ASSESSING CAUSAL RELATIONSHIPS BETWEEN CONSTRUCTION RESOURCES AND COST OVERRUN USING PLS PATH MODELLING FOCUSING IN SOUTHERN AND CENTRAL REGION OF MALAYSIA

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ABSTRACT

Construction resources are fundamental requirement for any construction project to achieve project completion within estimated budget. The fundamental construction resources include material, manpower, machinery and money. These resources have significant effect on construction cost. Construction cost is now a days facing problem of coverrun. Hence, it is very critical to assess impact of various resources on cost overrun. Data collection was carried out using structured questionnaire survey amongst client, consultant and contractors in southern and central region of Malaysia. A total of 234 questionnaire were collected including 128 in southern part and 106 in central part. Data was analysed with PLS path modelling using SmartPLS v2.0 software. The result showed that resources have significant effect on cost overrun. Extracted variance showed that in southern region, around 40% of cost variation can be caused because of construction resource while in central region variance is achieved as 59%. Material resource was found as common and most significant resource in southern and central region. GoF value was achieved as 0.529 and 0.566 for southern and central regions respectively confirming the explaining power of the proposed path model.

KEYWORDS: Construction resources, central Malaysia, southern Malaysia, PLS path modelling

1.0   INTRODUCTION

Malaysia is one the fast growing economy of the world. In spite of global economic crises in last decades, it is undergoing rapid development

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and being popularized for tourism facilities by increased infrastructure development including roads, bridges and hospitals and hence huge amounts have been allocated for construction development under 10th Malaysian Plan (Mansor, 2010). But unfortunately, construction industry in Malaysia is facing a serious problem of cost overrun. It is evident from investigation of 308 public and 51 private projects by (Endut, Akintoye, & Kelly, 2009) investigated. The authors found that only 46.8% of public projects and 37.2% of private projects were completed within the estimated cost. In a survey to study cost performance in southern region of Peninsular Malaysia (Memon, Rahman, Azis, Rasiah, & Hanas, 2011) found that only 15% respondents mentioned that their projects were finished with cost while 85% of respondents agreed that mostly they face cost overrun in their projects. The overrun in construction cost affect significantly on development plans of the country. Hence a serious attention is required to on cost studies of construction to achieve the projects completed within estimate cost. These overrun can be caused because various factors and it is very critical and essential to understand the sources that cause construction cost overrun. Amongst, construction resources related issues are major factors which affect construction cost performance. 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. For successful construction project, prior and adequate arrangement for provision of resource involved in construction such as type and quantity of material, manpower, machines and finance is very essential at each stage of construction. Various studies have indicated different resource-related issues which cause cost overrun. For any project, 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.

1.1   Material Resource

Materials are the essence of any construction projects which represents a represent a substantial proportion of the total value of the project. A material management essentially focus on identifying, acquiring, storing, distributing and disposing of materials. Adequate planning of material is necessary to ensure regular and timely supply of the material in proper quantity required for execution of the construction activities 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.

1.2   Manpower Resource

Manpower resources or worker are also significant resources for any construction project as none of work can be executed without manpower. Hence, efficient use of manpower is very critical for any construction projects. 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. Effective manpower management can reduce labour costs and thereby increase profits for company.

1.3   Machines or Equipment Resources

Another important resource required for any projects is machine or equipment. Machinery resource is very beneficial as it help in improving efficiency especially when the amount of work is in bulk quantity it makes work faster with fewer resources. Hence, the selection and utilization of equipment on a project must be an integral part of the total plan to choose the appropriate type and number of the equipment required for any project depend.

1.4   Money

Money or finance is the most important resource as no work can be carried without enough and timely availability of money. Unavailability of money will affect all other resource and can cause stoppage of works. Hence effective management of money or finance is the most important, it will help in planning and decision making of the works and without management of money or finance; the management of other resource becomes useless. The design and specifications of a project depend upon it and without sufficient money or finance any project cannot be completed.

