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Analysis of Cost Overrun Factors for Small Scale Construction Projects in Malaysia Using PLS-SEM Method

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Abstract

This study investigated the effect of various factors affecting cost performance in achieving project success. Investigation was carried out with quantitative approach of questionnaire survey to understand the perception of practitioners involved in construction industry towards various factors in causing cost overrun. The targeted respondents were client, contractor, and consultant representative involved in handling small scale projects in Malaysia. A total of 54 completed responses were collected against 100 sets of questionnaire distributed. Collected questionnaires were analyzed with advance multivariate statistical approach of Partial Least Square Structural Equation Modeling (PLS-SEM). It modeled the relationship of various factors and their relative effects to cost overrun. Structural Model analysis results showed that the identified factors have overall substantial impact on cost overrun. This was assessed with convergent and discriminant validity test where R^2 value for the model is 0.71 which means that 71% variance extraction is resulted from investigated factors. Further, GoF value of the model achieved is 0.70 which shows that developed structural model has substantial power in explaining the factors of cost overrun in small scale projects of Malaysia. Amongst all the factors, contractor's site management related factors are found as most significant factors. This indicated that for achieving better cost performance in small projects, contractors are required to improve their management related to the identified factors. Beside that, these findings will benefit parties involved in managinging cost performance of small scale construction projects.

Keywords: cost overrun, small project, structural equation modelling, PLS-SEM, Malaysia

1. Introduction

Cost overrun problem has significantly affected on the prices of construction projects. This trend of overrun in construction projects has become a global concern. Together with country's development, it also has negative impact of low or middle class people in achieving the basic need for prosper life i.e. house. Various researchers have highlighted different findings about poor cost performance in construction projects such as Frame (1997) studying 8,000 projects and found that only 16% of the projects could satisfy the three famous performance criteria i.e. completing projects on time, within budgeted cost and quality standard, while Flyvberg et al. (2003) in a study of 258 projects in 20 nations concluded that 90% projects faced cost overrun and the cost performance has not been improved over the time, it is in the same order of magnitude as it was 10, 30 or 70 years ago. In Nigeria, Omoregie and Radford (2006) reported a minimum average of cost escalation in construction projects is 14%, while in Portugal construction projects faced a minimum of 12% of cost overrun (Moura et al., 2007).

This overrun of cost in construction projects is resulted from various factors which are vital to uncover and understand. Ameh et al. (2010) in his study investigating 42 cost overrun causes found that lack of experience of contractors, cost of material, fluctuation in the prices of materials, frequent design changes, economic stability, high interest rates charged by banks on loans and Mode of financing, bonds and payments as well as fraudulent practices and kickbacks were dominant factor causing cost overrun run in Nigeria.

Enshassi et al. (2009) found that the top 10 of 42 investigated factors causing cost overrun in construction projects of Gaza were increment of materials prices due to continuous border closures, delay in construction, supply of raw materials and equipment by contractors, fluctuations in the cost of building materials, unsettlement of the local currency in relation to dollar value, project materials monopoly by some suppliers, resources constraint: funds and associated auxiliaries not ready, lack of cost planning/monitoring during pre-and post contract stages, improvements to standard drawings during construction stage, design changes, and inaccurate quantity take-off.

Le-Hoai et al. (2008) found that poor site management and supervision, poor project management assistance, financial difficulties of owner, financial difficulties of contractor; design changes were most severe and common causes of cost overrun in Vietnamese construction industry. Koushki et al. (2005) studied private residential projects in Kuwait and concluded that contractor related issues, material-related problems and financial constraints were major reasons of cost overrun. Other than these, inadequate quality system has significant impact of profit (He, 2010).

In Malaysia also, the problem of cost overrun is major concern for researchers and practitioners (Ibrahim et al., 2010; Hussin et al., 2013). Hence, this study focused on analysing major causes of cost overrun in small construction projects in Malaysia. Small scale construction projects are those "where any project have contract sum of less than 5 Million Malaysian Ringgit" (Abdullah et al., 2009). The analysis adopts PLS approach to Structural Equation Modeling (SEM) as this method is more advisable and considered as most suitable method for testing the causal relation (Hair et al., 2011). Also, the functionality of SEM is better than other multivariate techniques including multiple regression, path analysis, and factor analysis (Ng et al., 2010).

