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Using Structural Equation Modelling to Assess Effects of Construction Resource Related Factors on Cost Overrun

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Abstract: Cost performance is the basic criteria for measuring success of any project. Since construction projects are highly dependable on resources, construction cost is significantly affected by various resource related factors. Compared to traditional methods of data analysis, Structural Equation Model (SEM) is the graphical equivalent of a mathematical representation to study relationship between dependant variable to explanatory variable. SEM is regarded as extension of standardized regression modelling and is important tool to estimate the causal relationship between factors. SEM functionality is better than other multivariate techniques including multiple regression, path analysis and factor analysis in analyzing the cause–effect relations between latent constructs. Since no study has estimated causal relations among resource factors and cost performance yet, hence this study adopted structural equation modelling to assess the effects of the resource related factors on project cost in the southern part of peninsular Malaysia. With 20 resource-related factor identified from literature, a theoretical model demonstrated how construction resources affect cost overrun. The model is tested using structural equation modelling technique with Partial Least Square (PLS) approach to SEM as PLS is dominant approach to establish rigor in complex models. A total of 159 data samples collected via structured questionnaire survey were used for estimation. Model estimation was carried out using SmartPLS 2.0 software. Results showed that approximately 47% of cost overrun was influence with resource related factors. Global Fit Index (GoF) value of the developed model is 0.517, indicating that the model has enough explaining power to generalize the phenomenon of Malaysian construction industry. Money (finance) related factors were found as most dominant factors causing cost overrun. The authors conclude that effective financial management can significantly improve the projects success and help in reducing the cost overrun.

Key words: Structural Equation Modelling • PLS-SEM • Cost Overrun • Construction Resource

INTRODUCTION

In Malaysia, construction industry plays a vital role in economic growth of the country. It helps in improving the quality of life of the citizenry by providing the necessary socio-economic infrastructure such as roads, hospitals, schools and other basic and enhanced facilities. Despite of global economic downfall, construction industry contributes significantly to the Gross Domestic Product (GDP) of Malaysia's economy. As reported by CIDB, construction sector had been consistently contributing an average of 3.8% of GDP over the last thirty years. Furthermore, construction industry is rapidly growing and improving significantly. Construction Sector registered a strong growth of 5.8% in 2009 and subsequently 8.7% for the first quarter of 2010 as against the overall GDP growth of 10.1% during the first quarter of the year. Under the 10th Malaysian Plan, RM230 billion

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development allocations and RM20 billion facilitation funds have been allocated to create the impetus in driving demand for the Construction Sector. Out of the RM230 billion for development expenditure, 60% or RM138 billion will be expended in physical development to be undertaken by the Construction Sector. The RM20 billion facilitation fund is allocated to attract private sector investments [1]. However, construction industry is observed facing a lot of challenges such as the delay to complete the project in time, the expenditure exceeding the budget, the building defects and over dependent of foreign workers [2]. Endut *et al*. [3] investigated 301 new construction projects and 58 refurbishment projects in Malaysia. Studying 308 public projects and 51 private projects, the authors concluded that only 46.8% and 37.2% of public sector and private sector projects completed within the budget, while 84.3% of the private sector projects completed within the 10% cost deviation compared with 76.0% of the public sector projects. This leads to need of serious attention to improve the project performance in order to achieve the projects completed within cost. For that, the first and important stage is to understand the sources that cause construction cost overrun. Amongst the various source affecting project success, one of the major component is construction resources.

Various studies have focused in identifying causes of cost overrun; however none of the previous studies has substantively estimated causal relationships among the construction cost factors [4]. Hence, this study adopted Structural Equation Modeling (SEM) to assess the causes of cost overrun. SEM is the graphical equivalent of a mathematical representation whereby a set of equations relates dependent variables to their explanatory variables [5]. It allows analysts to determine what factors underlie a set of indicators; it is also possible to examine the strength of the relationship between these theoretical constructs [6, 7]. SEM has become a very popular in marketing and management research when it comes to analyzing the cause–effect relations between latent constructs [8]. SEM is regarded as an extension of standardized regression modeling used to deal with poorly measured independent variables and is ideally suited for many research issues in the fields of construction engineering and management [9]. However, the functionality of SEM is better than other multivariate techniques including multiple regression, path analysis and factor analysis [10]. Structural Equation Model is composed of two sub-models: the measurement model and the structural model. The first one takes into account the relationships between each latent variable and the corresponding manifest variables, while the structural model takes into account the relationships among the latent variables [11, 12]. There are two approaches that may be used for SEM analysis (i) Covariance-based structure analysis (ii) Component-based analysis using partial least square estimation also known as PLS-SEM [13]. For the current study PLS approach to SEM is used as it is more advisable when the objective of study is testing the causal relation [8].