Hence, this study focused on assessing effect of construction resources on construction cost overrun. However, this study was limited to compare effect of resource on cost in southern region (Johor, Negeri Sembilan and Melaka) and central region (Kuala Lumpur and Selangor state) of peninsular Malaysia only. Further, PLS Path modelling also known as PLS structural equation modelling, a graphical equivalent of a mathematical representation (Byrne, 2010) was adopted to assess relationship between resource and cost overrun. This approach very effective and popular especially in analyzing the cause–effect relations between latent constructs because of better functionality is better than other multivariate techniques including multiple regression, path analysis, and factor analysis (Ng, Wong, & Wong, 2010).

2.0   DEVELOPMENT OF HYPOTHETIC MODEL

Figure 1 shows the causal relationships between various resources and cost overrun, where MAN represents material resource, MAN denotes manpower (labour) resource, MAC stands for machinery (equipments) resource and MON stands for money (finance) resource. Each of construct is measured by various indicators.
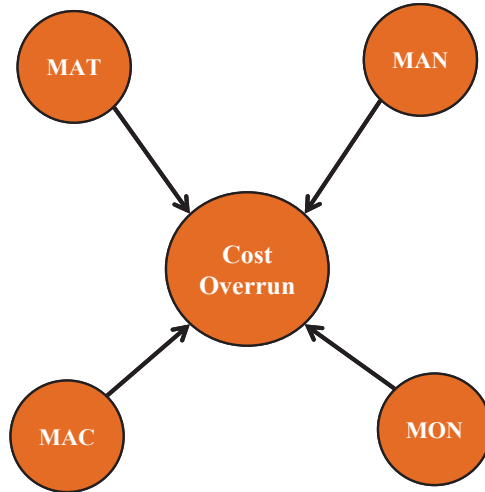

Figure 1. Causal relationship between construction resources and cost overrun

In order to identify the indicator representing each construct or category of resource, a comprehensive literature review was carried out. Table 1 shows the items representing their relative construct.

Table 1. Indicators/measurement items of constructs

Factor	Description	Source
Machinery related Factors (MAC)		
MAC01	Late delivery of equipments	(Creed, 2005; Latin, Abiding, & Trigunarsyah, 2008)
MAC02	Insufficient Numbers of equipment	(Moura, Teixeira, & Pires, 2007)
MAC03	Equipment availability and failure	(Creedy, 2005; Moura et al., 2007)
MAC04	High cost of machinery and maintenance	(Ameh, Soyingbe, & Odusami, 2010; Azhar, Farooqui, & Ahmed, 2008)
Money or Finance Related Factors (MON)		
MON01	Delay payment to supplier /subcontractor	(Moura et al., 2007)
MON02	Delay in progress payment by owner	(Creedy, 2005)
MON03	Poor financial control on site	(Ameh et al., 2010; Azhar et al., 2008)
MON04	Cash flow and financial difficulties faced by contractors	(Le-Hoai, Lee, & Lee, 2008; Long, Ogunlana, Quang, & Lam, 2004)
MON05	Mode of financing, bonds and payments	(Ameh et al., 2010; Omoregie & Radford, 2006)
MON06	Financial difficulties of owner	(Le-Hoai et al., 2008; Oladapo, 2007)

Manpower Related Factors (MAN)

MAN01	shortage of technical personnel	(Creedy, 2005)
MAN02	labour productivity	(Moura et al., 2007)
MAN03	High cost of labour	(Ameh et al., 2010; Koushki, Al-Rashid, & Kartam, 2005)
MAN04	Shortage of site workers	(Ameh et al., 2010; Azhar et al., 2008)
MAN05	Labour Absenteeism	(Moura et al., 2007)
MAN06	Severe overtime	(Long et al., 2004)

Material Related Factors (MAT)

MAT01	Fluctuation of prices of materials	(Ameh et al., 2010; Enshassi, Al-Najjar, & Kumaraswamy, 2009)
MAT02	Shortages of materials	(Latif et al., 2008; Moura et al., 2007; Omoregie & Radford, 2006)
MAT03	Late delivery of materials	(Latif et al., 2008; Moura et al., 2007)
MAT04	Changes in material Specification	(Moura et al., 2007)

