



Structural Relationship of Factors Affecting PMO Implementation in the Construction Industry

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Abstract

This paper focused on studying the factors affecting PMO implementation in the construction industry. A PLS-SEM model was developed for achieving this objective. The model used 171 survey data sets consisting the model was developed and evaluated using SmartPLS software. Model evaluation at the measurement level found that it has achieved the convergent and discriminant validity thresholds. While at the structural level, the model has reached its criterion fitness values. For the hypothesis testing, it was found that all three paths of factors have a significant relationship to the PMO implementation in the construction industry. From this validated model, the most dominant factors affecting PMO implementation are Resistance to change for organizational culture group; Additional administrative workload for project management group, and Inexperience PMO leadership for the resource management group. These findings will help construction practitioners in understanding the importance of PMO implementation in the construction industry.

Keywords: PMO; PLS Model; Construction Industry.

1. Introduction

Project Management Office (PMO) is established as an oversight system to ensure that concurrent project processes are well executed and reflect the organization's plans [1]. The primary role of PMO is to effectively coordinate several projects by a single organization to attain consistency in operations [2]. Project managers require PMO in their operations as it seeks to help in strategic plan execution and improve performance in terms of quality and resource allocation [3]. Organisations can use different PMO tools to evaluate project management in various construction activities. As a result, PMO can perform at varying levels of projects, portfolios, and programs [4]. Several studies have suggested that specific factors are necessary when integrating a successful PMO, including clearly stated objectives, senior management support, a clearly defined plan, and good communication [5]. The fundamental factors in PMO implementation are management experience, project size, and organization type [2]. PMO restructures the organizational structure to improve the resources' performance and achieve success [6]. Thus, several organizations have adopted PMO set up, but yet the performance of the construction industry is not satisfactory. One of the reasons is that traditionally the performance measurement focuses solely on financial or tangible asset performance measures

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parameters such as profit, cash flow, and return of investment (ROI) [7, 8]. Finance is considered as the core element of a project [9]. However, non-financial aspects should be regarded to provide a more holistic assessment of the organization [10].

The inability of PMO to meet the set objectives of a construction organization could be attributed to challenges such as unrealistic objectives, poor setup and implementation and staff mismanagement [11]. In the United Arab Emirates (UAE), these challenges are generally related to the nature and size of constructions. Presently UAE faces improper government policy to guide PMO implementation, especially for construction firms [12]. There are several hurdles faced for proper implementation of PMO, such as the incorporation of inexperienced managers, lack of clear perspective of PMO, unawareness by the management on the scope for performance, and failure to follow processes that can benefit the organization [13].

Like other countries, the UAE construction industry is also concerned about project performance and interested in implementing PMO in the industry. In UAE, the owners or clients of mega projects are concerned with the timely completion of the projects. Hence, an extra burden is put on the construction experts, i.e., contractors, engineers, and designers. In UAE, mega-projects are describes as projects dealing with airports, hydropower, and large power generation schemes, significant rail developments, and even relatively modest Oil & Gas projects. Megaprojects are facing several challenges and risks [14]. For mega projects, PMO can be proved more efficient as compared to a traditional contractual arrangement. Hence, most clients demand the use of PMO in their projects even though they do not understand what it means and the implications to finances and quality [15]. The success of a construction project may not necessarily need to establish formalized PMO, but PMO can be with the organization structure. Even the name may not be PMO, but the roles it performs are similar to PMO [16]. To achieve PMO's goal, it is essential to take appropriate measures at the right time [17]. Hence, several studies have highlighted the issues regarding PMO, but those studies are lacking in focusing in-depth reasons or hurdles in achieving successful implementation of PMO. Therefore, this paper was intended to integrate factors affecting PMO implementation and PMO performance indicator in construction organisation through Structural Equation Modeling (SEM) using the Partial Least Squares (PLS) path modelling technique.

