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Research Article

Modeling Causes of Cost Overrun in Large Construction Projects with Partial Least Square-SEM Approach: Contractor's Perspective

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Abstract: Construction cost overrun is a major problem faced by the construction industry globally and it needs serious attention to alleviate. Cost overrun is a result of one or combination of several causes which are very important to identify for effective cost performance. Current methodologies focusing on the identification of causes does not give the insight of underlying relationships between the causes. Hence, this study focused on studying the fundamental relationship between factors of cost overrun using Partial Least Square-SEM method. This is an advanced multivariate analysis technique for estimating and analyzing causal relationships in path models. Data collection was carried out with structured questionnaire survey amongst contractors involving in large construction projects in Malaysia. Hierarchal model for assessing causative factors and cost overrun was developed and analyzed using Smart PLS software of SEM and it was found that contractor's site management related factors had strong effect on cost overrun. The calculated Global Fit (GoF) Index of model was 0.405, which indicates that the developed model had substantial explaining power to represent the Malaysia construction industry focused of large construction projects. Hence, improvement in contractor's site management is the critical requirement to control construction cost overrun.

Keywords: Construction cost, cost overrun causes, large projects, Malaysia, PLS-SEM, structural equation modeling

INTRODUCTION

Construction industry now-a-days is being faced by chronic problems like delay in completion, low productivity, low quality and cost overrun etc., of these, cost overrun is the most significant issue faced globally. Commonly, most of the projects faced cost overrun when executed (Azhar *et al*., 2010) and these overruns produce immediate effects on construction stakeholders and on the country's economy (Moura *et al*., 2007). This is because construction industry plays vital role in economic and social growth of any country. In Malaysia, like other countries, construction industry is rapidly growing and consequently huge amount is invested to this industry. Under 10th Malaysian Plan, RM230 billion have been allocated for construction development (Abu Mansor, 2010). However, the construction projects are rarely finished within stipulated time and at the estimated cost. In a study conducted on 308 public and 51 private projects, it was found that only 46.8 and 37.2% of public sector and private sector projects completed within the budget, respectively. Conversely, 84.3% of the private sector and 76% public sector projects completed within 10% of cost deviation (Endut *et al*., 2009).

To prevent poor cost performance, it is often required to evaluate a project's vulnerability of cost overrun before it is too late (Cha and Shin, 2011). Ibrahim *et al.* (2010) stated that in Malaysia very little research has been carried out by academic and practitioners on problems faced by construction industry, more specifically there is lack of investigation on construction cost factors (Toh *et al*., 2011). Hence, this study focused on developing the path model of causative factors of cost overrun in construction, however it was limited to large construction projects only and the targeted group for data collection was the contractors of the firms. In Malaysia, any construction project of contract sum more than RM 5 Million is regarded as large project (Abdullah *et al.*, 2009).

Due to lack of assessing causal relationship of cost overrun factors, Structural Equation Modeling (SEM) approach was adopted to analyze these factors. SEM is regarded as an extension of standardized regression modeling used to deal with poorly measured independent variables and is ideally suited for many

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research issues in the fields of construction engineering and management (Molenaar *et al.*, 2000). SEM method is suitable for exploring relationships among key variables and is highly applicable for resolving the complicated problems in the construction domain (Yang and Ou, 2008) as the functionality of SEM is better than other multivariate techniques including multiple regression, path analysis, and factor analysis (Ng *et al*., 2010). There are two approaches that may be used for SEM analysis:

- Covariance-based structure analysis
- Component-based analysis using partial least square estimation also known as PLS-SEM (Haenlein and Kaplan, 2004)

For this study, PLS approach was used as it is more advisable when the objective of study is testing the causal relation and theory development (Hair *et al*., 2011).