3.0 RESEARCH METHODS AND DATA COLLECTION

Data collection was carried out using structured questionnaire survey amongst the client, consultant and contractors. A 5-points likert scale was adopted to understand the perception of the respondents as 1 for not significant, 2 for slightly significant, 3 moderately significant, 4 for very significant and 5 for extremely significant. Partial Least Square (PLS) path modelling also termed as Partial Least Square Structural Equation Modelling (PLS-SEM) was used to assess the hypothetic model. 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 (Ringle, Sarstedt, & Mooi, 2010). PLS uses a component-based approach, similar to principal components factor analysis (Compeau, Higgins, & Huff, 1999). The use of PLS path modelling can be predominantly found in the fields of marketing, strategic management, and management information systems (Henseler, Ringle, & Sinkovics, 2009). However, it is still new in the context of construction engineering and management. In modelling the willingness of construction organizations to participate in e-bidding (Aibinu & Al-Lawati, 2010) used PLS-SEM while (Lim, Ling, Ibbs, Raphael, & Ofori, 2011) adopted PLS-SEM for Empirical Analysis of the Determinants of Organizational Flexibility in the Construction Business and (Aibinu, Ling, & Ofori, 2011) used PLS-SEM for modelling organizational justice and cooperative behaviour in the construction project claims process.

4.0   RESULTS AND DISCUSSIONS

4.1   Respondent Demographics

Data collection was carried out in two regions of Malaysia i.e. southern and central part of Malaysia amongst the client, consultant and contractors. A total of 400 questionnaire sets were distributed as 200 in southern part and 200 in central regions. As result 128 completed questionnaire set with return rate of 64% percentage from southern regions and 106 set with 53% return rate from central region were received back. The respondents involved in survey were engaged in handling various types of construction project for many years. The demographic are summarized in table 2.

Table 2. Demographics of respondents

	Southern		Central	
	Frequency	%	Frequency	%
Type of Organization				
Client	21	16.4	18	17.0
Consultant	27	21.1	52	49.0
Contractor	80	62.5	36	34.0
Size of Projects Handling				
Small Projects	31	24.3	11	10.4
Large Project	97	73.7	95	89.6
Working Experience				
Less than 5 years	24	18.8	7	6.6
6 – 10 years	52	40.6	20	18.9
More than 10 Years	52	40.6	79	74.5

Table 2 shows that majority of respondent had experience of handling large projects and had experience more than 10 years which showed that the respondents were competent enough and capable to participate in the survey.

4.2   PLS Path Modelling

The statistical software application Smart PLS 2.0 (Ringle, Wende, & Will, 2005) was used to compute the PLS path model. Analysis was carried out in two stages to calculate PLS model criteria including (i) assessment of construct validity and (ii) assessment of path Model.

2.1.1   Assessment of Construct Validity

Construct validity was assess to measure of the internal consistency. Composite reliability scores (CR), Cronbach's alpha and average variance extracted (AVE) tests were used to determine the construct validity of measured constructs. The results of construct validity are shown in table 3.

Table 3 .Construct validity

Construct	Southern Region			Central Region		
	AVE	CR	Alpha	AVE	CR	Alpha
Machinery	0.686	0.897	0.848	0.602	0.851	0.760
Manpower	0.533	0.870	0.823	0.514	0.862	0.814
Material	0.568	0.838	0.740	0.537	0.772	0.772
Money	0.647	0.916	0.892	0.507	0.860	0.806

According to (Fornell & Larcker, 1981) as cited by (Aibinu & Al-Lawati, 2010; Akter, Ambra, & Ray, 2011) AVE for each construct should be higher than 0.5. This means that at least 50% of measurement variance is captured by the latent variables. The reliability test depicts the degree of internal consistency. The most commonly used reliability coefficient is CR and Cronbach's alpha. Reliability can be used to check how well a construct is measured by its assigned indicators. CR value 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., 2011). 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 (Akter et al., 2011; Wong & Cheung, 2005; Yang & Ou, 2008). Hence, it can be summarized that for satisfactory construct validity the cut-off values for AVE, CR and Cronbach Alpha are 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 in both cases of southern region and central region analysis. Thus, the constructs are considered satisfactory with the evidence of adequate reliability, convergent validity.

