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Predicting the level of organizational effectiveness: a methodology for the construction firm

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Researchers have offered a variety of models for examining organizational effectiveness, yet there is little consensus as to what constitutes a valid set of criteria for measurement. In today's environment it is vital for construction firms aiming to maintain and improve performance to utilize an appropriate method to predict their organizational effectiveness. This paper illustrates a methodology for predicting the level of organizational effectiveness in the construction firm. The competing values approach towards understanding organizational effectiveness and its assessment is used to identify 14 variables. These variables are conceptualized from four general categories of organizational characteristics, relevant for examining effectiveness: structural context, organizational flexibility, rules and regulations, person-oriented processes and strategic means and ends. The methodology hypothesizes a multivariate linear model of the 14 variables as predictors and effectiveness operationalized by the level of overall performance as the response variable. Cross-sectional data were collected from 76 firms operating in institutional and commercial (IC) construction. The validated model shows that five of the hypothesized 14 variables are highly significant in predicting the level of organizational effectiveness in the construction firms studied: organizational attitude towards change, multiple project handling ability, level of planning by management, strength of organizational culture and level of workers' participation in decision making.

Keywords: prediction, organizational effectiveness, construction firm.

Introduction

The measurement of organizational effectiveness is a very important step in the improvement process of any organization. Its importance in creating and designing effective organizations is discussed by Hitt (1988). Yet, Steers (1975) and Zammuto (1982) described the measurement of effectiveness as one of the most problematic issues in the field of organization theory. Researchers have offered a variety of models for examining effectiveness, yet there is little consensus as to what constitutes a valid set of effectiveness criteria (Cameron and Whetten, 1983; Lewin and Minton, 1986). According to Das (1990) the definition and, consequently, the criteria and approaches employed in evaluating effectiveness are various and, in some instances, paradoxical as shown by the variability of definitions. Georgopoulos (1957) referred to it as the extent to which an organization as a social system fulfils its objectives without incapacitating its means and resources and without placing a strain upon its members. Yuchtman and

Seashore (1967) defined it as the ability of the organization, in absolute or relative terms, to exploit its environment in the acquisition of scarce and valued resources. Price (1972) described it as the degree of achievement of multiple goals and Hannan and Freeman (1977) as the degree of congruence between organizational goals and observable outcomes. Pennings and Goodman (1977) suggested that organizations perform effectively if the relevant constraints imposed by the constituency of the organization can be satisfied and if the results meet or exceed a set of criteria for the constituency multiple goals. Miner (1988) defined effective organizations as those that receive inputs, transform them into outputs, export them to environments, monitor changes in the environments and take corrective actions to ensure their survival.

Although there is some degree of overlap, it is apparent that a variety of approaches exist as to what constitutes organizational effectiveness. Many variables are being used as indicators and predictors. Campbell (1976) found over 25 types of variables that fall into three

general classes: economic and technical such as profits, growth, productivity and quality of products and services, social such as workers' turnover, involvement and morale and organizational characteristics such as the level of flexibility and control.

Approaches to effectiveness

In the literature, most models and approaches that are used to understand organizational effectiveness can be classified into three general classes. First are the qualities of organizational approaches. These attempt to relate effectiveness to certain organizational characteristics such as the degree of formalization, openness of communication, level of control and other qualities related to structure, culture and strategy.

Second are the goal-setting approaches. Models that fall into this category use the degree of achievement of a certain output goal or goals as an indicator of organizational effectiveness. Third are the systems approaches. Included here are models that emphasize the organization as a system and attempt to assess the effectiveness of the system in terms of its input, transformation and output. Models that fall into this category include the resource model which views effectiveness as the ability of the organization as a system to exploit its environments, the internal process model where effectiveness is judged by the efficiency of the process inside the system, the strategic adaptation model which recognizes and judges effectiveness by the degree of adaptability to external forces and the open system model which views the organization as an open system. Effectiveness here is indicated by the ability to meet internal and external challenges.

Another perspective, the multiple constituencies approach, proposes that an effective organization is one that satisfies the demand of those constituencies in its environment from whom it requires support for its continued existence.

There are other approaches that utilize a configurational view of organizational strategy, structure and dominant values to analyse effectiveness. These approaches define ideal types or configurations that organizations tend to pursue based on their structure, strategy and dominant values. Effectiveness is determined by how close the characteristics of the organization are to that of a configuration. Included here are Miles and Snow's (1978) typology that identified four ideal types based on strategy: the prospector, the analyser, the defender and the reactor. Mintzberg's (1979) typology identified five ideal types based on structure: simple structure, machine bureaucracy, professional bureaucracy, divisionalized form and *ad hoc*ocracy. Quinn and Rohrbaugh's (1983) competing values approach identified four ideal types of organizations based on

dominant values of structural context, focus and strategic means and ends.