Related Works: Currently construction industry is facing lot of challenges in achieving desired cost performance. As a consequence practitioners are suffering significant amount of cost overrun. Cost overrun is a global phenomenon. Angelo and Reina [14] state that the problem of cost overruns is critical and needs to be studied more to alleviate this issue in the future. They also point out that cost overruns are a major problem in both developing and developed countries. The trend is more severe in developing countries where these overruns sometime exceeds 100% of the anticipated cost of the project [15]. As cited by [16], in Croatia, a multiannual research pointed out the occurrence of price overrun in no less than 81% projects out of 333 analyzed projects. In Slovenia, a study on a sample of 92 traffic structures indicates an average of 51% of contracted construction price overrun, while in Bosnia and Herzegovina, a research on 177 structures built indicated that the contracted price was not met in 41.23% of structures. Similarly, in a study of 8,000 projects it was found only 16% of the projects could satisfy the three famous performances criteria: completing projects on time, within budgeted cost and quality standards [17]. In Nigeria a minimum average percentage of cost escalation was reported as 14% [18].

Like other countries, Malaysian construction industry is also facing a lot of challenges in completion of construction projects within estimated cost. As stated by [19] cost overrun is still common problem in Malaysian construction industry and there is lack of investigation on construction cost factors in Malaysia [4], these motivated authors to study the cost overrun factors. There are various causes which contribute to cost overrun. However, this study focuses to address the cause related to construction resources as resources are the basic need of any project and play vital role for successful completion of any project. Hence, prior and adequate arrangement for provision of resource involved in construction such as type and quantity of material, manpower, machines and finance are required at each stage of construction. For any project, various types of resources are essentially required be managed for the success of any project. Various studies have indicated different resource-related issues which cause cost overrun. A comprehensive literature review was included in this study to identify resource related factors and develop hypothetical model with latent variables in order to investigate in Malaysian construction industry. Fundamental Construction resources include Material, Manpower (Labour), Machinery (Equipments) and Money (Finance) and hence this study is limited in addressing the factors related to these four categories.

- Material Resource: Materials are the essence for the construction industry. Material resource represents a substantial proportion of the total value of the project. A material management system includes the major functions (needed in construction project) i.e. identifying, acquiring, storing, distributing and disposing of materials. Material planning may vary depending on the project size, location, cash flow requirements and procedure for purchasing and inspection. Regular supply of the material in proper quantity must be ensured. It is extremely important because the late or irregular delivery or wrong type material delivery during construction are major factors that contribute to the delay of the project and ineffective utilization of manpower which lead to cost overrun.
- Manpower Resource: For any project, manpower resource or people are as significant as financial resources and that efficient use of manpower is critical for success. Good results certainly cannot be achieved without the adequate availability of skilled and unskilled manpower, most suitable allocation and management of human or manpower resource. Construction progress can be achieved only through the attainment of effective man-hour effort and the meeting of scheduled mile stone dates. Effective manpower management can reduce labour costs and thereby increase profits for company.
- Machines or equipment Resources: This type of resource has an advantage over manpower resource as it can work under adverse circumstances continuously, requires fewer persons and other facilities like manual labour. The selection and utilization of equipment on a project must be an integral part of the total plan. The type and number of the equipment required for any project depend on the nature of the project. It affects significantly on construction cost.
- Money: Financial management is the use of financial or accounting information at all levels to assist in planning, making decisions and controlling the activities of an enterprise [20]. Money has great importance in the construction industry. It is the first and foremost resource or item required for any construction work. The design and specifications of a project depend upon it and without sufficient money or finance any project cannot be completed. Cash flow affects the progress of construction. A project cannot be completed in the absence of money and it will be entirely wastage of time and energy in designing the project. Therefore, it is absolutely necessary to manage the money for project, without management of money or finance; the management of other resource becomes useless.