2. Research Frame Work

Research design is a strategic framework that integrates research questions and the execution of the research strategy [18]. The research design must contain a strategy for interpreting the analyzed data to provide adequate findings and conclusions from the research, allowing for the recommendations or implications based on the study [19]. This study employs a quantitative approach to respond to research questions. This study is planned to investigate the factors affecting PMO implementation performance in UAE construction organisations. The research design includes all the steps to achieve its objective, as shown in Figure 1.

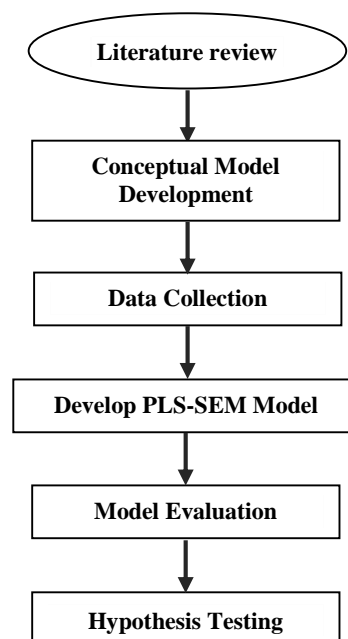


Figure 1. Research Flowchart

Data collection for this study involved a questionnaire survey using a five-point liker scale [20, 21]. A total of 171 questionnaire samples were gathered and analyzed, as discussed in the following sections.

3. Model Development

The data was prepared in a Microsoft Excel worksheet and saved as a comma-delimited (CSV) type. Then, data was uploaded in the SmartPLS software for modeling purposes. PLS technique was selected because it is meant for theory development rather than theory confirmation as adopted by [22]. The constructed PLS model consists of 3 groups known as exogenous variables with 28 factors affecting PMO implementation, and 1 group with three types of PMO performance indicators is an endogenous latent variable. The exogenous latent variable represents Resource Management (RM) consisting of 11 indicators, Project Management (PM) consisting of 9 indicators and Organizational Culture (OC) consisting of 8 indicators. Three parameters describe the endogenous latent variable in this study. The developed model is shown in Figure 1.