The need for better measurement

Gameson (1992) found that one in five commercial construction clients were dissatisfied with the service they received. One of the reasons that leads to such a low performance is the use of inappropriate measures to assess effectiveness. Improper assessment by organizations leads to inaccurate conclusions which in turn result in a substandard performance. Although most managers use some indicators (mostly financial) these do not capture all of the salient elements of effectiveness and cannot be relied upon as predictors of effectiveness. Measures used by the management of construction firms are rarely justified or linked to the approaches discussed above. The development of better methods to measure effectiveness should be a high priority in order to achieve and maintain improved performance.

A number of researchers have noted that, when developing effectiveness measurement, it is important to specify whether it is the variables that predict effectiveness or the variables that indicate effectiveness that are of interest (Cameron, 1986). Here the focus is on developing a method to predict effectiveness.

Approach

To have a comprehensive understanding of organizational effectiveness, the key variables in the domain of effectiveness must be identified and then the relationship of these variables to effectiveness must be determined. Such an approach would provide a reliable method of predicting the level of effectiveness. The types of variables or criteria that can be used vary by domain and level of analysis. Cameron and Whetten (1983) and Cameron (1986) suggested that in order to develop accurate measurement at the organizational level, variables/measures must be combined into an overall model that indicates performance in the multiple domains of effectiveness. He added that, although organizations could operate in multiple domains, they may perform well only in a limited number. Tsui (1990) argued that this multidimensional view of performance implies that different patterns of relationships between organizational performance and its determinants will emerge. Miller and Friesen (1984), in their study of organizational effectiveness and its analysis, suggested that researchers should attempt to use an approach based on recurring patterns of attributes or configurations of attributes that relate effectiveness empirically. According to Meyer *et al.* (1993) using configurational approaches in organizational analysis represents a holistic stance. Rather than trying to explain how order is

designed into the parts of an organization, configurational inquiry tries to explain how order emerges from the interactions of these parts as a whole. Organizational assessment according to configurations can be justified on the grounds of attempting to understand commonalities across a homogenous group of organizations.

Dotty *et al.* (1993) suggested three main steps in order to develop valid quantitative models based on configurational inquiry. First, organizational configurations in an identified approach must be conceptualized and modelled as ideal types where effectiveness is highest. This is necessary because the fit among the contextual, structural and strategic factors is at a maximum in these configurations. Second, organizational characteristics which represent the different effectiveness domains in the ideal types must be integrated into an overall multivariate profile or model. Then the level of these characteristics must be determined against a valid measure of effectiveness. Third, based on an assessment of the level of these characteristics in the organization under study, the overall model can then be used to predict the effectiveness of the organization.

After a careful review of all the models and approaches used by organizational researchers in the analysis and assessment of organizational effectiveness, the competing values were chosen as a valid configurational approach on which to identify criteria of effectiveness for the developed method. The reasons are 2-fold. First, its configurations, as will be explained later, represent the integration of most of the effectiveness criteria already used by researchers and managers. Second, it has already been validated for construction organizations by Maloney and Federle (1993). A detailed discussion of the approach and a related methodology follows.

The competing values approach

The competing values approach was first proposed by Quinn and Rohrbaugh (1983). The approach has also been discussed by Lewin and Minton (1986), Cameron (1986), Quinn (1988), Robbins (1990) and Maloney and Federle (1991) and is based on the premise that there is no one best criterion for evaluating effectiveness. It organizes, consolidates and integrates multiple criteria in the domains of effectiveness into three sets of incompatible dimensions. These are flexibility versus control, internal versus external focus and means versus ends. The first set contrasts two dimensions of an organization's structure: flexibility values innovations, adaptation and change, while control favours stability, order and predictability. The second set deals with whether focus and emphasis should be placed internally on the well-being and development of the people in the organization or externally on the well-being of the organization itself. The third set relates to organizational

means versus ends, the former stressing internal processes and the long-term and the latter emphasizing final outcomes and the short-term.

These three sets are depicted in the four organizational models or configurations shown in Figure 1. The models are the open system model, the human relations model, the rational goal model and the internal process model. In the figure, there are axes of contrasting values that define the four models. Each model represents a particular set of values/criteria of effectiveness and has a polar opposite with contrasting emphasis. The vertical axis pertains to organization structure context and it contrasts stability and control with flexibility. The horizontal axis pertains to focus indicating whether dominant values are internal or external to the organization. The two inner axes pertain to organizational means and ends for each model and they contrast the processes or means (e.g. goal-setting) with organizational outcomes and the outcomes or ends (e.g. productivity) themselves.