LITERATURE REVIEW

Cost overrun and common causes: Cost is among major consideration throughout the project management life cycle and is considered as prime factor for success of any project. However, in spite of its proven importance it is uncommon to see project completion within estimated cost (Azhar *et al*., 2008). In today's construction industry, cost overrun is very common phenomenon worldwide. The problem of cost overrun is critical and needs to be studies more to alleviate this issue (Angelo and Reina, 2002). A study conducted by Frame (1997) consisting of 8,000 projects showed that only 16% of the projects could satisfy the three famous performance criteria: completing projects on time, within budgeted cost and quality standard (Ameh *et al*., 2010), while In a global study on cost overrun issues in transport infrastructure projects covering 258 projects in 20 nations, Flyvbjerg *et al*. (2003) concluded that 9 out 10 projects face cost overrun and cost performance has not improved over time, it is in the same order of magnitude as it was 10, 30 or 70 years ago.

Similarly, Omoregie and Radford (2006) reported a minimum average of cost escalation in construction projects in Nigeria to be 14%, while in Portugal construction projects face a minimum of 12% of cost overrun (Moura *et al*., 2007). In Pakistan, minimum cost overrun was reported as 10% of the estimated cost of project, this trend is sometimes is more severe in developing countries where cost overrun sometime exceeds 100% of the anticipated cost of the project (Azhar *et al*., 2008).

Cost overrun in construction project can occur due to various causes. A number of researchers have investigated various causes of cost overrun. 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. Memon *et al*. (2010) investigated large project of MARA Malaysia and found that cash flow and financial difficulties faced by contractors, contractor's poor site management and supervision, inadequate contractor experience, shortage of site workers, incorrect planning and scheduling by contractors were most severe factors while changes in scope of project and frequent design changes are least affecting factors on construction cost. 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. Several others researchers have conducted survey in different areas of the world contributing to identify the main causes of construction cost overrun which were reviewed in order to identify the common causes of cost overrun. This results in identifying 35 common causes of cost overrun categorized in 7 groups 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. These factors were considered for further investigation in Malaysian construction industry and presented in Table 1.

Partial Least Square Structural Equation Modeling (PLS-SEM): Use of Partial Least Square Structural Equation Modeling (PLS-SEM) in literature is also referred as PLS path modeling (Ringle, 2010). The PLS