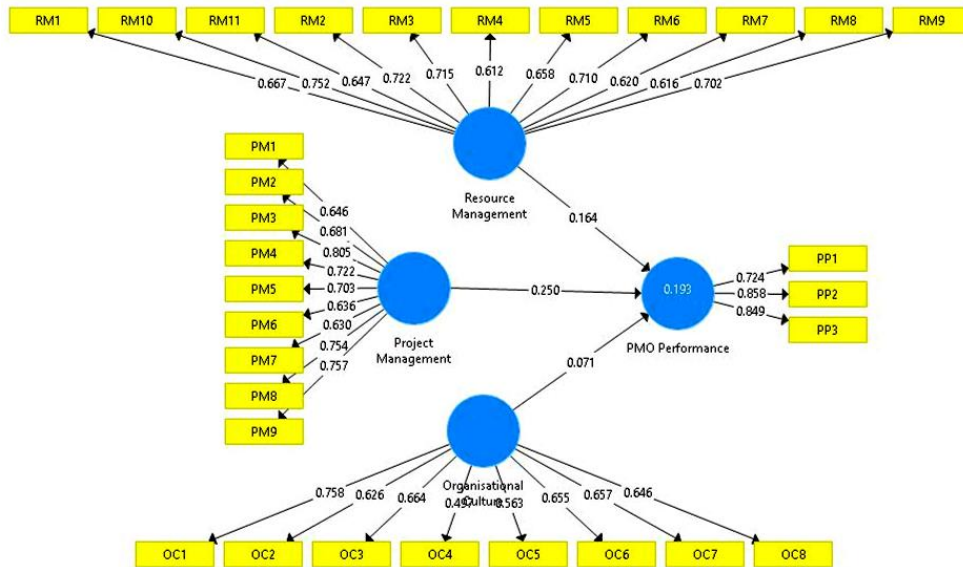


Figure 1. Developed conceptual model

4. Measurement Model Evaluation

The measurement model is assessed based on convergent validity and discriminant validity. First, the model's convergent and discriminant validity is checked against the acceptable criteria [23]. If still not achieve the criteria, the deletion and iteration are conducted until the measurement criteria are fulfilled. For this, items with low factor loading in each construct are deleted for every iteration until all the items have a loading factor ≥ 0.5 . When weak indicators are deleted in each stages of iteration, it will then improve the Average Variance Extracted (AVE) errors of latent constructs to an acceptable level [24]. This study conducted 12 iterations processes until it achieved all the measurement criteria, and the final model is as Figure 2.

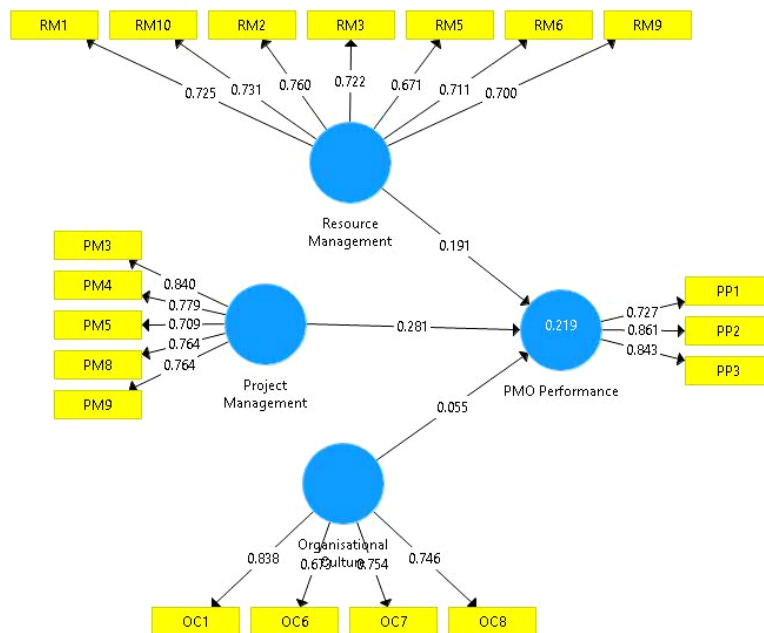


Figure 2. Final Model

4.1. Convergent Validity

For convergent validity, two main criteria are considered: Composite Reliability (CR) and Average Variance Extracted. For a significant model, CR should be greater than or equal to 0.70, and the required Average Variance Extracted (AVE) value is higher than 0.50 [23]. The results of the final iteration of the measured model are as in Table 1.

Table 1. Convergent validity (Iteration No. 12)

Construct	Left items	Convergent validity	
		CR	AVE
Organisational culture (OC)	OC1; OC6; OC7; OC8	0.840	0.569
PMO performance (PP)	PP1; PP2; PP3	0.853	0.661
Project management (PM)	PM3; PM4; PM5; PM8; PM9	0.888	0.570
Resource management (RM)	RM1; RM2; RM3; RM5; RM6; RM9; RM10	0.881	0.515

Table 1 indicates that Composite Reliability (CR) for all constructs are above 0.70, and the Average Variance Extracted (AVE) values are within 0.515 and 0.661, which is more than the cut-off value of 0.5. Hence, the evaluation of the convergent validity of the measurement model has successfully above the acceptable limit.

4.2. Discriminant Validity

Discriminant validity assumes that items within a construct should have a high correlation with each other more than items in other constructs [25]. The Fornell-Larcker and cross-load criteria are used for discriminating validity evaluation. Fornell-Larcker compares latent correlations of the AVE Square root values [26]. This approach states that the construct shares more variance with itself than any other construct [27]. The cross-loading values measure the correlation of the individual items to all models, including the constructs to be reflected [28]. Fornell-results Larcker's are as shown in Table 2.