Resources are organizational assets. Resource planning should take into consideration not only what is best for an individual project, but also what is best for the organization as whole. Table 1 shows the indicators to measure the effect on cost overrun.

In order to assess effect of resource related factor on cost overrun as hierarchical conceptualization, reflective construct was adopted. A complete Hierarchal model showing each construct (Material, Manpower, Machinery and Money) related to their respective indicators (manifest variables) is shown in Figure 1.

Partial Least Square Structural Equation Modeling: Use Partial Least Square Structural Equation Modelling (PLS-SEM) in literature is also referred as PLS path modelling. The PLS path modelling approach is a general method for estimating causal relationships in path models that involve latent constructs which are indirectly measured by various indicators [30]. PLS uses a component-based approach, similar to principal components factor analysis [31]. 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 manifest variables, with each of these indicators associated with a particular latent variable [30]. PLS path models are formally defined by two sets of

Table 1: Indicators/measurement items of constructs

Construct	Factor	Description	Source
Machinery related Factors (MAC)	MAC01	Late delivery of equipments	[21], [22], [23]
	MAC02	Insufficient Numbers of equipment	[22]
	MAC03	Equipment availability and failure	[22], [23]
	MAC04	High cost of machinery and its maintenance	[15], [24]
Money or Finance Related	MON01	Delay payment to supplier /subcontractor	[22]
Factors (MON)	MON02	Delay in progress payment by owner	[23]
	MON03	Poor financial control on site	[15], [24]
	MON04	Cash flow and financial difficulties faced by contractors	[23], [25], [26]
	MON05	Mode of financing, bonds and payments	[15], [18], [24]
	MON06	Financial difficulties of owner	[22], [25] [26], [27], [28]
Manpower Related Factors (MAN)	MAN01	shortage of technical personnel (skilled labour)	[23]
	MAN02	labour productivity	[22]
	MAN03	High cost of labour	[15], [18], [24]
	MAN04	Shortage of site workers	[15], [24], [25]
	MAN05	Labour Absenteeism	[22]
	MAN06	Severe overtime	[26]
Material Related Factors (MAT)	MAT01	Fluctuation of prices of materials	[15], [23], [24], [25], [28], [29]
	MAT02	Shortages of materials	[18], [21], [22], [23], [25], [26]
	MAT03	Late delivery of materials	[21], [22], [23]
	MAT04	Changes in Material Specification and type	[22]

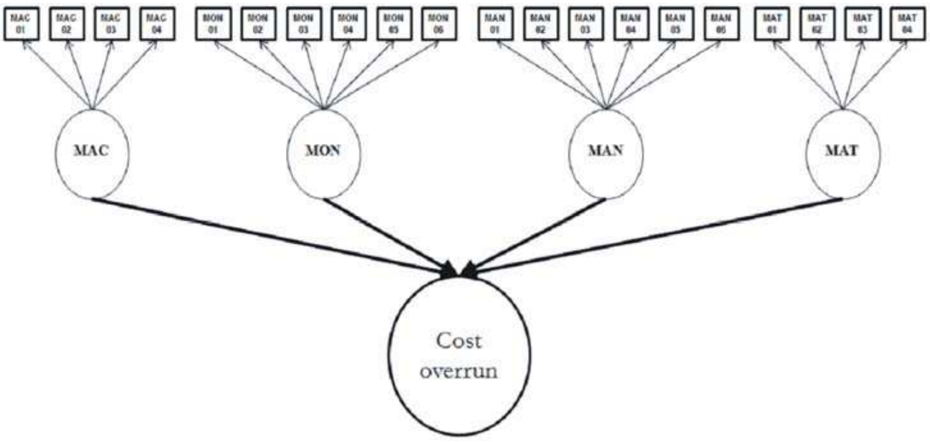

Fig. 1: Measurement Model for causes of cost overrun

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 [32]. In PLS outer relationships or outer model include two (2) types of models: formative and reflective models. 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 [32].

The use of PLS path modeling can be predominantly found in the fields of marketing, strategic management and management information systems [32]. However, it is still new in the context of construction engineering and management. Aibinu and Al-Lawati [33] used PLS-SEM to model willingness of construction organizations to participate in e-bidding. Lim *et al*. [34] adopted PLS-SEM for Empirical Analysis of the Determinants of Organizational Flexibility in the Construction Business and Ref. [35] used PLS-SEM for modelling organizational justice and cooperative behaviour in the construction project claims process.