Table 1: Causes of cost overrun identified from previous studies

Group/construct	Item	Description of item	Sources
Contractor's Site Management related factors (CSM)	CSM1	Poor site management and supervision	Le-Hoai *et al*. (2008), Harisweni (2007) and Memon *et al*. (2010)
	CSM2	Incompetent subcontractors	Le-Hoai *et al*. (2008) and Omoregie and Radford (2006)
	CSM3	Schedule delay	Omoregie and Radford (2006) and Harisweni (2007)
	CSM4	Inadequate planning and scheduling	Ameh *et al*. (2010), Enshassi *et al*. (2009), Azhar *et al*. (2008), Harisweni (2007), Frimpong *et al*. (2003), Jackson and Steven (2001) and Memon *et al*. (2010)
	CSM5	Lack of experience	Ameh *et al*. (2010), Enshassi *et al*. (2009), Jackson and Steven (2001), Kaming *et al*. (1997) and Memon *et al*. (2010)
	CSM6	Inaccurate time and cost estimates	Le-Hoai *et al*. (2008), Omoregie and Radford (2006), Harisweni (2007), Frimpong *et al*. (2003) and Jackson and Steven (2001)
	CSM7	Mistakes during construction	Le-Hoai *et al*. (2008), Omoregie and Radford (2006) and Frimpong *et al*. (2003)
	CSM8	Inadequate monitoring and control	Azhar *et al*. (2008), Harisweni (2007) and Frimpong *et al*. (2003)
Design and Documentation related Factors (DDF)	DDF1	Frequent design changes	Ameh *et al*. (2010), Enshassi *et al*. (2009), Le-Hoai *et al*. (2008), Azhar *et al*. (2008), Omoregie and Radford (2006), Harisweni (2007), Frimpong *et al*. (2003), Oladapo (2007) and Memon *et al*. (2010)
	DDF2	Mistakes and errors in design	Le-Hoai *et al*. (2008) and Oladapo (2007)
	DDF3	Incomplete design at the time of tender	Enshassi *et al*. (2009)
	DDF4	Poor design and delays in design	Oladapo (2007)
	DDF5	Delay preparation and approval of drawings	Omoregie and Radford (2006)
Financial management related factors (FIN)	FIN1	Cash flow and financial difficulties faced by contractors	Le-Hoai *et al*. (2008), Frimpong *et al*. (2003) and Memon *et al*. (2010)
	FIN2	Poor financial control on site	Ameh *et al*. (2010) and Azhar *et al*. (2008)
	FIN3	Financial difficulties of owner	Le-Hoai *et al*. (2008), Frimpong *et al*. (2003), Kaming *et al*. (1997), Moura *et al*. (2007) and Oladapo (2007)
	FIN4	Delay in progress payment by owner	Frimpong *et al*. (2003)
	FIN5	Delay payment to supplier /subcontractor	Omoregie and Radford (2006) and Moura *et al*. (2007)
	FIN6	Contractual claims, such as, extension of time with cost claims	Enshassi *et al*. (2009)
Information and Communication related factors (ICT)	ICT1	Lack of coordination between parties	Ameh *et al*. (2010), Enshassi *et al*. (2009), Azhar *et al*. (2008) and Oladapo (2007)
	ICT2	Slow information flow between parties	Enshassi *et al*. (2009), Le-Hoai *et al*. (2008) and Frimpong *et al*. (2003)
	ICT3	Lack of communication between parties	Long *et al*. (2004) and Memon *et al*. (2010)
Human resource (workforce) related factors (LAB)	LAB1	Labour productivity	Harisweni (2007) and Moura *et al*. (2007)
	LAB2	Shortage of site workers	Ameh *et al*. (2010), Azhar *et al*. (2008), Harisweni (2007), Frimpong *et al*. (2003), Kaming *et al*. (1997), Moura *et al*. (2007) and Memon *et al*. (2010)
	LAB3	Shortage of technical personnel (skilled labour)	Le-Hoai *et al*. (2008), Harisweni (2007) and Frimpong *et al*. (2003)
	LAB4	High cost of labour	Ameh *et al*. (2010), Azhar *et al*. (2008) and Kaming *et al*. (1997)
	LAB5	Labour absenteeism	Moura *et al*. (2007)
Non-human resource related Factors (MMF)	MMF1	Fluctuation of prices of materials	Ameh *et al*. (2010), Enshassi *et al*. (2009), Le-Hoai *et al*. (2008), Azhar *et al*. (2008), Omoregie and Radford (2006), Frimpong *et al*. (2003), Jackson and Steven (2001), Kaming *et al*. (1997) and Memon *et al*. (2010)
	MMF2	Shortages of materials	Le-Hoai *et al*. (2008), Omoregie and Radford (2006), Harisweni (2007), Frimpong *et al*. (2003) and Moura *et al*. (2007)
	MMF3	Late delivery of materials and equipment	Harisweni (2007), Frimpong *et al*. (2003) and Moura *et al*. (2007)
	MMF4	Equipment availability and failure	Harisweni (2007), Frimpong *et al*. (2003) and Moura *et al*. (2007)

Table 1: Continue

Group/construct	Item	Description of item	Sources
Project Management and Contract Administration related factors (PMCA)	PMCA1	Poor project management	Le-Hoai *et al*. (2008) and Azhar *et al*. (2008)
	PMCA2	Change in the scope of the project	Enshassi *et al*. (2009), Azhar *et al*. (2008), Harisweni (2007), Frimpong *et al*. (2003), Jackson and Steven (2001), Kaming *et al*. (1997), Moura *et al*. (2007), Oladapo (2007) and Memon *et al*. (2010)
	PMCA3	Delays in decisions making	Enshassi *et al*. (2009), Frimpong *et al*. (2003) and Memon *et al*. (2010)
	PMCA4	Inaccurate quantity take-off	Enshassi *et al*. (2009) and Kaming *et al*. (1997)