Table 2. Fornell-Lacker criterion

	OC	PP	PM	RM
OC	0.755			
PP	0.320	0.813		
PM	0.558	0.422	0.755	
RM	0.599	0.412	0.680	0.717

#note: OC= Organisational culture, PM=Project management, PP=PMO performance, RM=Resource management

Table 2 shows the interrelationship value between constructs of the AVE square root and non-bolded values. All off-diagonal elements are indicated to be lower than square AVE roots in diagonal, representing that the constructs have a high correlation with themselves as compared to other constructs. This confirms that the model has met the discriminating validity criterion. The Cross load values are presented in Table 3.

Table 3. Results of cross-loadings

Indicator	Exogenous/ Endogenous construct (Groups)			
	OC	PM	PP	RM
OC1	0.838	0.373	0.358	0.375
OC6	0.672	0.446	0.159	0.463
OC7	0.754	0.515	0.179	0.569
OC8	0.746	0.452	0.161	0.537
PM2	0.572	0.669	0.138	0.538
PM3	0.470	0.845	0.319	0.532
PM4	0.515	0.773	0.308	0.499
PM5	0.211	0.698	0.431	0.450
PM8	0.475	0.764	0.310	0.546
PM9	0.465	0.768	0.256	0.573
PP1	0.252	0.218	0.734	0.321

PP2	0.307	0.394	0.858	0.373
PP3	0.219	0.391	0.841	0.310
RM1	0.420	0.434	0.281	0.725
RM10	0.345	0.514	0.281	0.731
RM2	0.496	0.461	0.319	0.761
RM3	0.507	0.459	0.327	0.722
RM5	0.391	0.469	0.246	0.671
RM6	0.411	0.551	0.321	0.710
RM9	0.418	0.532	0.279	0.699

#note: OC= Organisational culture, PM=Project management, PP=PMO performance, RM=Resource management

Table 3 shows that the cross-loading values of the latent construct indicators are higher (as signified with bold font) compared with values to other latent constructs of the model. Thus, it indicates that the model has achieved the cross-loading criteria. Hence, the discriminant validity of the model is attained.

5. Structural Model Evaluation

Structural model evaluation assesses the path strength, model predictive accuracy, impact of exogenous to endogenous, predictive relevancy, the goodness of fit, and hypothesis testing [29-30].

5.1. Path Strength

Path strength is described with the path coefficients or beta (β) value determined from the analysis of the final model. Path coefficients are standardized values that lie in between +1 and -1 (values may be smaller/larger but usually fall within these borders) [29]. Path coefficients values close to +1 show strong positive relationships with usual statistically significant negative values and vice versa. The path values extracted from the model are shown in Table 4.

Table 4. Path coefficients values (β)

Dependent variable	Independent variable	Beta value	Status
PMO performance indicator	Resources management	0.191	Medium
	Project management	0.281	Highest
	Organisational culture	0.055	Lowest

Table 4 indicates that the beta values of independent variables of factors affecting PMO implementation towards the dependent variable of PMO performance indicator. Based on the beta values, it appears that the project management construct has the highest beta value, which indicates that project management attributes have a high influence on the PMO performance indicator. On the other hand, resource management with a beta value of 0.191 is at second-ranked, and organizational culture has the least impact on the PMO performance indicator.

5.2. Model Predictive Accuracy

The predictive accuracy of the PLS model is assessed by the determination coefficient (also called as R^2). R^2 is symbolized as the combined effect of the exogenous variables on endogenous variables [31]. The R^2 is considered moderate if it has a value of 0.13 and above while the model is referred to as substantial if the value is equal or higher than 0.13 [32]. The value R^2 of the developed model for this study is 0,219. This implies that the three latent exogenous variables of resource, project and organizational management moderately explain 21.9% of the variance of the PMO performance of endogenous latent variable variables.