RESULTS AND DISCUSSIONS

Respondent's Demographics: Data collection was carried out using questionnaire survey amongst the practitioners of construction industry in southern part of peninsular Malaysia and also the city of Kuala Lumpur. The respondents involved in survey were engaged in handling various types of construction project for many years. The demographic details showed that majority of the respondents i.e. 97 of 159 (61%) were contractors organizations followed by consultants and clients with 39 (24.5%) and 23 (14.5%) respectively. Majority of respondents involved in survey had experience of handling large project. Further, only 23% of respondents were involved in small project while 77% of respondents had experience of handling large construction projects i.e. the contract amount of project exceed RM 5 million [36]. Also, respondents had experience of several years in handling construction projects. A significant number of respondents had experience of handling construction project more than 10 years with a percentage of 50.9%, while 29.6% of respondents had experience of 6-10 years and only 19.5% of respondents were engaged in construction industry for less than 5 years. It is notable that majority of respondents were holding managerial and executive positions. A significant number of respondents i.e. 56 respondents (35.2%) were holding managerial positions in their organization. These include 32 Project Managers, 3 General Managers, 6 Construction Managers, 3 Finance Managers, 5 Technical Managers, 3 Assistant Project Managers and 4 Site Managers. On the other hand 26 respondents (16.4%) were holding executive and directorial position. These included 19 Managing directors, 5 operation directors and 2 Executive Directors. While 52 respondents (32.7%) were holding engineering positions and remaining 25 respondents (15.7%) were holding different positions that include project coordinator, quantity surveyor, head of production and site supervisor.

PLS Model Analysis: The statistical software application Smart PLS 2.0 [37] was used to compute the PLS path model. A two-step process [32] was adopted to calculate PLS model criteria. The PLS path model evaluation steps are:

- Outer model (measurement model) evaluation with regard to the reflective constructs' reliability and validity or the reflective constructs' validity
- Inner model (structural model) evaluation in respect of variance accounted for, path estimates and the predictive relevance of the inner model's explanatory variables for the endogenous latent variable [38].

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 [35].

Assessment of Outer Model (Measurement Model): Properties of the measurement scales were assessed by calculating (A) Indicator reliability and convergent validity; and (B) Discriminant validity as adopted by [35, 39].

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. It is the correlations of the items with their respective latent variables. Individual item reliability is evaluated by outer loadings of factors. Convergent validity is the measure of the internal consistency which, according to [38], ensures that the items assumed to measure a particular construct actually measure it and not another construct. Composite reliability scores (CR), Cronbach's alpha and average variance extracted (AVE) tests were used to determine the convergent validity of measured constructs [40]. Table 3 shows the results of individual item reliability and convergent validity.

Items with loadings of less than 0.4 should be dropped [38]. Since, results in table 2 show that item loadings were larger than 0.4, therefore no item was deleted from the model. 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 as adopted by [39].

Table 2: Individual Item Reliability and Construct Validity

Construct	Factor	Description	Loading	AVE	CR	Alpha
Machinery related Factors	MAC01	Late delivery of equipment	0.744	0.641	0.877	0.814
	MAC02	Insufficient Numbers of equipment	0.847			
	MAC03	Equipment availability and failure	0.819			
	MAC04	High cost of machinery and its maintenance	0.789			
Manpower Related Factors	MAN01	shortage of technical personnel (skilled labour)	0.734	0.528	0.869	0.818
	MAN02	labour productivity	0.790			
	MAN03	High cost of labour	0.524			
	MAN04	Shortage of site workers	0.804			
	MAN05	Labour Absenteeism	0.704			
	MAN06	Severe overtime	0.768			
Material Related Factors	MAT01	Shortages of materials	0.745	0.541	0.824	0.714
	MAT02	Fluctuation of prices of materials	0.838			
	MAT03	Late delivery of materials	0.626			
	MAT04	Changes in Material Specification and type	0.718			
Money or Finance Related Factors	MON01	Delay payment to supplier /subcontractor	0.739	0.586	0.894	0.860
	MON02	Delay in progress payment by owner	0.720			
	MON03	Poor financial control on site	0.817			
	MON04	Cash flow and financial difficulties faced by contractors	0.797			
	MON05	Mode of financing, bonds and payments	0.721			
	MON06	Financial difficulties of owner	0.793			

