volunteering to help works contractors solve external difficulties	0.082	0.040	0.192	2.026	0.048	0.507	1.971

[a]Variable acronym as in Eq. (3).

[b]Variables as defined in Eq. (3).

[c]Regression coefficient.

[d]Standard error of variable regression coefficient.

[e]Standardized regression coefficient which gives measure of the contribution of each variable to the model.

[f]Value of t-statistics.

[g]Significance of t-statistics.

[h]Tolerance for multicollinearity measure.

[i]Variance inflation factor for multicollinearity measure.

J. Constr. Eng. Manage., 2008, 134(8): 618-629

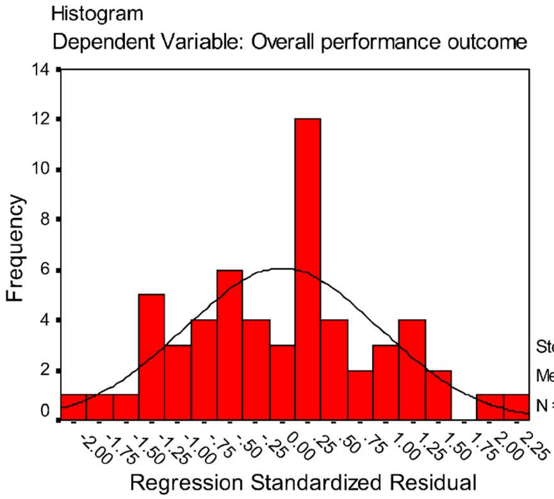


Fig. 2. Histogram for frequency against regression-standardized residual

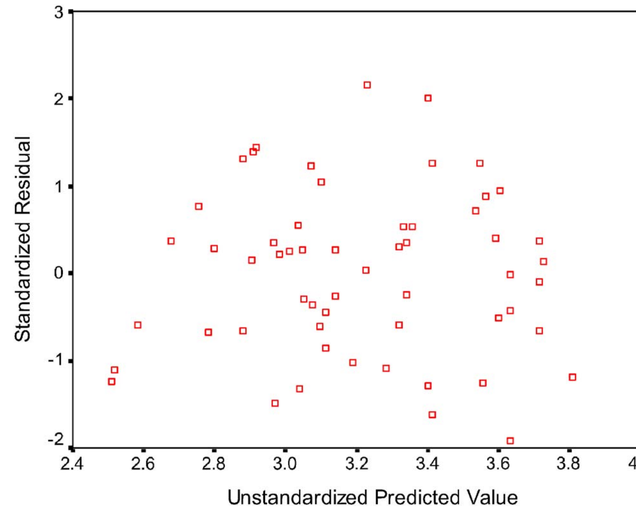


Fig. 4. Scatter of standardized residual against unstandardized predicted value

and variance inflation factor (VIF) were undertaken to check whether high correlations (i.e., multicollinearity) exist among the sets of predictor variables in the regression model (Table 3). The tolerance values are a measure of the correlation between the predictor variables and can vary between 0 and 1. The closer to zero the tolerance value is for a variable the stronger the relationship between this and other predictor variables (Brace et al. 2003). The findings suggested that multicollinearity should be discounted.

Residual analysis was also undertaken to help confirm the goodness of fit. Figs. 2 and 3 show the distribution for the histogram and normal probability plot for regression standard residuals. The histogram is an indication that the distribution is close to normal. Equally, the normal probability plot shows that the points lie close to a straight line confirming that the residuals are approximately normally distributed (Fig. 3). A plot of the standard residuals against unstandardized predicted values is also shown in Fig. 4. The scatter indicates that about 95% of the variables lie in the recommended +2 and −2 intervals. Further, the scatter does not seem to depict any specific pattern, which is also a good measure of normality (see for instance, Field 2005). Thus, all the necessary analysis undertaken as part of regression confirms the goodness of fit of the model.