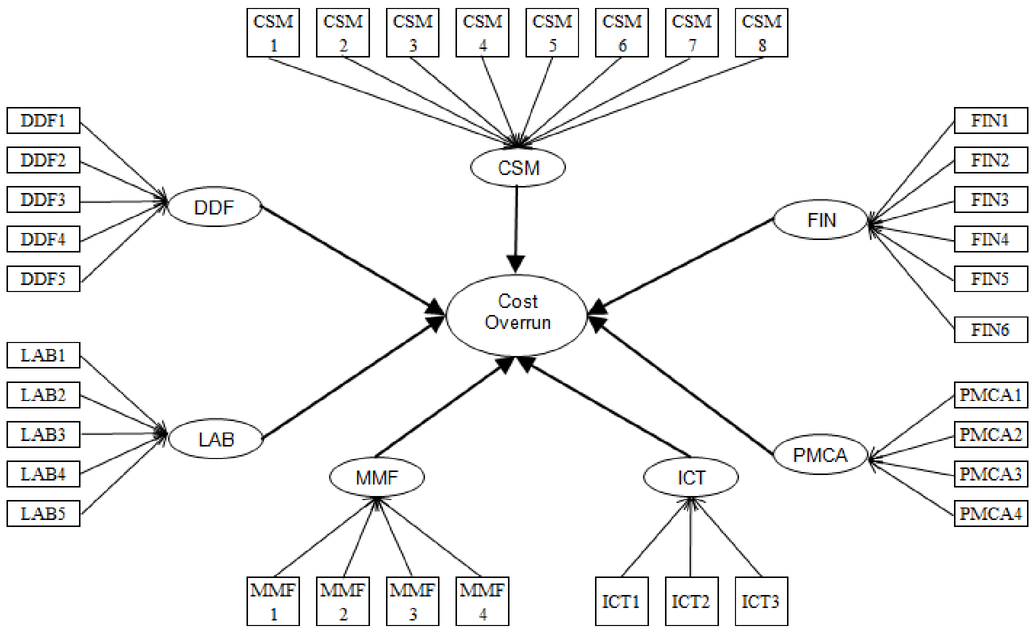

Fig. 1: Conceptual hierarchal model

path modeling approach is a general method for estimating causal relationships in path models that involve latent constructs which are indirectly measured by various indicators (Ringle, 2010). PLS uses a component-based approach, similar to principal components factor analysis (Compeau *et al*., 1999). The PLS path analysis predominantly focuses on estimating and analyzing the relationships between the latent variables in the inner model. However, latent variables are measured by means of a block of items or manifest variables, with each of these indicators associated with a particular latent variable (Ringle, 2010). PLS path models are formally defined by two sets of equation: the inner model (or structural model) and outer model (measurement model). The inner model specifies the relationships between unobserved or latent variables, whereas the outer model specifies the relationship between a latent variable and its observed or manifest variables (Henseler *et al*., 2009). In PLS outer relationships or outer model include 2 types of models: formative and reflective models (Gudergan *et al*., 2008; Henseler *et al*., 2009). A formative measurement model has cause-effect relationships between the manifest variables and the latent index (independent causes), a reflective measurement model involves paths from the latent construct to the manifest variables or dependent effects (Henseler *et al*., 2009).

The use of PLS path modeling can be predominantly found in the fields of marketing, strategic management, and management information systems (Henseler *et al*., 2009). However, it is still new in the context of construction engineering and management. Aibinu and Al-Lawati (2010) modeled willingness of construction organizations to participate in e-bidding using PLS-SEM. Lim *et al*. (2011) adopted PLS-SEM for Empirical Analysis of the Determinants of Organizational Flexibility in the Construction Business and Aibinu *et al*. (2011) used PLS-SEM for modeling organizational justice and cooperative behavior in the construction project claims process.

DEVELOPING CONCEPTUAL MODEL

In order to assess effect of causative factors on cost overrun as hierarchical conceptualization, reflective construct was adopted. A hierarchal model based on groups and items identified in Table 1 showing relation to endogenous latent variable i.e., cost overrun is shown in Fig.1.

