# IMPACT OF PROJECT MANAGEMENT ON PROJECT PERFORMANCE: A STRUCTURAL EQUATION MODELLING APPROACH

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The relationship between project management and project performance is evaluated from a Structural equation modelling (SEM) perspective. This approach differs from many studies that have examined this relationship. The approach taken in this research argues for an extended understanding of the strength of the direct and indirect influence of the different project management influencing factors on project performance. A survey investigating the influence of project management processes on performance was conducted. Using structural equation modelling the direct and indirect causal influence of project management influencing factors was evaluated. The use of SEM was compared to other multivariate methods that have been used in similar studies. The findings show that the use of SEM improves the understanding of the direct and indirect relationship between project management influencing factors and project performance.

Keywords: critical success factor, performance, project management, structural equation modelling.

## INTRODUCTION

The purpose of project management on a construction project is undoubtedly to add value to projects by delivering successful projects in terms of agreed project objectives. Generally, project management literature suggests that project management processes are geared towards the delivery of successful projects (Zulu 2007). The Construction Industry Council (2007), for example, describe the purpose of construction project management as intending to add significant value to the project delivery process through the use of management principles suited to projects. The general definitions of project management also suggest that project management is designed to deliver value in projects.

In an effort to understand the impact of project management processes on performance, many studies have examined project management factors that contribute to successful projects. For example Pocock and Kim (1997) were concerned with organizational aspects of project management and how this influences project management results. While Pinto and Mantel (1990), and Sherman and Wideman (2000) modelled factors, within project management processes and practices that would influence project results. These studies and many others [Yeo 2002; Milis and Mercken 2002; Pheng and Chua 2006; Olander and Landin 2005 and Fortune and White 2006] were concerned with the understanding of factors in project management that contribute to successful project performance.

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An examination of these studies show that the methods used in evaluating the relationship between critical success factors and project performance has mostly involved the assessment of the direct relationships only. Such an approach limits the understanding of how these project management variables interact with each other and collectively impact on project performance. This research departs from the simplified perspective of the direct relationship between project management variables and project performance and examines both the direct and indirect impact of project management variables on project performance.

## METHODS USED IN EVALUATING IMPACT OF PROJECT MANAGEMENT ON PERFORMANCE

A range of methods have been used in the evaluation of the relationship between project management and performance. These have ranged from simple ranking based on frequency of responses to Structural Equation Modelling. Some studies on critical success factors have used simple statistics in classifying factors that are perceived to have significant impacts on project performance. For example Yeo (2002) used relative ranking of the influence factors on IT project success by using mean scores. Such a method whilst providing insights into issues affective project performance, is does not explain the level of contribution to project performance nor does it account for indirect relationships between the influencing factors and project success.

Studies on critical success factors have mostly used correlation analysis to determine which factors correlate significantly to project performance. For example Ibbs and Kwak (2000) tested for correlations between organizations project management maturity levels and actual project performance in terms of cost and schedule performance. Their analysis however was only concerned with the direct relationships and did not account for indirect relationships in the project management process.

Regression has also been used to examine the impact of project management on performance. Kuprenas (2003) used linear regression and correlation to quantify the management impacts on project performance, while Phua (2004) in exploring the determinants of multi-firm project success, also used regression analysis to model the project success. The use of simple regression analysis however only considers single linear relationships and does not provide an opportunity to analyse multiple dependence relationships simultaneously. The simultaneous analysis of multiple dependence relationships is necessary to the understanding of the individual and collective impact of project management process quality variables on project performance.

Brown and Adams (1999) however, used path analysis to measure the effect of project management on construction project performance. Path analysis accounts for both the direct and indirect relationships. This analysis suits examination of a project management quality model, which contains both direct and indirect relationships. However Structural Equation Modelling (SEM), is considered a better alternative to path analysis (Hair *et al.* (1998). Gowan and Mathieu (2005) examined the influence of project management practices on project performance using SEM as an evaluation too. The strength of this method was that it accounted for both direct relationships between variables and the interrelationships between the project management variables thereby accounting for the indirect relationships between variables and project performance.

## STRUCTURAL EQUATION MODELLING

This research took an SEM approach in evaluating the relationship between project management influencing factors and project performance. Bryne (2001) defines SEM as a statistical methodology that takes a confirmatory approach to the analysis of a structural theory bearing on some phenomenon and states that this conveys two issues. Firstly, that the causal relationships under study are represented by a series of structural equations and secondly that these structural relationships can be modelled pictorially to enable a clearer conceptualization of the theory under study. SEM provides a method for statistically testing hypothesized relationships between variables simultaneously to determine the extent to which the model is consistent with the data.