2. Theoretical Model

Prior to the application of SEM method for analysis, it needs a theoretical model which indicates the relationship of the identified factors with cost overrun. A total of 35 factors of cost overrun were investigated and these factors were classified into 7 groups (known as exogeneous latent variables) named as Contractor's Site Management Related Factors (CSM) with 8 items (also known as manifest variable), Design and Documentation Related Factors (DDF) with 5 items, Financial Management Related Factors (FIN) having 6 items, Information and Communication Related Factors (ICT) containing 3 items, Human Resource (Workforce) Related Factors (LAB) with 5 items, Non-human Resource Related Factors (MMF) with 4 items; and Project Management and Contract Administration Related Factors (PMCA) with 4 items. Based on these groups and its factors, a theoretical model is developed (adopted from on the developed model of the author's previous work (Ismail et al., 2013) as in Figure 1.

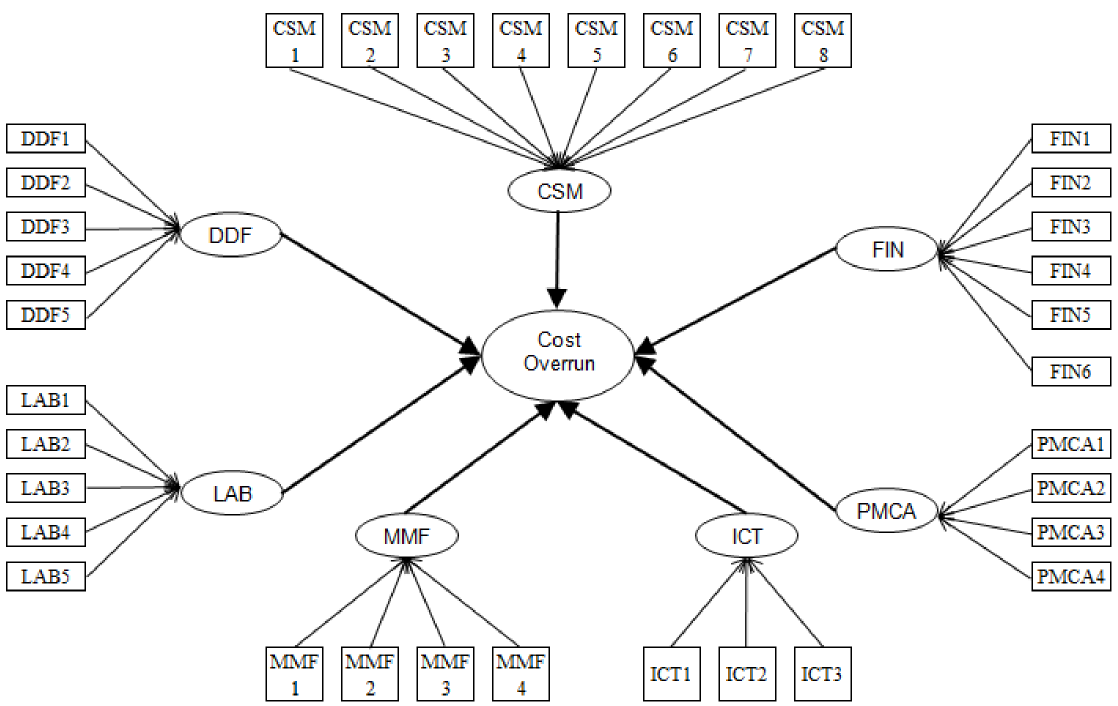

Figure 1. Thoeretical model of cost overrun factors

This theoretical model of Figure 1 is applied in SmartPLS v2.0 (Ringgle et al., 2005) software to model the influence of these causative factors on cost overrun of construction project. The groups are known as exogenous latent variables while the factors are relative manifest variables. The description of the exogenous latent variables and relative manifest variables of the model is presented in Table 1.