In brief, each model has characteristics which differ from the other and which influence the level of effectiveness in the organization differently. The rational goal model emphasizes control and organizational focus as dominant effectiveness values; planning and goal setting are means and productivity and efficiency are ends. The open system model emphasizes flexibility and an organizational focus as dominant effectiveness values; readiness and flexibility are means, while growth and external support are ends. Dominant effectiveness values for the internal process model are control and internal focus, stressing communication processes as means and control as ends. The human relations model emphasizes flexibility and internal focus, with cohesion and morale as means and skilled workers as ends.

Organizations tend to pursue the values of more than one model at the same time. This is represented by the

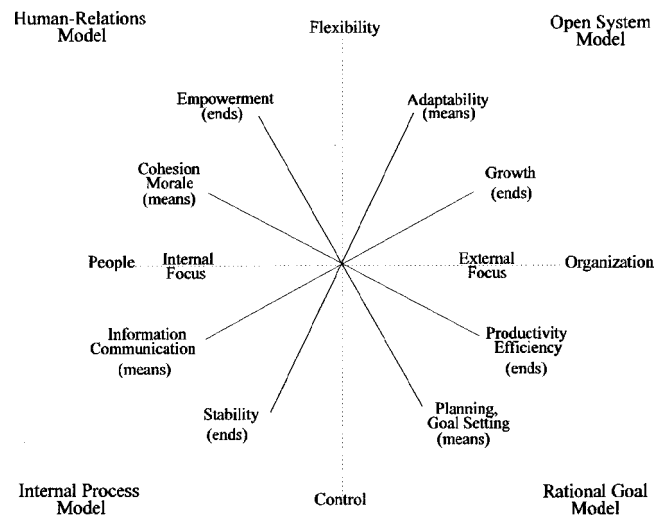


Figure 1 Competing values configurations and criteria of organizational effectiveness

hybridization of values between the four models. When the values pursued by an organization are paradoxical or conflict, this would result in certain trade-offs between levels of these values based on the specific environmental situation faced by the organization. For example, stressing a moderate level of competitiveness and external focus by an organization does not exclude it from placing some emphasis on the development of its workers and adopting strategies to enhance morale and cohesion among them. From this perspective, viewing effectiveness as the result of hybridization of certain levels of values in the four models represents a more realistic view of the nature of the organization and how it organizes itself to achieve effectiveness.

Related methodologies

Maloney and Federle (1993) developed an assessment methodology based on the application of the competing values approach to organizational culture in engineering and construction organizations. The backbone of the methodology is classification of the organization according to culture types. Ratings of the organization by management and workers are analysed and compared with each other. Particular attention is placed upon the comparison of the ratings of the manager and that of the subordinates. The potential for organizational ineffectiveness is indicated by the degree of gap between perceptions of the organization across culture types of the four models.

Kotter and Heskett (1992) studied the relationship between strength of culture and organizational effectiveness. Although they have found relationships between strong culture and performance, in some instances, organizations that were rated with weak cultures performed just as well or better than organizations with stronger cultures. Kotter and Heskett (1992) attributed these irregularities to the effects of organizational characteristics not included in the assessment.

By delineating variables from the four models of competing values, Ostroff and Schmitt (1993) studied configurations of organizational effectiveness and efficiency. Their findings indicate that effective and efficient organizations are influenced not only by strength of culture, but also by other variables such as participation in decision making, goal emphasis, attitude towards change and level of structural contextual emphasis.

Methodology

A multivariate model was developed to relate a number of organizational characteristics of the construction firm identified along the domains of effectiveness in the four

configurations of the competing values approach to a construct of organizational effectiveness. This was done in three main steps (Adas, 1995). First, the organizational characteristics' categories and variables relevant for examining the effectiveness of the construction firm were identified. Second, a field study was designed and carried out. In the study, identified variables were operationalized, scales of measurement were constructed and their reliability tested and cross-sectional data were collected from a sample of construction firms using self-administered questionnaires that targeted management and workers. Third, statistical analyses were used to determine and validate a multivariate linear model. The model relates organizational effectiveness, operationalized by a measure of the level of overall performance and the variables that were deemed significant by the analysis.

Identification of variables

Analysis of a construction firm's characteristics that pertain to structural context, focus and strategy (means and ends) along the dimensions of effectiveness as represented by values of the four models, helped to identify the important variables included in the methodology. A construction firm that pursues strategic flexibility must have a structure that is better suited for contractual arrangements that provide flexibility such as subcontracting, joint venturing, partnering and alliances. Although pursuing these contractual arrangements may provide cost-effectiveness, they limit the degree of control the organization has over its processes. In its quest for the flexibility of services offered, a construction firm may integrate vertically upward by offering financing and Architectural/Engineering (A/E) design and material supply services or downward by offering maintenance services in an effort to exercise a greater degree of control over the quality of the construction product and increase its market share. However according to Krippaehne *et al.* (1992), a construction organization with integrated services will develop defensive strategies and rigidity to compensate for increases in risks and potential increases in fixed costs.