SEM is a multivariate analysis technique different from many of the multivariate techniques such as multiple regression, factor analysis, multivariate analysis of variance, discriminate analysis, which provide researchers with analytical tools to examine relationships between variables. These methods fail to analyse multiple relationships between variables simultaneously and are limited to the analysis of single relationships at one time. SEM extends these techniques and provides for a mechanism for the examination of a series of dependant relationships simultaneously (Hair *et al.* 1998).

## THE PROJECT MANAGEMENT PERFORMANCE MODEL

The purpose of this research was to examine the direct and indirect relationships between project management variables and project performance. In order to perform such an analysis there was need to identify a suitable theoretical model that can be used to represent project management processes as a causal model. Consideration was given to a number of possible models. However a quality award based framework was used in this research to define a project management performance model. A project management performance model based on the European Foundation for Quality Management (EFQM) business excellence model was developed to represent the interrelationships between project management variables. Such a model has been used by Zulu (2007) Bryde (2003) and Westerveld (2003). The rationale behind the use of such a model is explained in Zulu (2004).

Figure 1 depicts the conceptual Project Management Performance (PMP) model based on the EFQM Criteria. It is noted that the model contains constructs named suitably for recognition as project management related constructs. The model replaces leadership, people, policy and strategy, partnership and resources, and processes with project management leadership, project team, project management policy and strategy, project management partnerships and resources (communication) and project management processes. The results area in the PMP model are represented by one construct, project results. The interpretation in the model is that project performance is as a result of project management leadership driving project team, project management policy and strategy project communication and project management processes. Thus project performance is directly influenced by project management processes and indirectly by project management leadership, project team, project management policy and strategy and project communication. The postulated relationships between these constructs in the model formed the structural model part of the SEM.

As constructs can not be measured directly, there was need to define the measurement indicators. Measurement variables used in the model were developed from literature on critical success factors. The indicator variables formed the measurement model in the PMP model. These are presented in Table 1 and represent the PMP measurement model.

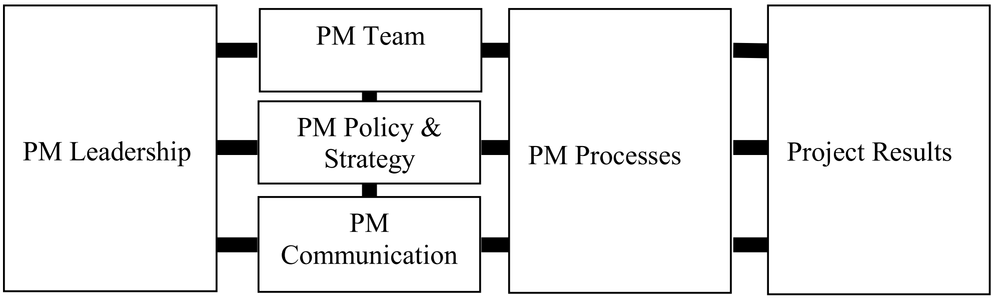


**Figure 1**: The PMPQ Model

## THE SURVEY

A total of 400 questionnaires were sent to project management firms and 67 completed questionnaires were received back representing a 17% response rate. This is within the expected response rate in questionnaire surveys (Denscomb 2003). Of these, four questionnaires were rendered unusable because they were largely incomplete or the answers were deemed to be inconsistent with the perceived pattern of answering. The remaining 63 (16%) were used in the subsequent analysis. Although the sample size of 63 was considered relatively small in light of recommendations in SEM literature (Hair *et al.* 1998), small sample sizes of less than 100 have been used in many studies and provided valid results (MacCallum and Austin 2000). Based on this, the sample size was considered as at least adequate to proceed with the use of SEM to evaluate the relationship between PMPQ and construction project performance.