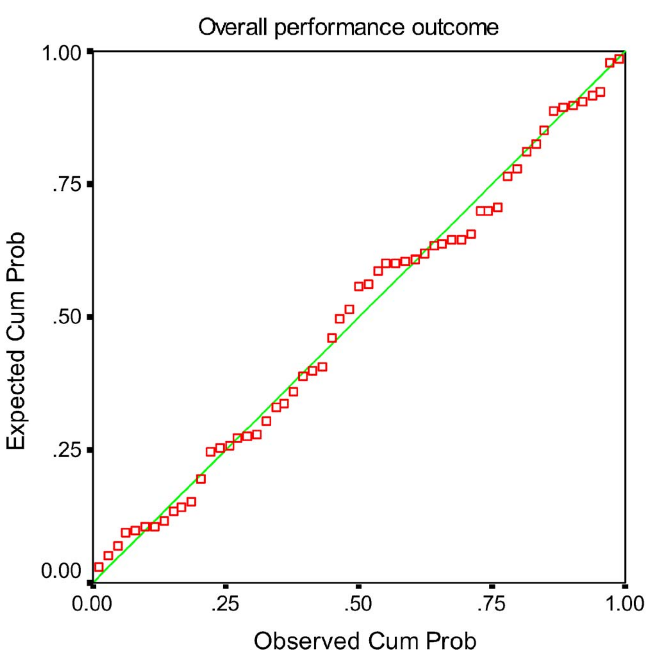


Fig. 3. Normal probability plot of regression standardized residual. (Note: Dependent variable: overall performance outcome.)

Validation of the Model

The model validation was undertaken using the mean absolute percentage error (MAPE) and Steins equation (Good and Hardin 2003; Field 2005). The MAPE measures the magnitude of the residual errors associated with the model whilst Stein equation recalculates the adjusted R^2 on the assumption of its effect on different samples within the sampling frame used for the study (refer Field 2005). The MAPE recorded a relatively strong value of less 5% and the Steins adjusted R^2 resulted in a relatively high of 69%. Thus, the cross validation indicated that model reflected reasonably high predictive accuracy and could be generalized. Full details of the validation exercise can be found in Ahadzie (2007).

Discussion

The discussion is been presented in two sections. The first section presents the convergence of the findings viz. the theoretical framework from the applied psychology literature whilst the second section discusses the findings viz. its significance for performance management in MHBPs. The terminology works contractors are used in this paper refers to "labor-only-subcontractors" who often work in small gangs on MHBPs in Ghana.

J. Constr. Eng. Manage., 2008, 134(8): 618-629

Table 4. Aspects of Independent Variables (Adapted from Ahadzie et al. 2007b)

Performance domain	Variables included	% variance of individual variables (R^2 change)	Total % variance accounted (R^2)
Contextual performance behaviors			24.90
Job dedication	• Dedication in helping works contractors to achieve works schedule	14.6	
Interpersonal facilitation	• Effective time management on all project sites	2.6	
	• Ability to provide solutions to conflicts, simultaneously maintaining good relationship	2.3	
	• Ease with which works contractors are able to approach PMs with their problems	3.5	
	• Volunteering to help works contractors in their personal problems	1.9	
Task performance behaviors			52.70
Job knowledge	• Knowledge of appropriate site layout techniques for repetitive construction works	44.3	
	• Knowledge of appropriate technology transfer for repetitive construction works	8.4	
Cognitive ability	Nil		
Task proficiency	Nil		
Experience	Nil		

Convergence with the Theoretical Framework

For the purpose of the discussion, the independent variables have been regrouped into contextual and task performance behaviors (Table 4). Table 4 shows that both aspects of contextual and task performance behaviors were accounted for in the model. This suggests that the established contextual-task typology adopted from applied psychology may be empirically relevant for validating PMs' performance measures in MHBPs. Borman and Motowidlo (1997) reported that contextual performance would normally account for about 30% of the variance in managerial performance. Conway (1999) also asserts that when a panel of industrial and organizational psychologist where asked to sort performance dimensions that appeared in the relevant literature into task or contextual performance domain using multitrait–multirater matrices, 55% were identified as task performance dimension and 30% as contextual performance dimension with some disagreement in regard the remaining 15%. A cursory look at Table 4 (see also model summary) shows that although aspects of task performance behaviors account for about 52% of the variance, aspects of contextual performance behaviors accounted for about 24%. The closeness of the findings provides some compelling evidence that both aspects of contextual and task performance behaviors are potentially relevant for judging managerial performance in MHBPs (Ahadzie et al. 2007a)