5.3. Impact of Exogenous on Endogenous

Impact of exogenous on endogenous is assessed based on coefficient of determination (R^2) values of the endogenous construct. The change in R^2 value when a specified exogenous construct is omitted from the model has a substantive impact on the endogenous construct [23]. This is certified based on effect size (f^2), which can be calculated by the expression suggested by Chin [28] is given by the following equation.

$$f^2 = \frac{R^2_{included} - R^2_{excluded}}{1 - R^2_{included}} \tag{1}$$

where; f^2 = effect size, $R^2_{included}$ = R^2 value of the endogenous construct where all exogenous constructs are included from the model, $R^2_{excluded}$ = R^2 value of the endogenous construct when a selected exogenous construct is excluded from the model.

Cohen [32] suggested that the effect size values of 0.02, 0.15, and 0.35 represent small, medium, and large effect sizes, respectively. Since there are 3 exogenous constructs, it required 3 iterations process to determine effect size and the results are as in Table 5.

Table 5. Effect size (f^2)

Exogenous construct	$R^2_{included}$	$R^2_{excluded}$	f^2	Status
Resource management	0.219	0.205	0.018	No substantive impact
Project management	0.219	0.180	0.050	Substantive impact
Organisational culture	0.219	0.218	0.001	No substantive impact

From Table 5 it can be perceived that the project management group has the highest predictive relevancy compared to resource management and organizational culture. Project management has a value of 0.050, higher than the minimum criteria for a small effect size i.e., 0.02. This implies that the project management (PM) construct has a substantive impact on endogenous construct.

5.4. Predictive Relevance of the Model

Predictive relevance is based on Q^2 , which measures the missed and predicted data points [28, 33]. The Q^2 values come from an iterative process that is blindfolded. Blindfolding is built on a sample reuse technique, in which 7th distance data point is omitted, and the parameters with the remaining data points are estimated [23]. The blindfolding procedure generates two types of Q^2 values: CVC and cross-validated redundancy (CVR). However, this PLS study model only used the invalidated redundancy value as suggested by Hair et al. [23] to predict eliminated data points, which already include the core element of the path model. Cohen [32] gives the following equation to calculate its predictive pertinence (q^2).

$$q^2 = \frac{Q^2_{included} - Q^2_{excluded}}{1 - Q^2_{included}} \quad (2)$$

where; q^2 = predictive relevance, $Q^2_{included}$ = value of the endogenous latent variable where all the exogenous construct variables are included in the model, $Q^2_{excluded}$ = a selected exogenous construct is excluded from the model

In 1988, Cohen stated that if the value of q^2 is 0.02, 0.15, 0.35, it is small, medium, large-scale prediction relevance for the model, respectively, for the respective exogenous building. Therefore, the blindfolded predictive relevance results are as described in Table 6.

Table 6. Predictive relevance (q^2)

Exogenous construct	$Q^2_{included}$	$Q^2_{excluded}$	q^2	Status
Resource management	0.123	0.113	0.011	No relevancy
Project management	0.123	0.103	0.023	Small
Organisational culture	0.123	0.127	-0.005	No relevancy

The predictive relevance (q^2) in Table 6 shows that only the project management construct has q^2 values of 0.023, which indicates the construct has small relevancy. In contrast, others construct have no predictive relevance to the structural model.

5.5. Goodness-of-Fit

Goodness-of-fit is the geometric mean of the average communality (AVE) and the model's average coefficients of determination (R^2) value [34]. The GoF value is in a range between 0 and 1 [35], which can be categorized into small (GoF=0.1), medium (GoF=0.25), and large (GoF=0.36), validating power [36] as baseline values for validating the PLS model globally. GoF index of a model can be calculated manually using the Equation 3:

$$GoF = \sqrt{AVE \times \bar{R}^2} \quad (3)$$

where; GoF = goodness-of-fit, \overline{AVE} = average communality, \bar{R}^2 = coefficients of determination.