## RELIABILITY AND VALIDITY OF THE MEASUREMENT MODEL

Preliminary analysis of the measurement model based on factor analysis was used to test the reliability of the measurement scales. This measures the internal consistency of the measurement model. The results from the analysis showed that the PMP constructs' measurement scales have generally good internal consistency based on the Cronbach alpha values as all cronbach alpha values were above the 0.70 threshold

Having conducted a preliminary analysis of the reliability of the measurement scales, the next step was the assessment of the measurement model by testing the factoral validity of the measurement model. However before SEM analysis could be performed, it was deemed prudent to reduce the number of measurement indicators per construct. This was based on the argument that, the more complex the model, the larger the sample size required. Seeing that the number of measurement items increases the complexity of the model, reducing the number of measurement items would simplify the model thereby reducing the effect of sample size on the results. This is consistent with MacCallum and Austin (2000) who suggested that small samples should be used with simpler models only.

**Table 1:** PMPQ Item Parcels

| Construct | Item Parcel | Variables |
|---|---|---|
| Leadership | Lead1 | Definition of clear goals |
| | | Competence of the project manager |
| | | Experience of the project manager |
| | Lead2 | Roles and responsibilities of the project manager |
| | | Suitability of organization structure |
| | | Leadership style |
| | Lead3 | Level of authority given to the project manager |
| | | Client support |
| Strategy | Strat1 | Project reviews |
| | | Awareness of project requirements |
| | Strat2 | PM methodology |
| | | Project manager's involvement in briefing |
| | Strat3 | Feedback mechanism |
| | | Clear definition of success criteria |
| | | Quality of plan/strategy |
| Team | Team1 | Capability of team |
| | | Roles and responsibilities of project team |
| | | Level of conflict |
| | | Experience of team members |
| | Team2 | Team skills and knowledge |
| | | Level of trust in team |
| | | Shared clear vision of goals |
| | Team3 | Cooperation between team members |
| | | Working relationship in team |
| | | Commitment of team members |
| Communication | Com1 | Timelines of communication |
| | | Communication procedures |
| | Com2 | Accuracy of information |
| | | Frequency of communication |
| | Com3 | Methods of communication |
| | | Adequacy of information |
| Process | Proc1 | Appropriates of pm processes and procedures |
| | | Change management |
| | | Frequency of feedback to client |
| | | Tools and techniques |
| | Proc2 | Implementation of pm processes and procedures |
| | | Frequency of control meetings |
| | | Risk management strategy |
| | Proc3 | Degree of monitoring and control |
| | | Implementation of methodology |
| | | Quality of planning |

The use of item parcelling is recommended in literature as a way of reducing the number of indicator variables (Schumacher and Lomax 2004 and Hau and Marsh 2004). Item parcelling involves forming composite items from a number of items, thereby reducing the number of items while still accounting for all. The single factor analysis procedure as recommended by Landis *et al.* (2000) was used to reduce the number of variables to three per construct. This involves pairing off items with highest and lowest loadings as first composites based on a single factor solution. The next set of items would be the second highest and the second from the bottom. This procedure continues until all items have been parcelled. The item parcels as presented in Table 1 are used in subsequent analysis in place of the individual indicator variables.

In order to test the validity of the measurement model it is important to check the factor loadings for each construct. Byrne (2001) recommended the use of factor analysis to test the factorial validity of the measurement model. An assessment of the measurement model revealed that the model was generally acceptable. All the estimates were deemed to be within acceptable limits and of the correct sign and size. However an examination of the statistical significance of the estimates revealed that one of the composite indicator variables (team 3) for the project team construct was not statistically significant and therefore was deleted from the measurement model.

A further examination of the goodness of fit indices for the modified measurement model (as presented in Table 2) showed that the measurement model was a relatively good fitting model. There are a number of goodness of fit indices that can be used to assess a model. It is generally recommended to use a range of indices in order to assess a model (Schumacher and Lomax 2004). The fit indices used here were the Chi Square statistic ($\chi^2$), Chi square divide by the degrees of freedom ($\chi^2$/df), Comparative Fit Index (CFI), Goodness of Fit Index (GFI), Incremental Fit Index (IFI) and the Tucker Lewis Fit Index also known as the Non normed fit index (TLI/NNFI).

An examination of the fit indices in Table 2 shows that the model moderately fits the data. The $\chi^2$ value of 141.19 (p=0.09) suggests that the model is accepted. For a well fitting model the $\chi^2$ should have a p-value >0.05 (Hair *et al.* 1998). The RMR, RMSEA, CFI, TLI and the IFI indices show that the model fits well. However the GFI (0.82) was below the acceptable 0.90 value for a model to be accepted. Overall however these indices indicate a moderate acceptable fit between the model and the data. Some studies have actually accepted this is a marginally acceptable model. For example Grandzol and Gershon (1998) passed values of 0.765 (AGFI), 0.795 (GFI) and 0.754 (NFI) as marginally acceptable. Hair *et al.* (1998; p 660) reported values for GFI of 0.865 as marginally accepted.