Table 4 further reveals that with regard to the contextual performance domain, aspects of job dedication and interpersonal facilitation were both accounted for in the model, with interpersonal facilitation featured strongly. This seems to confirm the assertion of Borman and Motowidlo's (1997) that the antecedents of contextual performance behaviors are more likely to involve personality factors. Subsequently they contended that if contextual performance behaviors are included as criteria for performance evaluation, then personality predictors are more likely to be successful for selection than if they are not included. That perhaps explains why in this instance, a greater number of variables relating to interpersonal facilitation were accounted for relative to job dedication. However, although more variables from interpersonal facilitation were extracted they do not necessarily account for a greater share of the total variance generally attributed to contextual performance behaviors (Table 4).

Thus, whilst a single variable was extracted for job dedication, an observation of the R^2 change in the model summary (Tables 1 and 4) shows that job dedication accounted for 14% of the variance, whereas the four aspects of interpersonal facilitation accounted for about 10%. This finding is also significant because Van Scotter and Motowidlo (1996) and Conway (1999) have contested which of these two should be more relevant for judging managerial performance. Although both researchers concur that job dedication and interpersonal facilitation is important, Van Scotter and Motowidlo (1996) seem to suggest that job dedication is marginal relative to interpersonal facilitation. In contrast, Conway (1999) argues that job dedication should not be discounted and might be more especially in the managerial domain. Here, the plausible conclusion is that interpersonal facilitation and job dedication could be important for engendering the performance improvement of PMs in MHBPs (see also Ahadzie et al. 2007a).

With respect to the task performance domain, it may seem quite surprising that only aspects of job knowledge were accounted for, yet this also converges with the relevant literature from applied psychology. For instance Hunter (1983) and later Schmidt et al. (1986) both found out (using path analysis) that, in evaluating managerial performance, the constructs; experience, cognitive ability, and task proficiency have their influence normally through their effect on job knowledge. It could therefore be argued here that despite the traditionally "task oriented nature" of the construction industry, PMs are not expected to normally demonstrate strong task proficiency as they often get jobs done through other team members.

Although the antecedents of cognitive ability are normally ex-

J. Constr. Eng. Manage., 2008, 134(8): 618-629

pected to predict task performance behaviors, the evidence suggests that their effect on job performance is mediated by other variables such as job knowledge. This perhaps explains why cognitive ability did not register in this result as well.

It is also interesting that experience did not register in the findings (Table 4). Admittedly, the construct experience when viewed in the global market (e.g., in terms of "seniority" or number of years in a work setting) is well recognized as important criteria for establishing the job potential of PMs (Ogunlana et al. 2002). However, the construct as used here reflects its potential effect in relation to the judgment of homebuilders concerning the performance of PMs on an ongoing (i.e., present) job or task. Thus, a plausible deduction from the earlier finding is that although the behaviors associated with the construct experience is an important determinant in helping to make informed decisions on the choice and selection of potentially competent PMs, in considering its effect in respect to the judgment of homebuilders on an ongoing job or the task at hand, it is how the experience acquired is translated into job knowledge that seems to matter. Thus, although the level of experience of the PM might be important, ultimately, it is how the relevant behavioral experience is successfully translated into job knowledge on an ongoing task that might be crucial in judging their current performance.

Significance of the Findings with regards to the Management of MHBPs at the Construction Phase

The importance of effective site layout on multiple projects such as MHBPs cannot be emphasized enough. Indeed, various researchers have highlighted the significance from a variety of perspectives. For instance, Sadeghpour et al. (2006) reiterates that space on construction sites is recognized as a resource that is as important as the other resources, i.e., money, time, material, labor, and equipment (see also Elbeltagi et al. 2001). Further, it is noted that a well planned site can contribute to reducing construction cost and time by minimizing travel time, decreasing time and effort spent in material handling, increasing productivity and improving safety (Elbeltagi et al. 2001). Elbeltagi et al. (2001) also opined that site layout has a huge impact on productivity and site safety. Pheng and Hui (1999) also elucidated how site layout can be used effectively to improve productivity, quality, and eliminate waste (see also Ngowi 2001). Tam and Tong (2003) also sums up that, an effective site layout including facilities is at the heart of efficient production on MHBPs