In PLS path modelling, a cut-off value of AVE (>0.5) as suggested by Fornell & Larcker [26] and R^2 (small: 0.02; medium: 0.13; large: 0.26) proposed by [32] are adopted to calculate the GoF. Table 7 shows the average of AVE for all the latent variables and R^2 value of the endogenous latent variables.

Table 7. Calculation of GoF

Constructs	Square root of AVE in construct validity and reliability	R^2 values
OC	0.569	-
PP	0.661	-
PM	0.570	-
RM	0.515	0.219
Average	0.579	0.219

For this model, the average of AVE for the endogenous variable is 0.579, and the average R^2 for all dependent variables is 0.219. Thus, the calculated, $GoF = \sqrt{(0.579 \times 0.219)} = 0.356$. Goodness-of-fit (GoF) describes how well the model fits into a set of observations/data set. GoF achieved for the model in this study indicates that the model has a global medium validating power.

5.6. Hypothesis Testing

This testing is conducted using the bootstrapping technique on the model. When performing the bootstrapping function, many resample, i.e., 5000, are taken from the original sample with replacement to check to bootstrap standard errors [37]. The test results are as shown in Table 8.

Table 8. Results of hypothesis testing

Hypothesis (Relationship)	t-value (≥ 1.96)	Significant level
H ₁ : Resource management has a significant effect to PMO performance	1.980	Significant
H ₂ : Project management has a significant effect to PMO performance	2.045	Significant
H ₃ : Organisational culture has a significant effect to PMO performance	1.964	Significant

Table 8 shows that all the exogenous constructs have a t-value above the cut-off value of 1.96, which indicates a significant relationship (supporting the hypothesis) to PMO performance. Most researchers agreed that project management has a strong effect on performance, such as Aftab et al. [38], Al-Hajj & Zraunig [39], and Unegbu et al. [40]. Furthermore, this finding is following the previous studies by Zulu [41] and Molaei, Bosch-Rekveltdt, & Bakker [42], which stated that project management impacts performance. Therefore, it is undeniable that project management is crucial in an organization to secure and guarantees the company's viability. Hence, all the hypotheses are supported.

6. Conclusion

The project Management Office (PMO) section in any organization plays critical role. First, it formulates the standard and policies to be adopted by the organization. PMO strengthens the coordination among the stakeholders involved in any project to achieve the common goals successfully. The success of PMO depends of various factors. This paper developed a PLS-SEM model of factors affecting PMO implementation with PMO indicator performance. The model was developed with the Smart-PLS software application. A total of 12 iterations were run to get the acceptable level of indicator reliability and convergent validity of the measurement model. The PLS model has attained the adequacy of discriminant validity verified by analyzing the Fornell–Larcker criterion and cross-loading. For structural model evaluation, the PLS model was run to assess the overall fit known as GoF. This model attained the satisfaction level with a GoF value of 0.356. The results imply the importance of project management to the Project Management Office (PMO) performance. This finding is beneficial for construction practitioners to understand PMO implementation performance in the UAE construction industry.

7. Declarations

7.1. Author Contributions

Conceptualization, M.T.S.A. and I.A.R.; methodology, M.T.S.A. and I.A.R.; software, M.T.S.A. and A.H.M.; validation, A.H.M. and I.A.R.; formal analysis, M.T.S.A. and N.A.N.N.; investigation, M.T.S.A. and N.A.N.N.; resources, A.H.M. and I.A.R.; data curation, M.T.S.A. and N.A.N.N.; writing—original draft preparation, A.H.M.; M.T.S.A.; writing—review and editing, A.H.M., M.T.S.A. and N.A.N.N.; visualization, I.A.R.; supervision, I.A.R.; project administration, I.A.R. All authors have read and agreed to the published version of the manuscript

7.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

7.3. Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

7.4. Conflicts of Interest

The authors declare no conflict of interest.

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