2.1.1 Assessment of Path Model

Path model can be assessed with path co-efficient and explained variance on the endogenous latent variables. Figure 2 shows the results of path model. Figure 2 (a) shows the path model results for southern region while figure 2(b) shows the path model results for central region. Figure 2(a) shows that material resource have highest path co-efficient with value of 0.452 showing the material are highly significant resource affecting construction cost in southern part. Second most significant factor was money (finance) resource. From figure 2(b) it is perceived that in central regions are material resource is most significant resource affecting construction cost with path co-efficient with value of 0.419 and second ranked significant resource was money. The results are similar in southern and central part which show that material resource is most critical resource in Malaysia.
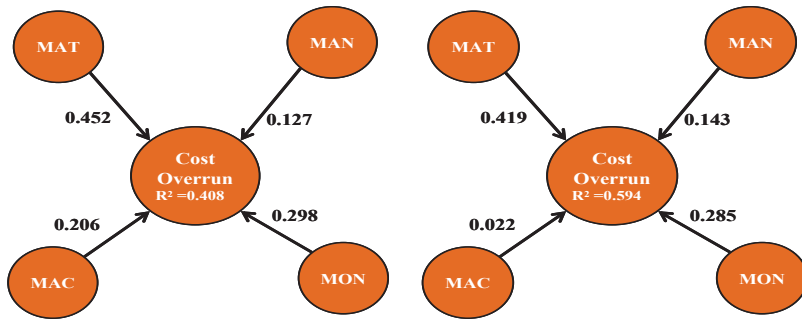
Figure 1. Path model results

Figure 2. (a) Path model results for Southern Regions

Figure 2. (b) Path model results for Central Regions

Further, R² of the endogenous latent variable is used assess the explained variance. According to (Cohen, 1988), R² 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(a), it is perceived that R² of the endogenous latent variable (cost overrun) in southern region is 0.408 which shows that 40% of variance can be explained by endogenous i.e. cost overrun. One the other hand, figure 2(b) shows that R² of the endogenous latent variable (cost overrun) in central part is 0.594 which shows that 59% of variance can be explained by endogenous i.e. cost overrun. R² of both models is higher than the cut-off value and hence the model lies at a very satisfactory level. Also, from the figure 2 (a) and 2(b) it can be seen that resources have high impact on construction cost in central region as compared to southern region. We conducted a global fit measure (GoF) for PLS path modelling, which is defined as the geometric mean of the average communality and average R2 (for endogenous constructs). GoF value was estimated for global validation of PLS model with following equation (1) as adopted by (Akter *et al.*, 2011).

$$GoF = \sqrt{AVE \times R^2} \tag{1}$$
$$GoF_{(South)} = \sqrt{0.687 \times 0.408} = 0.529$$
$$GoF_{(central)} = \sqrt{0.54 \times 0.594} = 0.566$$

In this study, GoF value obtained was 0.529 for the complete (main effects) model for southern region and 0.566 for central regions, which exceeds the cut-off value in comparison of baseline obtained using guidelines suggested by [29] as 0.1 as GoFsmall, 0.25 as GoFmedium and 0.36 as GoFlarge. This shows that the model has substantial explaining power.

5.0   SUMMARY AND CONCLUSION

This study assessed the causal relationships to assess the effect of construction resource on cost overrun in central and southern regions of peninsular Malaysia. The findings of study can be summarized as:

- ➢ Data collection was carried out questionnaire survey amongst southern and central regions of peninsular Malaysia
- ➢ A total of 128 and 106 completed questionnaire were received from southern and central region respectively
- ➢ Data was analyzed with SmartPLS v.20
- ➢ Path model analysis showed that material resource are most significant resources causing cost overrun and is common problem in both southern and central regions
- ➢ Approximately 40% variation in cost overrun is resulted from resources in southern part while 59% of variation is caused because of resources in central region of Malaysia.
- ➢ GoF values showed that the model has enough explaining power to generalize the model for explaining cost overrun problems.

6.0   ACKNOWLEDGEMENT

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