The problem however is that in multiple and large scale projects such as MHBPs, it is more difficult to manage the site layout efficiently due to the existence of vast number of trades and interrelated planning constraints (Tam and Tong 2003). Thus, the need for PMs to optimize site layout planning in MHBPs must be critical, especially because an efficient site organization exercises a decisive influence on performance (Enshassi 1997). Interestingly, the evidence suggests that PMs do not often give much thought to site layout planning during the currency of projects (Tam and Tong 2003). This may be because PMs are not empirically aware of the potential benefits that can accrue from a adopting a thorough approach to site layout planning. The fact that this variables alone accounted for 43.3% of the total R^2 is an indication of how important it should treated by PMs in the management of MHBPs.

Technology transfer in MHBPs is the application of technology that is new to the home builder and has the potential of significantly improving performance outcome by decreasing cost and improving the business of the process (Toole 1998). Many researchers concur that adopting these innovations have the potential of improving performance outcome (see, e.g., Yang et al. 2006). The problem is that property developers are generally reluctant to adopt new technologies because, often, the short-term benefits are intangible (see Yang et al. 2006). Toole (1998) identified five tasks that make it difficult for property developers to analyze how the choice of innovations may affect performance outcome: the end products vary considerably, a wide range of conditions are associated with the production process, the end products of the tasks consist of many interacting parts/and or subsystems, the tasks require high knowledge of tacit knowledge and skills and the tasks require interactions with a large number of diverse entities. Consequently, uncertainty (i.e., lack the relevant information) crops in, making it difficult for homebuilders to consider adopting innovations (Toole 1998). In effect, property developers seek convincing proof that technology transfer will provide significant advantages over existing processes/products (Toole 1998).

In many developing countries the urge to increase the quantity of housing has often brought to the foreground the need for adopting appropriate technology transfer especially with regard to the use of local materials. Indeed Mehta and Bridwell (2005) have shown that by adopting the appropriate innovative technology, cheaper and durable materials can be produced to help scale up housing production. However, the uncertainty surrounding the use of innovations is even more severe making domestically grown technologies and skills to account for a moderate share of total capacity (see Yang et al. 2006). The implication is for PMs to demonstrate that they have a rigorous understanding of the potential benefits of innovations they wish to introduce so that they can convince homebuilders of the significant advantages involved.

Regarding the interpersonal behaviors associated with dedication, time management, volunteering, and ability to solve conflicts, there are already widespread research studies of the importance of these in performance management (Pheng and Chuan 2006). From an applied psychology perspective, the reason why these contextual performance behaviors are critical is that although they may not be specifically goal oriented, their presence is needed to facilitate the successful achievement of organizational goals. What is particularly interesting is why the regression coefficient of the variable ability to provide effective solutions to conflicts, simultaneously maintaining good relationships emerged negative? This suggests that it has a negative impact on performance outcome, which seems to deviate from conventional wisdom.

Generally the issue of conflict and conflict resolution is a complex issue in the construction process (Leung et al. 2005). The most commonly held view(s) is that conflicts are detrimental to project success and must be eliminated and resolved. Others regard some moderate level of conflict as a catalyst to product/process improvement (Leung et al. 2005). Further, Leung et al. (2005) has provided evidence to suggest that in solving conflicts, various approaches tend to have different impacts on the satisfaction of the project participants and hence performance outcome. They argued that, there are basically three established approaches for solving conflicts, namely; emotional/rational, which focuses on the cognitive component of conflicts; task/relationship, which highlights how individuals differ in the extent to which they attribute conflicts to problems in relationships; the integration which signifies a "win–win" situation in the interest of all concerned parties. This evidence provided by Leung et al. (2005) suggests that, paying too much attention to the former two ap-

J. Constr. Eng. Manage., 2008, 134(8): 618-629

proaches does not necessarily prove a direct relationship with satisfaction and hence may induce a dysfunctional performance outcome. On the contrary, they found out that there is a positive relationship between the integrated approach and satisfaction of participants. Here, a plausible explanation for the negative coefficient of this variable (ability to provide effective solutions, simultaneously maintaining good relationships) may be that, at least in the Ghanaian situation (and perhaps for many other developing countries), homebuilders do often experience excessive conflicts amongst works contractors and moreover, PMs are not able to provide effective solutions toward improving performance outcome. There might therefore be the need for an in-depth study at least in the Ghanaian context in conflicts/conflict resolution toward understanding the situation better and establishing an effective way forward.