**Table 2*:*** Goodness-of-fit Indices for modified measurement model

| Fit Index | Acceptable fit | Indices for data |
|---|---|---|
| $\chi^2$ | | 141.19 |
| df | | 120 |
| *p* | >0.05 | 0.09 |
| $\chi^2$/df | ≤ 2 to 5 | 1.18 |
| RMR | <0.06 | 0.05 |
| GFI | ≥ 0.90 | 0.82 |
| RMSEA | ≤ 0.05 to 0.08 | 0.05 |
| CFI | ≥ 0.90 | 0.97 |
| NNFI?TLI | ≥ 0.90 | 0.96 |
| IFI | ≥ 0.90 | 0.97 |

## THE PMPQ FULL STRUCTURAL MODEL

Having assessed the measurement model as moderately fitting well the data, the next step was the assessment of the structural model. The interest in this assessment was the evaluation of the validity of the causal structure. The Hypothesized structural model showing both the constructs and their indicator variables is presented in Figure 2.

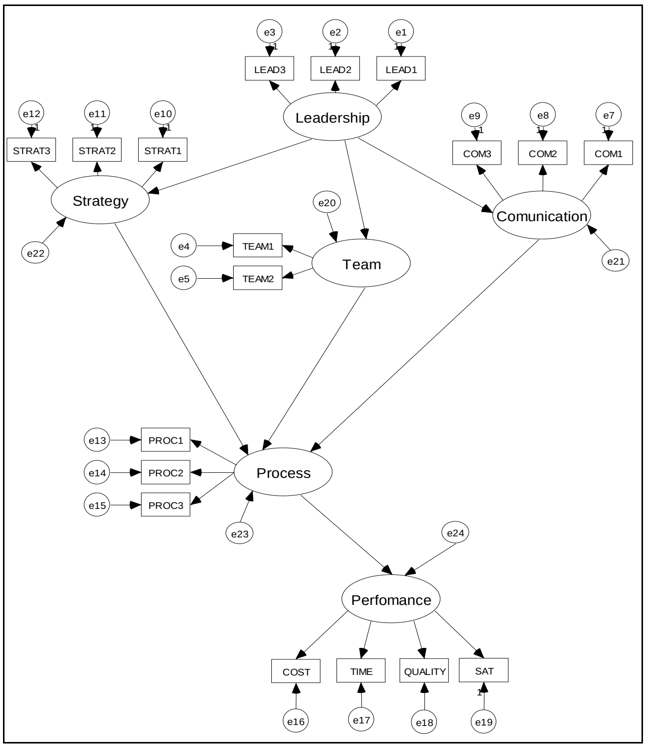


**Figure 2**: Path Diagram of the Full PMPQ Model

An examination of the goodness of fit indices in Table 3 indicates that the model moderately fits well with the data. The $\chi^2$ (p=0.06) indicate that the model is acceptable. The $\chi^2$/df also indicates that the model is acceptable as the value (1.20) is within the acceptable range ($\chi^2$/df< 2-5). The RMR value of 0.08 is above the acceptable limit, however Hair (1998) suggests that 0.08 should be the absolute maximum to accept a model. This, therefore, indicates that the model moderately fits the data. All other indices (RMSEA= 0.06, GFI= 0.81, CFI= 0.96, TLI= 0.95, and IFI= 0.96) are within the acceptable thresholds. Based on this it can was concluded that the model as presented in Figure 2 is acceptable.