Table 1. Causes of cost overrun

Group/Construct	Item	Description of Item
Contractor's Site Management Related Factors (CSM)	CSM1	Poor site management and supervision
	CSM2	Incompetent subcontractors
	CSM3	Schedule Delay
	CSM4	Inadequate planning and scheduling
	CSM5	Lack of experience
	CSM6	Inaccurate Time and Cost estimates
	CSM7	Mistakes during construction
	CSM8	Inadequate monitoring and control
Design and Documentation Related Factors (DDF)	DDF1	Frequent design changes
	DDF2	Mistakes and Errors in design
	DDF3	Incomplete design at the time of tender
	DDF4	Poor design and delays in Design
	DDF5	Delay Preparation and approval of drawings
Financial Management Related Factors (FIN)	FIN1	Cash flow and financial difficulties faced by contractors
	FIN2	Poor financial control on site
	FIN3	Financial difficulties of owner
	FIN4	Delay in progress payment by owner
	FIN5	Delay payment to supplier /subcontractor
	FIN6	Contractual claims, such as, extension of time with cost claims
Information and Communication Related Factors (ICT)	ICT1	Lack of coordination between parties
	ICT2	Slow information flow between parties
	ICT3	Lack of communication between parties
Human Resource (Workforce) Related Factors (LAB)	LAB1	labour productivity
	LAB2	Shortage of site workers
	LAB3	shortage of technical personnel (skilled labour)
	LAB4	High cost of labour
	LAB5	Labour Absenteeism
Non-human Resource Related Factors (MMF)	MMF1	Fluctuation of prices of materials
	MMF2	Shortages of materials
	MMF3	Late delivery of materials and equipment
	MMF4	Equipment availability and failure
Project Management and Contract Administration Related Factors (PMCA)	PMCA1	Poor project management
	PMCA2	Change in the scope of the project
	PMCA3	Delays in decisions making
	PMCA4	Inaccurate quantity take-off

3. Research Method

This study adopted quantitative research method involving data collection through structured questionnaire survey. Survey was carried out amongst client, consultants and contractors registered with CIDB Malaysia who are handling small scale projects. A total of 100 questionnaire sets were distributed among randomly selected organization. The addresses of contractors were taken from CIDB official portal. As a result of total of 54 completed questionnaire sets were received back. Gathered questionnaires were analyzed with SPSS software for assessing the demographic information of the respondents as summarized in Table 2.

Table 2. Demographic information of respondents

	Frequency	Percent	Cumulative Percent
Educational Qualification			
BE	32	59.3	59.3
BSc	2	3.7	63
Diploma	13	24.1	87
ME	1	1.9	88.9
MSc	6	11.1	100
Working Position			
Managerial	21	38.9	38.9
Directorate	16	29.6	68.5
Engineering	13	24.1	92.6
Chief Operating Office	1	1.9	94.4
Supervisory	3	5.6	100
Working Position			
0-5 years	18	33.3	33.3
6-10 years	13	24.1	57.4
11-15 years	8	14.8	72.2
16-20 years	9	16.7	88.9
More than 20 years	6	11.1	100
Type of Projects			
Building	14	25.9	25.9
Infrastructure	21	38.9	64.8
Others	4	7.4	72.2
Bldg-Infra	12	22.2	94.4
Infra-Other	3	5.6	100

Table 1 shows that respondents participating in survey have sound level of expertise to provide reliable information regarding the research question. As seen from the table, majority of respondents with 59.3% have attained engineering degree while 24.1% have received diploma in civil engineering. Further, 38.9% of respondents are holding managerial post in the organization and are responsible for managing construction projects. 29.6% of respondents are holding directorate positions while 24.1% of respondents are engineering staff which includes project engineers and site engineers. The respondents have different level of experience in handling construction project ranging from minimum of 4 years experience and some of the respondents have experience for more than 20 years. Also, the respondents have experience of handling different types of projects as infrastructure, building and other types of projects.

4. Analysis and Results

Analysis of the data is carried out using SmartPLS software in assessing the strength of each factor affecting cost overrun through the developed model. In order to ensure the strength of each factor is reliabile and consistent, the model needs to be evaluated. The evaluation process involves 4 steps as follows:

1) Individual Item reliability and Convergent Validity
2) Discriminant Validity
3) Structural Relationships
4) Overall Model Fitness

4.1 Individual Item Reliability and Convergent Validity

Individual item reliability is the correlations of the items with their respective latent variables. It is evaluated by calculating the standardized loadings (or simple correlation). Items with loading of 0.7 or above are considered significant items while Hulland (1999) suggested that items with loadings of less than 0.4 should be dropped and the item with loading between 0.4 to 0.7 be reviewed and may be dropped if they do not increase value to composite reliability. On the other hand, Convergent Validity (CV) is the measure of the internal consistency. It can be determined by calculating Cronbach's alpha, Composite reliability scores (ρc) and Average variance extracted (AVE) of the latend variables (Hair et al., 2011).