Obviously, the importance of time management in this study cannot be overemphasized enough given that all aspect of communication, monitoring, and progressing is linked to it. However, although managers are often busy managing the time schedule of others, they tend to forget to manage themselves effectively (Fryer 1990). This finding thus serves as a reminder to PMs that there is the need for a systematic and committed approach on their part toward effective time management at all levels. Given the multiple and interrelated works involved in MHBPs, the importance of the other personal skills (i.e., those related to dedication and volunteering) can also be useful in reducing intersite friction; and toward helping workers cope with problems affecting their performance. Indeed in many developing countries in particular, the problems faced by works contractors are personal (resulting from the lack of purposive and economic rationality) and these are often transferred to project sites.

For instance, in Ghana where the data were elicited, works contractors engaged on MHBPs are often poorly organized and do lack appreciation of essential management principles. Consequently, although they might be relatively skillful in their crafts, they need assistance in many ways on how to effectively schedule their works, manage their time judiciously, and also turn potential challenges into opportunities (Ahadzie et al. 2004). These weaknesses, coupled with the general socioeconomic situation prevailing means that virtually PMs cannot ignore volunteering to assist these works contractors on problems that might not be directly related to their terms of engagement. Thus ultimately, as far as the PM is concerned, in MHBPs where multiple skilled workers may be engaged for a considerable length of time, the human factor is decisive and remains very critical (drawing from Cooke-Davies 2002).

Potential Application of the Model

One of the main benefits of competency-based measures is their usefulness for the development of training programs (cf. Tett et al. 2000). Cheng et al. (2005)also pointed out that competency-based measures could assist PMs to contribute more effectively to their professional development by enabling understanding of the competency profiles involved (cf. Cheng et al. 2005). Therefore, there is the potential for the model to be used for developing unique training programs to help engender the professional development of PMs of MHBPs. Given that the skills and capabilities of PMs are influenced by different project types (Ogunlana et al. 2002), there is, therefore, the prospect that the model can be used (among others) as a foundation for establishing unique training programs in the management of MHBPs. Indeed, given the parsimony reflected in the findings, it is the contention that homebuilders who want to adopt the model for training purposes would find it practically easy for implementation.

As observed earlier competency-based models circumvent many of the weaknesses of the traditional systems, especially for matching PMs to jobs (cf. Dainty et al. 2004; 2005). The findings can therefore be used for administrative purposes with regard to the matching and selection of PMs to MHBPs. Subsequently, homebuilders can apply the findings to make informed and objective judgments in the selection and/or appointment of PMs who have the appropriate skills and competencies. Moreover, because of its predictive strength, the model can be used for the monitoring and evaluation of the performance of PMs. Thus, ultimately, the model will be practically useful for informing best practice improvement and the planning of management succession in MHBPs.

Limitations

The key limitation of this study is the relatively small sample size used, however, the writers take consolation from the fact that the relevant preliminary tests associated with the adequacy of the sample size (including the assumptions of central limit theorem) proved favorable for the analysis to proceed. In particular, the robustness demonstrated by the residual analysis also offers hope that there is reasonable normality in the data collected. This coupled with the high adjusted R^2 and high accuracy reflected in the cross validation shows that the findings could be generalized, at least in the context of the study. This, therefore, provides sufficient background for replicating the study in other geographical locations if necessary.