Table 3: Latent Variable Correlations

	Machinery	Manpower	Material	Money
MACHINERY	0.801*			
MANPOWER	0.646	0.727*		
MATERIAL	0.651	0.612	0.736*	
MONEY	0.579	0.687	0.570	0.833*

*Indicates square root of AVE

Similarly, the value of alpha can also vary from 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 [39, 41, 42] and AVE should be higher than 0.5 [40]. This means that at least 50% of measurement variance is captured by the latent variables. This can be summarized as the cut-off values for AVE, CR and Cronbach Alpha were 0.5, 0.7 and 0.7 respectively. Table 2 shows that Average Variance Extracted (AVEs), Composite Reliability (CRs) and alphas exceeded the cut-off values of 0.5, 0.7 and 0.7, respectively. Thus, the 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 [38]. The discriminant validity of the measurement was evaluated using analysis of the average variance extracted [35, 39]. Discriminant validity was confirmed by using the following criteria: a construct should share more variance with its measures than it shares with other constructs in the model [40]. 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 be 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 [43] 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 [38]. Table 3 presents the correlation matrix for the constructs. It was found that square root value of AVE for each construct was higher on itself than the correlation value shared on other constructs. Hence the test confirms the discriminant validity of the constructs.

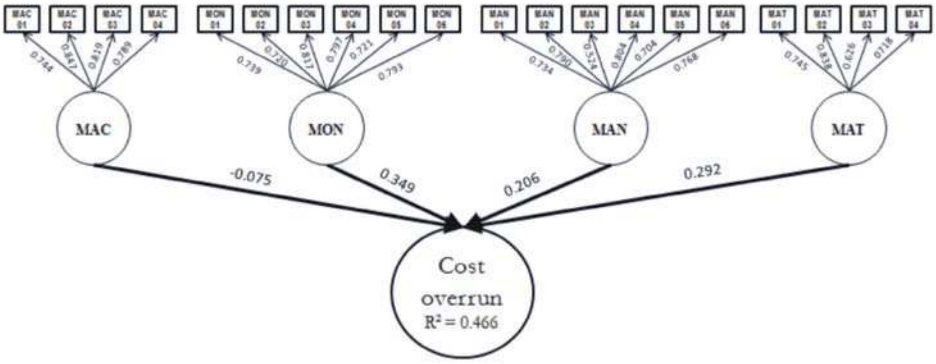

Fig. 2: Measurement Model for causes of cost overrun

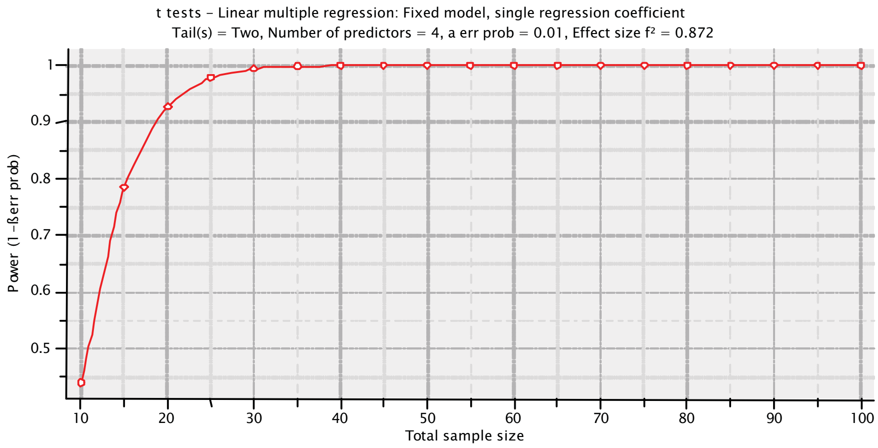

Fig. 3: Measurement Model for causes of cost overrun

Assessment of Inner Model (Structural Model): Structural model can be assessed by testing the explained variance, the explaining power of the model and path co-efficient. Figure 2 shows PLS with its path co-efficient values. R^2 of the endogenous latent variable is used assess the explained variance.