The construction firm's style of management of its workers, its criteria of success and the type and strength of culture that exists in the firm influence its organizational focus. Internally focused construction firms that value flexibility in the assessment of effectiveness should be more sensitive to their workers. They may achieve this by allowing a higher degree of participation in decision making through a strong culture of team-work. Internally focused construction firms that value control in the assessment of effectiveness, should stress adequate communication and information management through a

strong culture of hierarchy with clear rules and regulations for performance.

Externally focused construction firms which value flexibility in the assessment of effectiveness, should emphasize adaptability through a strong culture that promotes readiness and innovations. Externally focused firms which value control in the assessment of effectiveness should emphasize planning, goal setting and a strong culture that promotes productivity and accomplishment.

The analysis of organizational characteristics of the construction firm along the domain of effectiveness, as identified by the four models in the competing values approach, aided in identifying 14 variables that are deemed related to the organizational effectiveness of the construction firm. These variables can be grouped into four general categories: structural context, flexibility, rules and regulation, strategic means and goals and person-oriented processes (Table 1).

In the category of structural context, the study hypothesizes six variables which can be used to indicate the effectiveness of the structural component of the construction firm in dealing with its external and internal environment. This category includes the following variables.

1. The level of integration in services offered by the construction firm which reflects the structural complexity of the organization in its attempt to control the quality and range of its construction product.
2. The level of subcontracting used in the majority of construction projects which Eccles (1981a) has shown to influence the complexity of structure in the construction firm and reflects the firm's attitude towards risk sharing and enhancing its cost-effectiveness.

3. The level of multiproject handling which reflects the ability of the construction firm's structure to handle simultaneous work at different locations to increase its volume of business and, hence, its profits (Eccles, 1981b).
4. The level of partnering, joint venturing and strategic alliances which reflects how successful the organization's structure is in accommodating the added structural complexity resulting from such relationships. Typically construction firms enter into such relationships to access technology, share risks, secure financing, enter new markets, improve their competitive position and meet project requirements (Badger and Mulligan, 1995).
5. The level of organizational coordination which reflects the effectiveness of the structure in coordinating its internal and external relationship.
6. The level of information flow which indicates the degree of openness and quality of communication in the organizational structure.

In the second category of flexibility, rules and regulations, the study hypothesizes four variables that influence how effective the organizational structure is in mediating between the flexibility-control points of the flexibility dimension. These include the following.

1. Extent of using regulations in work procedures, instruction and evaluation.
2. Level of adherence to rules and regulation by management and workers of the construction firm.
3. Level of control the firm attempts to exert over its processes.
4. Firm's attitude towards change.

All these variables together underlie and reflect the

Table 1 Variables used for measuring effectiveness

Dimensions	Categories of variables	Variables
Structural Flexibility/control	Structural context	Level of integration of services Level of joint venturing Level of subcontracting Level of multiple project handling Level of coordination Level of information flow
	Flexibility, rules and regulations	Attitude towards change Level of rules and regulations Level of adherence to rules Level of process control
Focus Internal/external	Person-oriented processes	Strength of culture Level of workers' participation in decision making
Strategy Means/ends	Strategic means and goals	Level of planning Level of goal setting importance

effort of the firm to mediate between its flexibility and the control it should exercise over its processes in order to achieve effectiveness.

The third category of variables is based on the dimension of focus which represents whether the firm is internally or externally focused according to the competing values approach. This category represents the persons-oriented processes in the firm and contains two variables which are deemed important in determining the focus of the construction firm.

1. Strength of organizational culture which reflects the internal climate in the firm and its strengths or weaknesses which are directly tied to the organizational effectiveness of the construction firm (Maloney and Federle, 1993).
2. Level of workers' participation in decision making which underlies a firm's attempt to empower and motivate its workers.

The fourth category represents the strategic means used by the construction firm to achieve effectiveness. It includes two variables: the level of strategic planning and the level of goal setting. The former underscores the firm's attempt to adopt effective strategies that adapt and fit its environment. The latter reflects the level of importance that the firm puts on setting goals such as increasing profit levels, increasing cost-effectiveness, growth into other construction sectors, improving the level of process quality, improving client satisfaction and increasing workers' empowerment.

Data and procedures

Since all the identified variables cannot be directly observable through hard quantitative measures, questionnaires were designed to measure management and workers' perceptions of the variables' characteristics, aspects and magnitudes in the construction firm. A field study was conducted to collect the relevant data. Seventy-six firms completed self-administered questionnaires satisfactorily. Two questionnaires were used; one to solicit responses from upper management and one from workers.

The first questionnaire was used to solicit responses from two upper management level personnel (one at the home office and the other at the site level). A shorter form of the first questionnaire was used to solicit four responses from their workers. This shorter form excluded items which pertain to managerial variables including the level of subcontracting, the level of joint-venturing, the level of planning and the level of goal-setting importance.