Conclusion

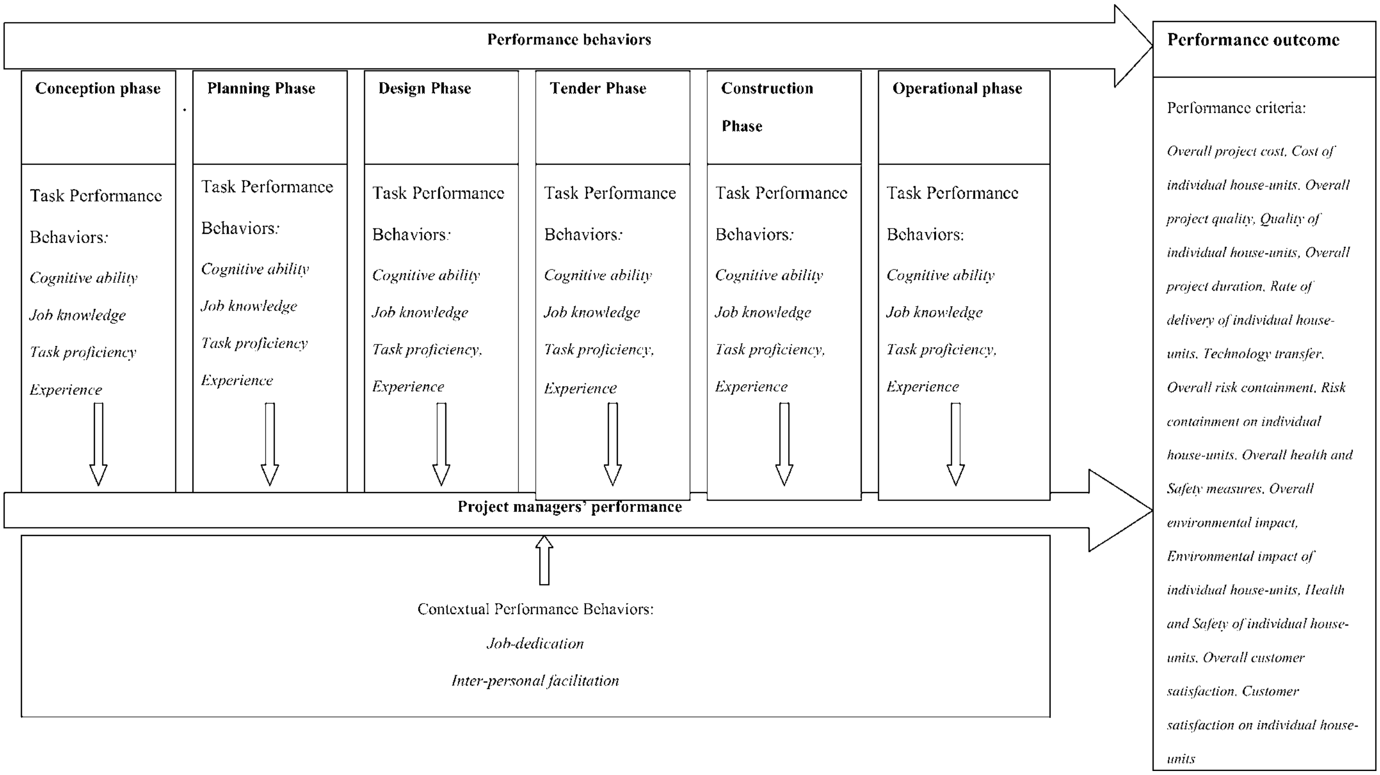
Based on data collected in a developing country (Ghana) a model for predicting the performance of PMs in MHBPs is presented. From a broad range of behavioral metrics relating to the management of MHBPs, the findings suggests the best predictors of the PMs' performances are: job knowledge in site layout techniques, dedication, job knowledge in technology transfer, time management, and ability to solve conflicts, and approachability and voluntary acumen. The various statistical tests employed confirm the goodness of fit and validity of the model. Generally, the findings converge with literature from which the theoretical framework was adopted. The significance of the findings viz. PM performance improvement in the management of MHBPs has also been highlighted. The model has considerable potential for immediate implementation within the housing industry.

Acknowledgments

The Government of Ghana is acknowledged for providing the scholarship funding. The writers also wish to thank Mr. William K. Ahadzie and Dr. Theophilus Adjei-Kumi for facilitating the distribution of the RIs in Ghana. Sincere thanks to Nii Tieku-Okine, an executive member at the GREDA Secretariat for assisting with the list of GREDA members. The writers wish to also thank all the participants who responded to the survey. Finally, they wish to thank two anonymous reviewers who made useful contributions to improve the quality of the paper.

J. Constr. Eng. Manage., 2008, 134(8): 618-629

Appendix. Competency-Based Model for the Project Life Cycle



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