Figure 2 shows PLS with its path co-efficient values. R^2 of the endogenous latent variable is used assess the explained variance. According to [44], R^2 of endogenous can be assessed as substantial when the value is 0.26, moderate at value of 0.13 and weak when the value is 0.02. From figure 2, it is perceived that R^2 of the endogenous latent variable (cost overrun) is 0.466 which shows that 46.6% of variance can be explained by endogenous i.e. cost overrun. R^2 of the model is higher than the cut-off value and hence the model lies at a very satisfactory level. We conducted a global fit measure (GoF) for PLS path modelling, which is defined as the geometric mean of the average communality and average R^2 (for endogenous constructs). GoF value was estimated for global validation of PLS model with following equation as adopted by [39].

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

$$GoF = \sqrt{0.574 X 0.466}$$

GoF = 0.517

In this study, GoF value obtained was 0.517 for the complete (main effects) model, which exceeds the cut-off value in comparison of baseline value as GoFsmall =0.1, GoFmedium =0.25, GoFlarge =0.36 [45]. This shows that the model has substantial explaining power.

Also, the model shows that with a path co-efficient of 0.349 money (finance) related factors were most significant factor causing cost overrun.

Power Analysis: Power analysis (1-•) test used to check the stability of the model's parameters with the sample size used for the analysis [43]. General convention for acceptable model is at least 0.80 as suggested by [44]. Parameters required to calculate the power of a model are: significance level (•) of the test, sample size (N) of the study and effect size (ES) of the population.

For this study, power of the model was calculated using the software package known as G*Power 3.1.2 [46]. The input parameters used are: significance level taken as 0.01 (i.e. 99% of confidence level), sample size (N) was 159 and effect size (ES) was calculated with following equation as suggested by [47]:

$$ES = \frac{R^2}{1 - R^2}$$

$$ES = \frac{0.466}{1 - 0.466} = 0.872$$

The calculated values of power for the developed model using G*Power is shown in Figure 3.

Figure 3 indicates that the power of the overall model increases as the number of samples size increases. The power is achieved 100% with sample size of 40. However, for this study a sample size of 159 was used. Thus it is obvious that the sample size used in this study is adequate for achieving substantial power.

CONCLUSION

The study examined the effect of resource related causes on the basic criteria of project performance. The data was collected in southern part of Peninsular Malaysia and the capital city of Kuala Lumpur through structured questionnaire. Partial Least Square path modelling was used to examine the parametric effects. The study provided a novel causal relationship model for construction resource related factors affecting on construction cost overrun. From the results it can be concluded that:

- The fitness level of the model is 0.517 which indicates that it is substantially significant.
- Power analysis has shown that the model can be used to assess the impact of hypothetic relationships among the resource factors and cost overrun.
- Most significant contributing resource factor to cost overrun was identified as money (Finance) related factors
- Effective financial management and control will help in achieving better cost performance of a project.

REFERENCES

1. Mansor, S.A., 2010. The 7th Malaysia Construction Sector Review and Outlook Seminar. Retrieved. from http://www.kkr.gov.my/files/PRESS%20CIDB%203%20Ogos_0.pdf Accessed on February 1st, Edition
2. CIDB., 2007. CIDB news issue 3 (www.cidb.gov.my).
3. Endut, I.R., A. Akintoye and J. Kelly, 2009. Cost and time overruns of projects in Malaysia. retrieved on August 21, 2009, from http:// www.irbnet.de/ daten/ iconda/ CIB10633.pdf, 243-252.
4. Toh, T.C., K.N. Ali and G.U. Aliagha, 2011. Modeling Construction Cost Factors in the Klang Valley Area of Malaysia. Paper presented at the IEEE Symposium on Business, engineering and Industrial Applications (ISBEIA).
5. Byrne, B.M., 2010. Structural Equation Modeling with AMOS Basic Concepts, Applications and Programming (2nd ed.), Taylor and Francis Group, LLC.
6. Hair, J.F. R.E. Anderson, R.L. Tatham and W.C. Black, 1998. Multivariate data analysis: 5th ed. Prentice-Hall, Upper Saddle River, N.J.
7. Jackson, J.L., K. Dezee, K. Douglas and W. Shimeall, 2005. Introduction to structural equation modeling (path analysis) [Electronic Version]. Precourse PA08. Society of General Internal Medicine (SGIM), Washington, D.C. Available from: http://www.sgim.org/userfiles/file/AMHandouts/AM05/handouts/PA08.pdf.
8. Hair, J.F., C.M. Ringle and M. Sarstedt, 2011. PLS-SEM: Indeed a Silver Bullet. Journal of Marketing Theory and Practice, 19(2): 139-151.
9. Molenaar, K., S. Washington and J. Diekmann, 2000. Structural equation model of construction contract dispute potential. Journal of Construction Engineering and Management, 126(4): 268-277.
10. Ng, T.S., Y.M.W. Wong and J.M.W. Wong, 2010. A structural equation model of feasibility evaluation and project success for public private partnerships in Hong Kong. IEEE Transactions on Engineering Management, 57(2): 310-322.
11. Islam, M.D.M. and O.O. Faniran, 2005. Structural equation model of project planning effectiveness. Construction Management and Economics, 23(2): 215-223.