The raw scores for all variables except strength of culture were based on responses to a seven-point ordinal

Likert scale ('very high' 7 to 'very low' 1). For each variable, a different number of items (statements) were used in the measurement scale to which the respondents rate the attributes of the variable under question. For example, five items were used to assess the level of integration in services offered by the construction firm and they included the extent of services offered by the firm in the A/E design field, the level of self-owned construction materials supply, the level of construction financing services offered to clients, the level of operating and maintenance services offered to customers and the extent of providing construction management services.

Equal weights were assumed for each item in calculating variables' scores. For the variables where both responses were obtained from the two different levels in the firm, the responses were first aggregated and then averaged within each firm in order to create firm-level scores.

A pilot study was conducted to test the reliability of the questionnaires in soliciting the desired data. Cronbach's α -values for the scales used in the measurement indicate their fairness and suitability (0.66–0.89).

The constant-sum scale used by Maloney and Federle (1993) to measure their six major aspects of culture (dominant organizational characteristics, organizational climate, success factors, organizational glue, leadership style and management style) was also used here. The results were converted to a seven-point Likert scale in a two-step process to make it compatible with other scores.

Organizational effectiveness: a measure

Effectiveness is operationalized by a measure of the construction firm's performance in the three domains of effectiveness that are most commonly used in the construction industry. These relate to the work undertaken by the firm and its duration of execution, its cost of completion and its finished quality. The average level of performance over the previous 5 years of operation is used by this study as an output indicator of the effectiveness of the construction firm. It is calculated as the mean percentage of the percent of projects completed within scheduled time or less, the percent of projects that were completed within budgeted costs or less and the percent of projects that were completed without claims and within an acceptable level of compliance to clients' specifications.

Analysis and results

The mean organizational scores for the 76 organizations in the sample were used to calculate Kendall τ intercorrelation coefficient scores for all 14 variables and the

effectiveness indicated by the level of performance measure, *Y*. Table 2 shows the intercorrelation values and the corresponding *p* values for each correlation below it. *p* values are considered at the 0.05 level for significance testing. Use of Kendall τ correlation coefficients in the analysis is due to the ordinal nature of the scales used in scoring and measuring the variables of the study.

As shown, the level of subcontracting (1) has a very low correlation with organizational effectiveness ($\tau = 0.0256$) with no statistical significance, which could be interpreted as there being no relationship. The level of integration in services (3), level of goal setting (12) and level of using joint venturing, partnering and strategic alliances (13) show low correlations with τ values of 0.2896, 0.2643 and 0.2648, respectively. However, their level of statistical significance is moderately high with *p* values of 0.0005, 0.0017 and 0.0032, respectively. This indicates a very weak and significant relationship between these variables and the level of performance in the firms studied.

The level of adherence to rules and regulations (4), level of coordination (5), information flow (6) and level of control (14) have somewhat higher coefficients that range from 0.3345 to 0.3630 and a high level of statistical significance (all *p* values are <0.0002). This is an indication that these variables have a weak but significant relationship with the level of effectiveness, *Y*. Variables that include the level of planning (8) and extent of rules and regulations (11) have moderately strong and highly significant relationships with *Y* shown by correlations value of 0.5542 and 0.5002, respectively (both *p* values <0.0001).

Values of τ of 0.7332, 0.6076, 0.8223 and 0.6921 and their respective *p* values (all *p* values <0.0001) for the variables that include attitude towards change (2), level of multiproject handling ability (7), cultural strength (9) and level of workers' participation in decision making (10) indicate that there are strong and highly significant relationships between these variables and the level of effectiveness, *Y*.

Based on these findings, it is seen that in the firms that were studied, a high level of organizational effectiveness indicated by a high level of performance in past projects is associated with a strong culture that promotes a high level of participation in decision-making processes by its workers, a high level of positive attitude toward change by management and workers, a high level of planning as a strategy to adapt to environmental risks, a high level of multiproject handling ability and a moderate level of using rules and regulations by the firm. These variables account for much of the variability in performance of the firms studied. However, the other variables that have weak but significant associations also contribute to high levels of effectiveness in the firms studied.

Model

Typically, there are two goals of mathematical modeling. One is to obtain a valid estimate of a causal relationship and the other is to obtain a good predictive model. According to Retherford and Choe (1993), when the goal is 'prediction' it is appropriate to develop linear models because of their simplicity of use. As the goal of this study was to obtain a prediction model based on the linear combination of the hypothesized variables, a statistical computer program (SAS) was used in developing, diagnosing and fitting the desired linear model. Multiple regression procedures based on the least square method were used to estimate the best model with the highest r^2 value based on analysis of variance and parameter estimates. Only 66 records from the 76 records collected were used in the model development. The remaining ten records were reserved for model validation purposes.