Cronbach's alpha is measure of the reliability (or consistency) of the data. While composite reliability measure can be used to check how well a construct is measured by its assigned indicators. Composite reliability is similar to Cronbach alpha. Composite reliability score is superior to Cronbach's Alpha measure of internal consistency since it uses the item loadings obtained within the theoretical model (Fornell & Larcker, 1981). Cronbach's Alpha weighs all items equally without considering their factor loadings. Nonetheless, the interpretation of composite reliability score and Cronbach's Alpha is the same. For reliable data, Litwin (1995) suggested that value of cronbach alpha should be higher than 0.7 while Churchill (1979) and Chin (1998) suggests that a Cronbach's alpha value of 0.6 is acceptable to confirm internal consistency. For composite reliability, Nunnally (1978), Chin (1998) and Hair et al. (2011) suggest 0.7 as a benchmark.

AVE (Fornell & Larcker, 1981) test is used to assess internal consistency of the construct by measuring the amount of variance that a latent variable captures from its measurement items relative to the amount of variance due to measurement errors. A basic assumption is that the average covariance among indicators has to be positive. Fornell and Larcker (1981), Barclay et al. (1995) and Hair et al. (2011) stated that AVE should be higher than 0.5. This means that at least 50% of measurement variance is captured by the latent variables. The results of individual item reliability and convergent validity are presented in Table 3.

Table 3. Individual item reliability and convergent validity

Variable/Factcor	Iteration 1				Iteration 2			
	Loading	AVE	CR	Alpha	Loading	AVE	CR	Alpha
CSM01	0.864	0.741	0.958	0.95	0.864	0.741	0.958	0.95
CSM02	0.921				0.921			
CSM03	0.786				0.786			
CSM04	0.895				0.895			
CSM05	0.908				0.908			
CSM06	0.892				0.892			
CSM07	0.801				0.801			
CSM08	0.807				0.807			
DDF01	0.858	0.767	0.943	0.924	0.858	0.767	0.943	0.924
DDF02	0.888				0.888			
DDF03	0.852				0.852			
DDF04	0.887				0.887			

DDF05	0.891				0.891			
FIN01	0.681	0.611	0.903	0.874	0.681	0.611	0.903	0.874
FIN02	0.865				0.865			
FIN03	0.713				0.713			
FIN04	0.849				0.849			
FIN05	0.831				0.831			
FIN06	0.732				0.732			
ICT01	0.923	0.883	0.958	0.934	0.923	0.883	0.958	0.934
ICT02	0.946				0.946			
ICT03	0.95				0.95			
LAB01	0.76	0.473	0.816	0.732	0.744	0.519	0.811	0.705
LAB02	0.648				0.633			
LAB03	0.581				Omitted			
LAB04	0.745				0.783			
LAB05	0.689				0.713			
MMF01	0.517	0.575	0.839	0.749	0.517	0.575	0.839	0.749
MMF02	0.849				0.849			
MMF03	0.894				0.894			
MMF04	0.716				0.716			
PMCA01	0.877	0.707	0.906	0.861	0.877	0.707	0.906	0.861
PMCA02	0.887				0.887			
PMCA03	0.818				0.818			
PMCA04	0.778				0.778			

Table 3 shows that in iteration 1 all the manifest variable have loading value higher than 0.4, hence no any item required direct deletion. However, in construct Financial related factors (FIN) and labour related factor (LAB) some of the indicator had loading value lower than 0.7. These include FIN01 with loading value 0.681, LAB 02 with loading value 0.648, LAB03 with loading 0.581 and LAB05 with loading 0.689. However, convergent validity parameters for FIN group had achieved cut-off value hence this group was not modified. But the AVE value of LAB group was below 0.5 hence this group was modified by reviewing the identified non-significant indicators. It was done with following iterative method by omitting the indicator with lowest loading value i.e. LAB03 and model was run for iteration 2. The results of iteration 2 (in Table 3) show that after omission of LAB03 the convergent validity of the group LAB was improved and achieved cut-off value for all parameters. Hence, no more modification was carried out and the model was evaluated for further assessment.

4.2 Discriminant Validity

After assessing the individual reliability and convergent validity of the measurement model, discriminant validity of construct was evaluated. Discriminant validity indicates the extent to which a given construct is different from other constructs (Hulland, 1999). Disciminant validity of the measurement can be tested by analysis of cross-loadings. It follows the rule that "items should have a higher correlation with the latent variable that they are supposed to measure than with any other latent variable in the model (Chin, 1998)". Disciriminant validity was assessed through analysis of cross-loading and results are shown in Table 4.