12. Vinzi, V.E., L. Trinchera and S. Amato, 2010. PLS Path Modeling: From Foundations to Recent Developments and Open Issues for Model Assessment and Improvement. In V. Esposito Vinzi *et al*. (eds.), Handbook of Partial Least Squares, Springer Handbooks of Computational Statistics, pp: 47-82.
13. Haenlein, M. and A.M. Kaplan, 2004. A beginner's guide to partial least squares (PLS) analysis. Understanding Statistics, 3(4): 283-297.
14. Angelo, W.J. and P. Reina, 2002. Megaprojects need more study up front to avoid cost overruns. Retrieved May 29, 2011, from http://flyvbjerg.plan.aau.dk/News%20in%20English/ENR%20Costlies%20150702.pdf
15. Azhar, N., R.U. Farooqui and S.M. Ahmed, 2008. Cost Overrun Factors In Construction Industry of Pakistan. Paper presented at the First International Conference on Construction in Developing Countries (ICCIDC–I) Advancing and Integrating Construction Education, Research & Practice.
16. Zujo, V., D. Car-Pusic and A. Brkan-Vejzovic, 2010. Contracted price overrun as contracted construction time overrun function. Technical Gazette, 17(1): 23-29.
17. Frame, J.D., 1997. Establishing project risk assessment teams. In K. Kahkonen & K. A. Artto (Eds.), Managing risks in projects: E & FN Spon, London.
18. Omoregie, A. and D. Radford, 2006. Infrastructure delays and cost escalation: Causes and effects in Nigeria. Paper presented at the Proceeding of sixth international postgraduate research conference.
19. Ibrahim, A.R., M.H. Roy, Z. Ahmed and G. Imtiaz, 2010. An investigation of the status of the Malaysian construction industry. Benchmarking: An International Journal, 17(2): 294-308.
20. Lock, D., 1993. Handbook of Engineering Management, 2nd edition. Oxford: Butterworth-Heinemann.
21. Latif, Y., I. Abidin and B. Trigunarsyah, 2008. Knowledge-based Material Cost Control for Building Construction Project using Expert System Approach. Paper presented at the CIB International Conference on Building Education and Research, Heritance Kandalama, Sri Lanka.
22. Moura, H.P., J.C. Teixeira and B. Pires, 2007. Dealing With Cost and Time in the Portuguese Construction Industry. Paper presented at the CIB World Building Congress.
23. Creedy, G., 2005. Risk factors leading to cost overrun in highway projects. Paper presented at the Proceeding of Queenland University of Technology Research Week International Conference, Brisbane, Australia.
24. Ameh, O.J., A.A. Soyingbe and K.T. Odusami, 2010. Significant factors causing cost overruns in telecommunication projects in Nigeria. Journal of Construction in Developing Countries, pp: 15.
25. Le-Hoai, L., Y.D. Lee and J.Y. Lee, 2008. Delay and Cost Overruns in Vietnam Large Construction Projects: A Comparison with Other Selected Countries. KSCE Journal of Civil Engineering, 12(6): 367-377.
26. Long, N.D., S. Ogunlana, T. Quang and K.C. Lam, 2004. Large construction projects in developing countries: a case study from Vietnam. International Journal of Project Management, 22: 553-561.
27. Oladapo, A.A., 2007. A quantitative assessment of the cost and time impact of variation orders on construction projects. Journal of Engineering, Design and Technology, 5(1): 35-48.
28. Koushki, P.A., K. Al-Rashid and N. Kartam, 2005. Delays and cost increases in the construction of private residential projects in Kuwait. Construction Management and Economics, 23(3): 285-294.
29. Enshassi, A., J. Al-Najjar and M. Kumaraswamy, 2009. Delays and cost overruns in the construction projects in the Gaza Strip. Journal of Financial Management of Property and Construction, 14(2): 126-151.
30. Ringle, C.M., M. Sarstedt and E.A. Mooi, 2010. Response-Based Segmentation Using Finite Mixture Partial Least Squares Theoretical Foundations and an Application to American Customer Satisfaction Index Data. In Data Mining, Annals of Information Systems: R. Stahlbock *et al.* (eds.), 8: 19-49.
31. Compeau, D.R., C.A. Higgins and S. Huff, 1999. Social cognitive theory and individual reactions to computing technology: a longitudinal study. MIS Quarterly, 23(2): 145-158.
32. Henseler, J., C.M. Ringle and R.R. Sinkovics, 2009. The Use of partial least Squares Path modeling in International Marketing. Advances in International Marketing, 20: 277-319.
33. Aibinu, A.A. and A.M. Al-Lawati, 2010. Using PLS-SEM technique to model construction organizations' willingness to participate in e-bidding. Automation in Construction, 19: 714-724.