In developing the model, dummy variables are used to code the variables because of the ordinal nature of scales used in scoring the firms in the sample. Dummy variables or contrast variables' use is proposed as outlined by Retherford and Choe (1993). The prime function of dummy variables is to represent categorical and ordinal variables to gain a better realistic model than by modeling the ordinal variables as ratio or interval variables. According to Judd and McClelland (1989) $m-1$ contrast codes must be employed to code a categorical or ordinal variable with *m* levels.

Therefore, in coding the seven level (7 = very high to 1 = very low) scales used in the measurement, six dummy variables must be employed to represent each of the original variables. This would have resulted in dealing with a large number of variables in the model which would render it impractical. A solution was to crash down the seven-point ordinal scale to a three-point scale of high, moderate and low for each of the variables. Two contrast codes were employed for each variable which made the possible total number of variables in the model more manageable. The three levels in the crashed scales were assumed between values that mark the 33rd and 67th percentiles of the cumulative distribution for each variable obtained from scores on the seven-point scales. Table 3 shows these values for the 14 variables. So that all scores below the value that marks the 33rd percentile on the cumulative distribution were classified as low scores, all scores that fall between the 33rd and 67th percentile values were classified as moderate and all scores above the 67th percentile were classified as high.

To illustrate the use of the table, an example is discussed. A firm was scored by its management and workers and an average aggregate score was calculated to equal 4 relating to the strength of culture variable (9). To convert this score to a high, moderate or low level rating,

Table 2 Kendall τ correlation coefficients

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Y
1. Level of subcontracting	1.0000														
	0.0000														
2. Attitude toward change	-0.068	1.0000													
	0.4037	0.0000													
3. Level of integration	0.187	0.1094	1.0000												
	0.0267	0.1833	0.0000												
4. Level of adherence	-0.147	0.3105	-0.159	1.0000											
	0.0861	0.0002	0.0637	0.0000											
5. Level of coordination	0.013	0.1692	0.0793	0.2248	1.0000										
	0.8743	0.0350	0.3390	0.0074	0.0000										
6. Level of information	-0.009	0.2264	0.2483	0.2103	0.2104	1.0000									
	0.9174	0.0099	0.0062	0.0220	0.0175	0.0000									
7. Level of multiproject handling ability	0.0778	0.5409	0.2913	0.1945	0.1010	0.2546	1.0000								
	0.3898	0.0001	0.0014	0.0347	0.2553	0.0088	0.0000								
8. Level of planning	0.0273	0.5028	0.2118	0.1947	0.3559	0.2963	0.3685	1.0000							
	0.7414	0.0001	0.0109	0.0206	0.0001	0.0010	0.0001	0.0000							
9. Strength of culture	0.0300	0.7057	0.3025	0.2678	0.2885	0.3053	0.5579	0.6186	1.0000						
	0.7202	0.0001	0.0003	0.0017	0.0004	0.0007	0.0001	0.0001	0.0000						
10. Participation in decision making	0.0705	0.5005	0.4616	0.1934	0.3074	0.3263	0.4688	0.5236	0.7076	1.0000					
	0.3909	0.0001	0.0001	0.0207	0.0001	0.0002	0.0001	0.0001	0.0001	0.0000					
11. Extent of rules and regulations	0.0045	0.3219	0.2524	0.1309	0.3774	0.2553	0.3098	0.3202	0.4932	0.5485	1.0000				
	0.9564	0.0001	0.0033	0.1324	0.0001	0.0054	0.0008	0.0001	0.0001	0.0001	0.0000				
12. Level of goal setting	0.1510	0.1251	0.0516	0.0608	0.3296	0.1934	0.1126	0.2741	0.2758	0.2392	0.1202	1.0000			
	0.0769	0.1323	0.5483	0.4845	0.0001	0.0346	0.2211	0.0011	0.0012	0.0042	0.1668	0.0000			
13. Level of joint venturing, partnering and alliances	-0.056	0.2770	-0.042	0.3669	0.0402	0.1489	0.2362	0.1308	0.2271	0.1755	0.0662	-0.006	1.0000		
	0.5390	0.0018	0.6510	0.0001	0.6531	0.1285	0.0162	0.1446	0.0125	0.0490	0.4754	0.9460	0.0000		
14. Level of control	0.0323	0.3570	0.0251	0.2555	0.0894	0.1205	0.3657	0.2325	0.2952	0.1943	0.1118	0.2311	0.3734	1.0000	
	0.7158	0.0001	0.7788	0.0046	0.3040	0.2057	0.0001	0.0077	0.0008	0.0251	0.2156	0.0104	0.0001	0.0000	
Level of effectiveness (Y)	0.0256	0.7332	0.2896	0.3445	0.3630	0.3350	0.6076	0.5542	0.8223	0.6921	0.5002	0.2643	0.2648	0.3345	1.0000
	0.7551	0.0001	0.0005	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0017	0.0032	0.0001	0.0000

p values are listed under each τ . All $p < 0.05$ are significant.