Table 2: Summary of data collection

No of questionnaire distributed	200
No of response received	124
No of invalid (incomplete) responses	6
No of responses	118
% of responses received	62
% of valid responses	59

Data collection and sample characteristics: A quantitative approach using structured questionnaire was used to understand the perception of contractors in Malaysia towards factors influencing construction cost at construction projects. In order to be able to select the appropriate method of analysis, ordinal scales of measurement were used. A five likert scale was adopted as 1 = Not Significant (NS); 2 = Slightly Significant (SS); 3 = Moderately Significant (MS); 4 = Very Significant (VS); 5 = Extremely Significant (ES). A total of 200 questionnaire sets were distributed to randomly selected contractor organizations registered in G7 category of registration (the top class for large contractors) using CIDB Malaysia official portal (CIDB, 2011). Of which 124 responses were received back, however, some of the questionnaire sets were incomplete and filled partially which were considered invalid and not suitable for further analysis. Table 2 shows the summary of data collection.

The respondents involved in the survey have had several years of experience in handling various types of projects. The characteristics of the respondents participated in survey showed that 39% of respondents were engaged in handling building projects while 29% of respondents had experienced handling infrastructure project. However, 32% of respondents had experience of handling both types of project i.e., buildings as well as infrastructure projects. Although all the respondents had experienced in handling large projects i.e., projects with contract amount more than RM 5 million. A significant number of respondents (36%) had experience of handling very large projects i.e., project with contract amount more than RM 50 Millions, while 45 and 19% of respondents were involved in handling projects with contract amount RM 10-50 Million and RM 6-10 Million respectively. Majority of the respondents had working experience of more than 10 years and significant number of respondents i.e., 31% of respondents had were engaged to work in construction industry for more than 20 years and 23% of respondents had experience of more than 16 years in handling construction projects while 17 and 20% of respondents had experience of more than 11 and 6 years in handling of construction projects. Only 9% respondents were experienced below 5 years of practicing with construction industry. This shows that the respondents were competent enough and capable to participate in the survey.

Data analysis: The theoretical model (Fig. 1) was analyzed with partial least square estimation approach. Smart PLS 2.0 (Ringle *et al.*, 2005) was used to estimate measurement and structural model parameters. A two-step process (Henseler *et al*., 2009) was adopted to calculate PLS model criteria. The PLS path model evaluation steps are:

- Outer model (measurement model) evaluation to determine the reliability and validity of the construct (Hulland, 1999). This can be assessed by examining the individual loading of each item, internal composite reliability and discriminant validity (Chin, 1998).
- Inner model (structural model) evaluation to assess the relationship between exogenous and endogenous latent variables (independent latent variables and dependent variable) in respect of variance accounted for (Hulland, 1999). In the structural model, the hypotheses are tested by assessing the path coefficients "which are standardized betas" (Compeau *et al*., 1999). Non-parametric bootstrapping (Akter *et al*., 2011a) with 5000 replications was applied to test the hypothesis and obtain the standard errors of the estimates.

The sequence ensures that reliability and validity of measures of constructs are ascertained before attempting to draw conclusions about the nature of the relationships between constructs (Aibinu *et al*., 2011). Then Goodness of Fit (GOF) (Akter *et al*., 2011a) measure was used to assess the explaining power of the model. GoF index is crucial to assess the global validity of a PLS based complex model (Tenenhaus *et al*., 2005 cited by Akter *et al*., 2011b).

Assessment of measurement model: Properties of the measurement scales were assessed by calculating:

- Indicator reliability and convergent validity
- Discriminant validity as adopted by Akter *et al*. (2011a) and Aibinu *et al*. (2011)

Individual item reliability and convergent validity: Individual item reliability is the extent to which measurements of the latent variables measured with multiple-item scale reflects mostly the true score of the latent variables relative to the error (Hulland, 1999). It is the correlations of the items with their respective latent variables. To evaluate individual item reliability, the standardized loadings (or simple correlation) were assessed. Aibinu and Al-Lawati (2010) suggested that items with low loadings should be reviewed, and perhaps dropped since they would add very little explanatory power to the model and therefore biasing the estimates of the parameters linking the latent variables. According to Hulland (1999) items with