**Table 3**-Goodness-of-fit Indices

| Fit Index | Acceptable fit | Indices for data |
|---|---|---|
| $\chi^2$ | | 153.95 |
| df | | 128 |
| *p* | >.05 | 0.06 |
| $\chi^2$/df | ≤ 2 to 5 | 1.20 |
| RMR | <0.06 | 0.08 |
| GFI | ≥ 0.90 | 0.81 |
| RMSEA | ≤ 0.05 to 0.08 | 0.06 |
| CFI | ≥ 0.90 | 0.96 |
| NNFI?TLI | ≥ 0.90 | 0.95 |
| IFI | ≥ 0.90 | 0.96 |

Having concluded that the model is plausible based on goodness of fit indices, the next step was to assess the strength of the relationships as postulated in the model. The path coefficients represented by the regression weights are presented in Table 4. Based on these estimates it can be concluded that project management leadership has a statistically significant direct influence on project management team, project communication and project management strategy as the c.r. values are exceeding the 1.96 threshold. The impact of project team on project management processes was also found to be statistically significant (c.r. = 3.36). However the impact of project management strategy on project management processes and impact of project management processes on project performance were found not to be statistically significant. In addition the impact of project communication on processes was found to be negative and not statistically significant.

**Table 4*:*** Estimates-Regression Weights

| **Regression Weights** | | | | | | |
|---|---|---|---|---|---|---|
| | | | **Estimate** | **S.E.** | **C.R.** | **P** |
| Team | <--- | Leadership | 0.71 | 0.19 | 3.78 | *** |
| Communication | <--- | Leadership | 1.01 | 0.22 | 4.52 | *** |
| Strategy | <--- | Leadership | 1.46 | 0.28 | 5.22 | *** |
| Process | <--- | Communication | -0.01 | 0.13 | -0.05 | 0.96 |
| Process | <--- | Strategy | 0.08 | 0.1 | 0.81 | 0.42 |
| Process | <--- | Team | 0.53 | 0.16 | 3.36 | *** |
| Performance | <--- | Process | 0.22 | 0.14 | 1.52 | 0.13 |

## IMPLICATION OF RESULTS

The evaluation of the measurement model suggested that the variables used in the research were reliable and the measurement model was valid. Having ascertained that the measurement model was valid, an examination of the full structural equation model was conducted. The interest in assessing the structural model was the evaluation of the validity and significance of the relationships between constructs in the PMPQ model. The results of the initial SEM analysis of the PMP model suggested that the model was valid based on goodness of fit indices. However, an examination of the significance of the relationships, suggest that not all variables have statistical significant effect on project performance when presented in the form of the PMP model. The model postulated direct relationships between project management leadership and project management team, project communication and project management policy and strategy. The findings suggest that these relationships are statistically significant, that project management leadership has a profound influence on the effectiveness of project management teams, project management policy and strategy and project communication.

It was also postulated that project management processes was significantly influenced by project management team, project communication and project management policy and strategy. However, the results indicate that only project management team has a significant effect on project management processes. Project communication and project management policy strategy, it is suggested from the results, have no statistically significant influence on project management processes. It was further postulated that project performance is directly influenced by project management processes. This relationship, however, was found to be not statistically significant.

Although this result was not expected in project management research, similar results have been found by researchers in the general management field. For example Samson and Terzioski (1999), using a similar approach in analysing the relationship between total quality management practices and operational performance, found out that strategic quality planning (policy and strategy), information management and process management were not strongly or positively related to performance. Pannirselvam and Ferguson (2001) also, in evaluating the relationship between constructs in the Balbrige quality award framework, found out that, while human resource management (represented by project management team in the present case) had a significant direct effect on product and process management, the effect of strategic quality planning (policy and strategy) and information management were not significant.

The results are significant for construction project management research and application. This research examined the impact of project management on construction project performance using an approach that made it possible to evaluate both the direct and indirect influences on construction project performance. The implication of the findings is that the variables that impact on project performance should be seen from a perspective that accounts for both direct and indirect relationships as the direct relationship perspective seems to simplify the relationships between project management variables and project performance.

## CONCLUSION

The purpose of the research was to examine both the direct and indirect impact of project management variables on project performance. This builds on many studies on project management critical success factors. However a review of literature suggests that many studies on critical success factors are concerned with manly the direct relationships between the critical success factors and project performance. This research argued that such an approach is simplistic and proposed a methodology that attempts to evaluate both the direct and indirect relationships. In order to evaluate this relationship a project management performance model was developed. An evaluation of the postulated relationships based on the goodness of fit indices suggested a valid model portraying both direct and indirect relationships. However an examination of the significance of the relationships suggests that not all postulated relationships were statistically significant. Based on the findings it can be generally concluded that project management variables impacting on project performance can be portrayed as a myriad of causal relationships both directly and indirectly impacting on project performance. It is therefore recommended that in examining the factors affecting project performance the indirect influences of project management variables in addition to the direct impact should also be considered.

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