Table 3 Cumulative distribution percentiles for mean aggregated variables' scores based on seven-point Likert scales

Number	Variable	Value that marks 33rd percentile	Value that marks 67th percentile
1	Level of subcontracting	4.7	6.2
2	Attitude toward change	4.3	4.7
3	Level of integration in services	3.7	4.2
4	Level of adherence to rules and regulations	4.5	4.9
5	Level of coordination	4.4	4.5
6	Level of information flow	4.0	5.0
7	Level of multiproject handling ability	4.1	5.5
8	Level of planning	3.6	5.2
9	Strength of culture	3.5	5.3
10	Level of participation in decision making	3.8	4.7
11	Extent of rules and regulations	4.4	5.1
12	Level of goal setting	4.7	5
13	Level of joint venturing, partnering and alliances	4.5	5
14	Level of control	5	5.1

the table is used. A moderate level rating is indicated because the score falls between the 33rd percentile value of 3.5 and the 67th percentile value of 5.3. If the score is above 5.3, a high level rating is indicated and if it is below 3.5, a low level rating is indicated.

Each X_i of the 14 hypothesized variables is coded by two dummy variables (X_{i1}) and (X_{i2}). As shown in Table 4, the two dummy variables can represent the three levels for each variable. When the level of X_i is determined to be high, the variable is represented by the situation $X_{i1} = (0)$ and $X_{i2} = (1)$. When the level of X_i is judged to be medium, X_i is represented by $X_{i1} = (1)$ and $X_{i2} = (0)$. Where the level is low, the variable is represented by $X_{i1} = (0)$ and $X_{i2} = (0)$. It should be noted that substitution for dummy variables should always be considered in pairs to indicate the proper level of the variable. For a low level rating, both dummy variables that represent that variable should be given the value of 0. For a moderate or high level rating, the value of 1 is assigned to the dummy variable that represents that proper level and the value of 0 is given to the other dummy variable.

A multivariate linear regression was performed to develop a model. As shown in Equation 1, the general regression model considers 28 dummy variables to represent the original 14 variables. The intercept a is the low level or the reference level for the construction organizations studied ($X_{i1} = 0, X_{i2} = 0$). The b coefficient is the effect of each variable on the level of organizational effectiveness.

$$Y = a + b_{11}X_{11} + b_{12}X_{12} + b_{21}X_{21} + b_{22}X_{22} + b_{31}X_{31} + b_{32}X_{32} + \dots + b_{n1}X_{n1} + b_{n2}X_{n2} \quad (1)$$

After analysis of variance and diagnosis of residuals to

check on the assumptions of linearity, the fitted model yielded by SAS procedures is shown in Equation 2. The model is significant at $\alpha = 0.05$ and $p \leq 0.0001$.

Dummy variables that represent the high and moderate levels of only five of the original 14 hypothesized predictors were determined to be significant in predicting the level of effectiveness, Y , based on their p values. These are X_{21} and X_{22} representing the levels of attitude toward change by management and workers (2), X_{71} and X_{72} representing the levels of multiproject handling ability (7), X_{81} and X_{82} representing the level of planning (8), X_{91} and X_{92} representing strength of culture (9) and X_{101} and X_{102} representing level of workers' participation in decision making (10).

Analysis of variance shows that the model has a root mean square error of 0.043 which means that the model has a 4.3% error in prediction. The model's r^2 and adjusted r^2 are 0.93 and 0.91, respectively.

$$Y = (0.426 + 0.076X_{21} + 0.081X_{22} + 0.048X_{71} + 0.099X_{72} + 0.048X_{81} + 0.049X_{82} + 0.058X_{91} + 0.105X_{92} + 0.062X_{101} + 0.102X_{102}) \quad (2)$$

The partial coefficients in the model for any two dummy variables represent the effect of being moderate or high level in any of the five variables. A value of 0.426 is shown

Table 4 Variable's levels and corresponding coding of dummy variables

Case	Level	Dummy variables' values
1	High	($X_{i1} = 0, X_{i2} = 1$)
2	Moderate	($X_{i1} = 1, X_{i2} = 0$)
3	Low	($X_{i1} = 0, X_{i2} = 0$)

as the intercept in the model above. This value represents the low level or the reference level for the construction firms studied. It also represents the predicted level of organizational effectiveness in a firm with low ratings in all of the five variables. It is worth noting here that the actual level of effectiveness for such a firm may fall anywhere between 0.426 and 0. For a firm with high level ratings in all of the five variables, a maximum predicted level of effectiveness of 0.862 is calculated by the model. The actual level of effectiveness for such an organization may fall anywhere between this value and 1.00.