Table 3: Individual item reliability and construct validity

		Iteration 1				Iteration 2			
Construct	Item	Loading	AVE	CR	Alpha	Loading	AVE	CR	Alpha
	CSM01	0.691	0.512	0.892	0.901	0.691	0.512	0.892	0.901
	CSM02	0.632				0.632			
	CSM03	0.656				0.656			
	CSM04	0.860				0.860			
	CSM05	0.773				0.773			
	CSM06	0.668				0.668			
	CSM07	0.781				0.781			
	CSM08	0.629				0.629			
	DDF01	0.680	0.287	0.604	0.881	0.817	0.586	0.845	0.850
	DDF02	0.171				0.492			
	DDF03	0.714				0.879			
	DDF04	0.119				Omitted			
	DDF05	0.650				0.813			
	FIN01	0.626	0.487	0.848	0.846	0.652	0.537	0.851	0.820
	FIN02	0.668				0.672			
	FIN03	0.629				0.645			
	FIN04	0.542				Omitted			
	FIN05	0.804				0.780			
	FIN06	0.865				0.886			
	ICT01	0.878	0.806	0.926	0.894	0.878	0.806	0.926	0.894
	ICT02	0.921				0.921			
	ICT03	0.894				0.894			
	LAB01	0.799	0.516	0.841	0.786	0.799	0.516	0.841	0.786
	LAB02	0.740				0.740			
	LAB03	0.739				0.739			
	LAB04	0.682				0.682			
	LAB05	0.619				0.619			
	MMF01	0.750	0.536	0.818	0.759	0.750	0.536	0.818	0.759
	MMF02	0.869				0.869			
	MMF03	0.537				0.537			
	MMF04	0.733				0.733			
	PMCA01	0.673	0.512	0.807	0.682	0.673	0.512	0.807	0.682
	PMCA02	0.722				0.722			
	PMCA03	0.735				0.735			
	PMCA04	0.730				0.730			

loadings of less than 0.4 should be dropped while Chin (1998) argued that item with loading below than 0.5 should be dropped. A common threshold is that the items with outer loading higher than 0.7 should be considered highly satisfactory (Hulland, 1999; Henseler *et al*., 2009; Gotz *et al*., 2010) and for items with loading between 0.4 to 0.7 practical potential significance should be assessed prior to elimination. If an indicator's reliability is low and eliminating this indicator goes along with a substantial increase of composite reliability, it makes sense to discard this indicator (Henseler *et al*., 2009). Hence, Iterative process for elimination of the items suggested by Aibinu *et al*. (2011) was adopted considering that discarding the indicator increases the composite reliability.

Convergent validity is the measure of the internal consistency which ensures that the items assumed to measure a particular construct actually measure it and not another construct (Hulland, 1999). Composite Reliability scores (CR), Cronbach's alpha and Average Variance Extracted (AVE) tests were used to determine the convergent validity of measured constructs (Fornell and Larker, 1981 as cited by Akter *et al*., 2011a; Aibinu *et al*., 2011). The composite reliability measure (synonymous with factor reliability or Joreskog's rho) can be used to check how well a construct is measured by its assigned indicators. The reliability test depicts the degree of internal consistency. The most commonly used reliability coefficient is Cronbach's alpha, which is a generalized measure of a uni-dimensional, multi-item scale's internal consistency. A basic assumption is that the average covariance among indicators has to be positive. AVE measures the amount of variance that a latent variable captures from its measurement items relative to the amount of variance due to measurement errors.

The composite reliability can vary between 0 and 1. Researchers argue that composite reliability value for a good model should be more than 0.7 (Akter *et al*., 2011a). Similarly, the value of alpha can also vary between 0 to 1. A common threshold for sufficient values of Cronbach's alpha is 0.6 and if the value is more than 0.7, data is considered as highly acceptable (Yang and Ou, 2008; Wong and Cheung, 2005, Akter *et al*., 2011a). Fornell and Larcker 1981 (Akter *et al*., 2011a; Aibinu *et al*., 2010) stated that AVE should be higher than 0.5. This means that at least 50% of measurement variance is captured by the latent variables. This can be summarized as the cut-off value for AVE, CR and Cronbach Alpha were 0.5, 0.7 and 0.7, respectively. Table 3 shows the results of individual item reliability and convergent validity measures.