34. Lim, B.T.H., F.Y.Y. Ling, C.W. Ibbs, B. Raphael and G. Ofori, 2011. Empirical Analysis of the Determinants of Organizational Flexibility in the Construction Business. Journal of Construction Engineering and Management, 137(3): 225-237.
35. Aibinu, A.A., F.Y.Y. Ling and G. Ofori, 2011. Structural equation modeling of organizational justice and cooperative behaviour in the construction project claims process: contractors' perspectives. Construction Management and Economics, 29(5): 463-481.
36. Abdullah, M.R., A.A.A. Aziz and I.A. Rahman, 2009. Causes of delay and its effects in large MARA construction project. International Journal of Integrated Engineering (Issue on Mechanical, Materials and Manufacturing Engineering).
37. Ringle, C.M., S. Wende and S. Will, 2005. SmartPLS 2.0 (M3) Beta, Hamburg 2005, http://www.smartpls.de.
38. Hulland, J., 1999. Use of partial least squares (PLS) in strategic management research: a review of four recent studies. Strategic Management Journal, 20: 195-204.
39. Akter, S., J.D. Ambra and P. Ray, 2011. Trustworthiness in mHealth Information Services: An Assessment of a Hierarchical Model with Mediating and Moderating Effects Using Partial Least Squares (PLS). Journal Of The American Society For Information Science And Technology, 62(1): 100-116.
40. Fornell, C. and F.L. Bookstein, 1982. Two structural equation models: Lisrel and PLS applied to customer exit-voice theory. Journal of Marketing Research, 19: 440-452.
41. Wong, P.S.P. and S.O. Cheung, 2005. Structural Equation Model of Trust and Partnering Success. Journal of Management in Engineering, 21(2): 70-80.
42. Yang, J.B. and S.F. Ou, 2008. Using structural equation modeling to analyze relationships among key causes of delay in construction. Canadian Journal of Civil Engineering, 35: 321-332.
43. Chin, W.W., 1998. The partial least squares approach to structural equation modelling. In G.A. Marcoulides (Ed.), Modern Methods for Business Research, Erlbaum, Mahwah, NJ, pp: 295-336.
44. Cohen, J., 1988. Statistical power analysis for the behavioral sciences (2nd ed.).
45. Wetzels, M., G.O. Schroder and V.C. Oppen, 2009. Using PLS path modeling for assessing hierarchical construct models: Guidelines and empirical illustration. MIS Quarterly, 33(1): 177-195.
46. Faul, F., E. Erdfelder, A. Buchner and A.G. Lang, 2009. Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. Behavior Research Methods, 41(4): 1149-1160.
47. Cohen, J., P. Cohen, S.G. West and L.S. Aiken, 2003. Applied Multiple Regression/ Correlation Analysis for the Behavioral Sciences (Third ed.): Lawrence Erlbaum Associates, Publishers, Mahwah, New Jersey, London.