Table 4. Analysis of cross-loadings of factors

Indicator	CSM	DDF	FIN	ICT	LAB	MMF	PMCA
CSM01	0.864	0.653	0.700	0.604	0.614	0.666	0.761
CSM02	0.921	0.656	0.663	0.764	0.710	0.770	0.823
CSM03	0.786	0.650	0.610	0.677	0.602	0.708	0.757
CSM04	0.895	0.753	0.695	0.810	0.724	0.669	0.815
CSM05	0.908	0.705	0.663	0.775	0.759	0.692	0.815
CSM06	0.892	0.666	0.577	0.708	0.705	0.731	0.829
CSM07	0.801	0.576	0.535	0.674	0.691	0.653	0.782
CSM08	0.807	0.620	0.742	0.695	0.566	0.717	0.713
DDF01	0.600	0.858	0.409	0.687	0.582	0.643	0.715
DDF02	0.733	0.888	0.526	0.758	0.489	0.572	0.774
DDF03	0.680	0.852	0.560	0.688	0.598	0.612	0.674
DDF04	0.599	0.887	0.466	0.761	0.495	0.518	0.685
DDF05	0.710	0.891	0.560	0.837	0.622	0.581	0.717
FIN01	0.462	0.234	0.681	0.369	0.452	0.248	0.297
FIN02	0.685	0.572	0.865	0.548	0.624	0.569	0.605
FIN03	0.601	0.325	0.713	0.512	0.564	0.461	0.471
FIN04	0.598	0.561	0.849	0.519	0.570	0.529	0.472
FIN05	0.575	0.406	0.831	0.436	0.536	0.386	0.449
FIN06	0.538	0.503	0.732	0.477	0.621	0.597	0.569
ICT01	0.888	0.765	0.692	0.923	0.795	0.673	0.836
ICT02	0.724	0.856	0.510	0.946	0.630	0.623	0.799
ICT03	0.700	0.789	0.515	0.950	0.643	0.534	0.734
LAB01	0.469	0.272	0.509	0.465	0.744	0.382	0.404
LAB02	0.365	0.295	0.452	0.414	0.633	0.335	0.278
LAB04	0.803	0.677	0.647	0.713	0.783	0.696	0.749
LAB05	0.485	0.447	0.425	0.455	0.713	0.540	0.514
MMF01	0.414	0.432	0.499	0.494	0.461	0.517	0.395
MMF02	0.617	0.612	0.569	0.539	0.632	0.849	0.632
MMF03	0.806	0.597	0.682	0.603	0.677	0.894	0.715
MMF04	0.570	0.396	0.177	0.410	0.419	0.716	0.583
PMCA01	0.859	0.720	0.655	0.720	0.733	0.814	0.877
PMCA02	0.794	0.770	0.474	0.749	0.523	0.588	0.887
PMCA03	0.761	0.739	0.640	0.818	0.765	0.710	0.835
PMCA04	0.658	0.514	0.350	0.557	0.437	0.521	0.778

From Table 4 it is perceived that the loading of each variable in its construct is higher than share with other construct. This means that all the variables represent their constructs respectively. Hence the test confirms the discriminant validity of the constructs.

4.3 Structural Relationships

Structural relations are assessed to determine the explanatory power of the model and the significance of individual path in the model. The criteria for evaluating structural relationship model include squared multiple correlations (R^2) and path co-efficient (β) of each path. R^2 indicates the percentage of a construct's variance in the model, whilst the path coefficients indicate the strengths of relationships between constructs (Chin, 1998). According to Breiman and Friedman 1985 as cited by (Aibinu et al., 2011), the criterion, R^2 is critical in evaluating a structural model. The individual path coefficients of the PLS structural model can be interpreted as standardized beta coefficients of ordinary least squares regressions where highest β value indicates the highest effect of that particular path on endogenous latent variable. The results of model variance extraction (R^2) and path co-efficient (β) are presented in Figure 2.