Table 4: Correlation matrix

	CSM	DDF	FIN	ICT	LAB	MMFM	PMCA
CSM	0.716						
DDF	0.413	0.765					
FIN	0.469	0.356	0.733				
ICT	0.616	0.465	0.394	0.898			
LAB	0.392	0.440	0.549	0.454	0.718		
MMFM	0.358	0.243	0.425	0.418	0.517	0.732	
PMCA	0.672	0.595	0.519	0.678	0.492	0.312	0.715

Table 3 shows that in iteration 1 almost all the manifest items had outer loading more than 0.5 except DDF02 and DDF04 in DDF construct. Also the AVE of this construct was very low. This implied that this construction was required to apply modification by dropping the items DDF02 and DDF04. While manifest item of other constructs had loading value above 0.5, also AVE, CR and Alpha values of all construct were exceeded than cut-off value i.e., 0.5, 0.7 and o.7 respectively except the FIN construct which had AVE value lower that required. Hence this constructs also was considered for modification and the item with lowest loading value i.e., FIN 04 was selected for dropping. Using the iterative process of deletion, in iteration 2, DDF04 having lowest value in the construct and Fin04 were omitted and PLS algorithm was run to test the model properties. As depicted in results of iteration 2 in Table 2, the omitting of one item from each of construct FIN and DDF resulted in improving the value AVE, CR and Alpha which exceeded than required cut-off values. Also the outer loading value of DDF02 was improved to 0.492 which was higher that the value to be considered for deletion as suggested by Hulland (1999). Hence DDF02 was not deleted and measurement model was considered satisfactory with the evidence of adequate reliability, convergent validity.

Discriminant validity of constructs: Discriminant validity indicates the extent to which a given construct is different from other constructs (Hulland, 1999). The discriminant validity of the measurement was then evaluated using analysis of the average variance extracted (Akter *et al*., 2011a; Aibinu *et al*., 2011) by using the criteria that "a construct should share more variance with its measures than it shares with other constructs in the model (Fornell and Larker, 1981; Aibinu *et al*., 2011). This can be examined by comparing the AVE of construct shared on itself and other constructs. For valid discriminant of construct, AVE shared on it should greater than shared with other constructs. The rule that the square root of the AVE of each construct should be larger than the correlation of two constructs (Chin, 1998) was applied. This was done by replacing the diagonal of correlation matrix with the value of square root of the AVE. For adequate discriminant validity, the diagonal elements need to be greater than the off-diagonal elements in the corresponding rows and columns (Hulland, 1999). Table 4 presents the correlation matrix for the constructs. It was found that square root of AVE had

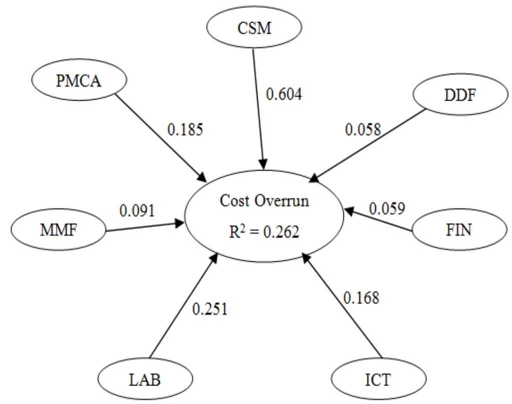

Fig. 2: Structural model results

Table 5: Path results

Relationship	Beta (β)	t-value	Inference
CSM -> cost overrun	0.604	31.444*	Significant
DDF -> cost overrun	0.058	2.844*	Significant
FIN -> cost overrun	0.059	3.182*	Significant
ICT -> cost overrun	0.168	11.923*	Significant
LAB -> cost overrun	0.251	18.588*	Significant
MMF -> cost overrun	0.091	8.852*	Significant
PMCA -> cost overrun	0.185	6.416*	Significant

large value that correlation value of the construct shared on other constructs. Hence the test confirms the discriminant validity of the constructs.