It is noted that the value of Y is influenced very little by whether a firm is rated as having a moderate level of attitude toward change or having a high level as represented by the two coefficients of 0.076 and 0.081 for X_{21} and X_{22} , respectively. The same holds true for the variable level of planning. The coefficient for a moderate level of planning (X_{81}) is 0.048 and 0.049 for a high level of planning (X_{82}). This could be interpreted as being that effectiveness is associated with a moderate level of attitude towards change and a moderate level of planning in the group of organizations studied.

Level of workers' participation in decision making in the construction firms studied, impacts on the value of Y by 0.102 (coefficient for X_{102}) for high level ratings and 0.062 (coefficient for X_{101}) for moderate level ratings. This indicates that an increase in the level of organizational effectiveness is associated with an increase in the level of workers' participation in decision making in the firms studied.

Rating the construction firm as having a high level of multiple project-handling ability contributes 0.099 (coefficient for X_{72}), while rating it as having a moderate

ability contributes only 0.048 (coefficient for X_{71}). This seems to indicate that a high level of multiple project-handling ability contributes more than double that of a moderate level to an increase in the predicted level of organizational effectiveness.

There is also a difference in the contribution to the predicted level of effectiveness of a construction firm, Y , between a moderate level strength of culture (X_{91} coefficient = 0.058) and a high level strength of culture (X_{92} coefficient = 0.105).

Validation

The prediction of the level of effectiveness by the model is based on the possible combination of high, moderate and low ratings of the five variables for any organization. Table 5 shows the ratings of the ten firms whose records were not used in model development, the predicted level of effectiveness and the actual level calculated from management response. The first record belongs to a firm with the following ratings of the five variables: highly favourable attitude toward change ($X_{21} = 0$, $X_{22} = 1$), a moderate level of multiproject handling ability ($X_{71} = 1$, $X_{72} = 0$), performs planning very regularly ($X_{81} = 0$, $X_{82} = 1$), has a strong culture ($X_{91} = 0$, $X_{92} = 1$) and a moderate level of participation in decision making by workers ($X_{101} = 1$, $X_{102} = 0$). The level of organizational effectiveness predicted by the model for the firm is equal to 0.77. Based on this value, the prediction can be made that this construction firm has a level of organizational effectiveness that would cause it to perform in 77% of its work projects on time and/or within budget and/or according to specifications and unsuccessfully in the

Table 5 Predictions of organizational effectiveness based on organizational ratings

Number	Levels of variables ^a					Predicted effectiveness	Actual effectiveness
	Attitude toward change (1)	Multiple project handling (2)	Level of planning (3)	Strength of culture (4)	Decision-making participation (5)		
1	H	M	H	H	M	0.77	0.79
2	L	L	M	M	L	0.58	0.53
3	H	H	M	H	M	0.82	0.80
4	M	H	L	M	M	0.72	0.75
5	L	M	L	L	L	0.47	0.50
6	M	M	M	M	L	0.66	0.67
7	H	H	H	H	M	0.82	0.77
8	M	H	M	L	M	0.71	0.73
9	M	M	M	M	L	0.59	0.60
10	M	M	L	M	H	0.70	0.67

^aLevels are shown by L, M and H to indicate low, moderate and high levels, respectively.

remaining 23%. The level calculated from the management response is approximately 79%.

The second record belongs to a firm that was rated as having an unfavourable (low) attitude toward change ($X_{21}=0$, $X_{22}=0$), a low level of multiproject handling ability ($X_{71}=0$, $X_{72}=0$), a moderate level of planning ($X_{81}=1$, $X_{82}=0$), a moderate strength of culture ($X_{91}=1$, $X_{92}=0$), and a low level of workers' participation in decision making ($X_{101}=0$, $X_{102}=0$). The level of organizational effectiveness predicted is approximately 53% and the actual level calculated is 58%.

As seen in the table, the predicted levels of effectiveness are very comparable with the actual levels of effectiveness calculated from data records. This indicates the robustness of the fitted model.

It should be noted that the model is intended as a tool that gives management an idea about how organizational characteristics measured by the variables in the model influence the overall performance and not specifically the rate performance on a project by project basis. According to the Y value achieved, the conclusion could be made that a firm would perform within scheduled time and/or within costs and/or according to specifications in some projects and that it would fail to achieve performance in all other cases ($1 - Y$).

Summary and conclusions

Fourteen organizational variables were identified to predict the effectiveness of the construction firm. Analysis of data from 76 construction firms indicated that only five of the original 14 variables are significant in predicting their level of effectiveness. These variables include firms' attitude toward change, its level of multiple project-handling ability, its level of planning, its strength of culture and the level of workers' participation in decision making in the firm.

The developed model is a practical tool. By rating the five variables in the model using the scales developed by this methodology, it is very simple to calculate the level of organizational effectiveness of the construction firm.

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