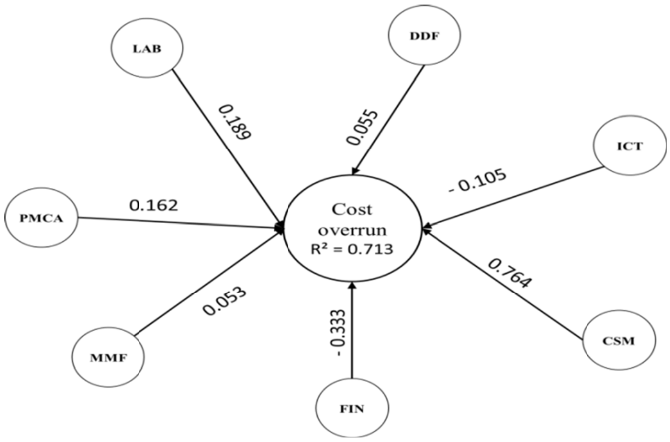

Figure 2. Results of structural relationships of the model

From Figure 2, it is perceived that R^2 of the endogenous latent variable (cost overrun) is 0.713. According to Cohen (1988) $R^2$of endogenous can be assessed as substantial if $R^2 \geq 0.26$, moderate for $R^2 \geq 0.13$ and weak for $R^2 \geq 0.02$. Since, $R^2$of the developed model is much higher than 0.26 which shows that developed model has substantial explaining power. In assessing the path co-efficient, comparison of beta value of all structural paths indicates that CSM has the highest co-efficient value of 0.764. This means the CSM shares high value of variance with respect to cost overrun have large effect on cost overrun. It is the most significant group of factors in affecting cost overrun in small scale projects of Malaysia.

4.4 Overall Model Fitness

Overall model fitness is tested for assessing global validity and explaining power of the model. This is done by evaluating Goodness of Fit (GoF) index. GoF is defined as the geometric mean of the average communality and average R^2 for all endogenous constructs (Tenenhaus et al., 2005; Akter et al., 2011a). The intent of GoF is to account for the PLS model performance at both the measurement and the structural model with a focus on overall prediction performance of the model (Chin et al., 2010). GoF cut-off values for global validation of PLS models were calculated following the guidelines of (Wetzels et al., 2009) suggesting that using 0.50 as the cut off value for communality (Fornel & Larcker, 1981) and different effect sizes of R^2 (Cohen et al., 1988) as shown in Table 5.

Table 5. GoF index and its criteria

GoF	GoF Criteria
$GoF = \sqrt{\overline{communality}\ X\ \bar{R}^2}$ Range of GoF values: GoF = (0 < GoF < 1)	Commonality = 0.5 (Fornel and Larcker 1981) R^2 effect small -= 0.02, Medium = 0.13, Large = 0.26 (Cohen 1988) Thus $GoF_{small} = \sqrt{0.5\ X\ 0.02} = 0.10$ $GoF_{medium} = \sqrt{0.5\ X\ 0.13} = 0.25$ $GoF_{large} = \sqrt{0.5\ X\ 0.26} = 0.36$

Source: Akter 2011b.

From Table 5 it is perceived that GoFsmall (0.10), GoFmedium (0.25) and GoFlarge (0.36) are obtained as cut-off value of GoF index. Overall model fitness was calculated by using following equation as adopted by (Akter et al., 2011a).

$$GoF = \sqrt{\overline{AVE} X \overline{R}^2}$$

Since, R^2 value in this study is 0.713 while $\overline{AVE}$ was calculate by taking the average of AVE value for all the exogeneous latent variable as given in Table 1. $\overline{AVE}$ value in this study was determined as 0.686. Hence,

$$GoF = \sqrt{0.686 X 0.713}$$

$$GoF = 0.70$$

Since, GoF value (0.70) for the complete model is higher than 0.36, the cut-off value required for substantial model. This certifies that the developed model is substantial in explaining the problem of cost overrun factors for small scale project in Malaysia. Thus the parameters considered in the model are consistent and reliable to be accepted for the Malaysian construction industry. With these parameters, cost performance of projects can be improved if these factors are managemed and controlled well by all the parties involved in the construction. In addition, He (2010) suggested that adequate quality system be applied in projects.

5. Conclusion

The developed structural model of cost overrun factors gives better understanding about the influence of each factor towards the cost overrun generation. With univariate statistical approach it only gives linear effect of each factors and this does not reflect the real scenario where factors are interrelated with each other in contributing to cost overrun issues. The findings of the study are summarized as follows.

1) Investigated factors have significant effect on small scale projects.

2) Developped model is substantial in representing the relationship of the factors on cost overrun with R^2 value of 0.713.

3) GoF value of the model was achieved as 0.7 which showed that the model has good explaining power in generalizing the cost overrun problem for small scale projects of Malaysia.

4) Constractor Site Management related factors are major contributors to cost overrun.

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