Assessment of structural model: Structural model can be assessed by testing the explained variance on endogenous latent variable and path co-efficient also termed as beta (β) values of each path while R^2 of the endogenous latent variable is used assess the explained variance. Figure 2 shows the results of structural model. According to Cohen (1988) R^2 of endogenous can be assessed as substantial = 0.26, moderate = 0.13 and weak = 0.02. From Fig. 2 it is perceived that R^2 of the endogenous latent variable (cost overrun) is 0.262 which is higher than the cut-off value and hence the model lies at satisfactory level. In assessing the path co-efficient, beta value of all structural paths is compared, higher the path co-efficient the significant effect on endogenous latent variable. Figure 2 show that CSM has the highest co-efficient value of 0.604. This means the CSM shares high value of variance with respect to cost overrun have large effect on cost overrun. The second major construct affecting cost overrun is LAB with path co-efficient of 0.251. Further, the significance of the path co-efficient was tested by calculating t-value using non-parametric bootstrap procedure with Smart

PLS software to provide confidence intervals for all parameter estimates, building the basis for statistical inference. In general, the boot strap technique provides an estimate of the shape, spread, and bias of the sampling distribution of a specific statistic. Bootstrapping treats the observed sample as if it represents the population. The procedure creates a large, pre-specified number of bootstrap samples (e.g., 5,000). Each bootstrap sample should have the same number of cases as the original sample. Bootstrap samples are created by randomly drawing cases with replacement from the original sample. The PLS results for all bootstrap samples provide the mean value and standard error for each path model coefficient. This information permits a student's t-test to be performed for the significance of path model relationships (Henseler *et al*., 2009). Table 5 shows the summary of the path results and the corresponding t values and estimated p value associated with each t value calculated with bootstrap run suing 5000 bootstrap samples. For all the paths, a two tail t-test was used. The exact p values (probability value) associated with the t values of each path coefficient were also estimated. Table 5 shows that all the paths retrieved t-value higher than minimum cut-off value i.e., 2.58 at significance level = 1% (Hair *et al*., 2011). This implies that all the construct have significant effect on cost overrun.

Overall model assessment: Global Fit measure (GoF) for PLS path modeling, defined as the geometric mean of the average communality and average R^2 (for endogenous constructs) was used to assess over all model fitness and explaining power of model. The GoF index is bounded between 0 and 1. Wetzels *et al*. (2009) suggest using 0.50 as the cut off value for communality (Fornel and Larcker, 1981) and different effect sizes of R^2 (Cohen, 1988 cited by Akter *et al*., 2011b) to determine GoFsmall (0.10), GoFmedium (0.25) and GoFlarge (0.36) leading to achieve GoFsmall = 0.1, GoFmedium = 0.25, GoFlarge = 0.36 as cut-off values for global validation of PLS model as adopted by Akter *et al*., 2011a, b). Following equation used by (Akter *et al*., 2011a) was adopted to calculate GoF:

$$GoF = \sqrt{\overline{AVE}\ X\ \bar{R}^2}$$
$$GoF = \sqrt{0.626\ X\ 0.262}$$
$$GoF = 0.405$$

In this study, GoF value was obtained of 0.405 for the complete (main effects) model, which exceeds the cut-off value in comparison of baseline value. This shows that the model has substantial explaining power.

DISCUSSION AND CONCLUSION

This study investigated various factor affecting cost overrun using partial least square approach to structural equation modeling. The results indicated that contractor's site management factors ware major contributing causes of cost overrun. These findings were supported by Frimpong *et al*. (2003), Žujo and Car-Pušić (2008) and Le-Hoai *et al*. (2008) found poor site management as 1st ranked causes of cost overrun in Vietnamese construction industry. In Pakistan also poor site management was a very significant cause of cost overrun. Aje *et al*. (2009) states that Contractors' performance is crucial to success of any construction project as it is the contractors who convert design into practical reality and contractors' management capability enhances project performance (Aje *et al*., 2009). Poor management causes many constraints at the projects, such as poor follow-up of progress, incorrect distribution of works, non-commitment of site employees, poor monitoring of project, etc., (Enshassi *et al*., 2009). Poor of site management reflects the weakness and incompetency of contractors (Le-Hoai *et al*., 2008). Therefore, improved site management and supervision of contractors can lead to improve the project performance and contribute in effective cost management of project that can result in control of cost overrun.

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