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Examining factors affecting budget overrun of construction projects undertaken through management procurement method using PLS-SEM approach

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Abstract

This study focused on examining the effect of various factors on budget overrun in construction projects undertaken with management procurement method in Malaysia. It adopted a quantitative method for data collection using structured questionnaire survey amongst contractors, consultant and clients. A total of 118 samples were collected against 200 questionnaires that had been distributed nationwide. Gathered data was analyzed with an advanced multivariate method of structural equation modeling with PLS approach using SmartPLS software. The major finding shows all the constructs in model contribute significantly to budget overrun with R² value of 0.623. Also, the developed model has substantial explain power with Gof value of 0.62. This indicates that the model is able to be generalized in representing the budget overrun factors occurring in construction projects nationwide. By identifying these factors, it will help the construction community to take measures in improving the cost performance of the projects.

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causal relationships between the factors of budget overrun to assess their effect on cost overrun. This model is drawn in SmartPLS v2.0 software for simulation process. Input data to this model was done through comma delimited (*.csv) file format which contains the respondent’s input from the questionnaire survey. Appendix B describes PLS-model together with input variables in SmartPLS software where exogenous and endogenous latent variables are presented with blue coloured oval shapes and indicators representing manifest/known variable represented by yellow coloured rectangles in the path diagram. The figure shows that 35 of the manifest/measured variables of budget overrun factors are categorized in 7 exogenous latent variables/groups which are assigned as (i) CSM, (ii) DDF, (iii) FIN, (iv) ICT, (v) LAB, (vi) MMF and (vii) PMCA; while there is only one endogenous latent variable i.e. budget overrun, where,

- CSM represents contractor’s site management group which consists of 8 manifest variables (CSM01: poor site management and supervision, CSM02: incompetent subcontractors, CSM03: schedule delay, CSM04: inadequate planning and scheduling, CSM05: lack of experience, CSM06: inaccurate time and cost estimates, CSM07: mistakes during construction, and CSM08: inadequate monitoring and control).
- DDF represents design and documentation group which consists of 5 manifest variables (DDF01: frequent design changes, DDF02: mistakes and errors in design, DDF03: incomplete design at the time of tender, DDF04: poor design and delays in design, and DDF05: delay in preparation and approval of drawings).
- FIN represent Financial Management group which consists of 6 manifest variables (FIN01: cash flow and financial difficulties faced by contractors, FIN02: poor financial control on site, FIN03: financial difficulties of owner, FIN04: delay in progress payment by owner, FIN05: delay payment to supplier/subcontractor, and FIN06: contractual claims, such as, extension of time with cost claims).
- ICT represents information and communication group which consists of 3 manifest variables (ICT01: lack of coordination between parties, ICT02: slow information flow between parties, and ICT03: lack of communication between parties).
- LAB represents labour group which consists of 5 manifest variables (LAB01: labour productivity, LAB02: shortage of site workers, LAB03: shortage of technical personnel (skilled labour), LAB04: high cost of labour, and LAB05: severe overtime).
- MMF represents material and machinery group which consists of 4 manifest variables (MMF01: fluctuation of prices of materials, MMF02: shortages of materials, MMF03: late delivery of materials and equipment, and MMF04: equipment availability and failure).
- PMCA represents project management and contract administration group which consists of 4 manifest variables (PMCA01: poor project management, PMCA02: change in the scope of the project, PMCA03: delays in decision making, and PMCA04: inaccurate quantity take-off).

3.2. Evaluation of Outer Model

Evaluation of the outer model (measurement model) is to examine the reliability and validity of the constructs of the model (Hulland, 1999). It determines how well the indicators (specific questions) load on the theoretically defined constructs. This can be carried out in two stages as:

A) Convergent validity of the measures (Hulland, 1999).

B) Discriminant validity of the research instruments (Gefen, Straub, & Boudreau, 2000)

3.2.1. Convergent validity of constructs

Convergent validity is the measure of the internal consistency. It is estimated to ensure that the items assumed to measure each latent variable measures them and not measuring another latent variable
3.4. Model Representation

Model representation was aimed to assess the power of developed model to generalize for construction industry of Malaysia in representing the effect of budget overrun factors. This was tested by assessing Goodness of Fit (GoF) index value. GoF is defined as the geometric mean of the average communality and average $R^2$ for all endogenous constructs (Akter, Ambra, & Ray, 2011). It can be used to determine the overall prediction power of the large complex model by accounting for the performance of both measurement and structural parameters. According to (Wynne W. Chin, 2010) “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”.

4. Performance of Model

Performance of the developed model was assessed with two-step process as (i) outer model evaluation to examine the reliability and validity of the construct, and (ii) inner 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).

4.1. Convergent Validity of Outer Model

Convergent validity assessment and modification of the PLS developed model was carried out simultaneously by adopting iterative process. A total of 2 iterations were run for achieving the optimum values of parameters as presented in appendix C. Table in appendix C shows that 5 constructs have achieved satisfactory convergent validity (factor loading, CR, Alpha, AVE values are all above the cut off values) in iteration 1. However, the other 2 constructs (FIN and MMF) managed to achieve cut-off values for factor loading, CR and Alpha but AVE value is lower that required value of 0.5. Hence, these 2 constructs were modified by omission of the manifest that has the lowest factor loading value from each of the construct. The 2nd iteration has improved the convergent validity for all the constructs after omitting FIN04 and MMF01 manifest variables.

4.2. Discriminant Validity of Outer Model

Discriminant validity of construct was evaluated by assessing correlation matrix generated from simulation of the model. The diagonals values of the matrix are replaced with the value of square root of the AVE. For adequate discriminant validity, the diagonal values should be greater than the off-diagonal values in the corresponding rows and columns (Hulland, 1999). The results for this study are presented in appendix D which shows that the diagonal values are above the other values. This testifies that the outer model has achieved the discriminant validity needed for further analysis.

4.3. Inner Model Assessment

The results of the inner model assessment are presented in appendix E. The $R^2$ value of endogenous latent variable (budget overrun) of the inner model is 0.623 which indicates that the all the exogenous latent variables (constructs) are significantly contributing effect to the endogenous latent variable. For path co-efficient, it was found that CSM group has the highest co-efficient value of 0.425. This means the CSM is the most significant group in causing budget overrun.


Appendix B. PLS-Model Development and Data Input Screenshot from SmartPLS Software
Appendix D. Discriminant Validity Results

<table>
<thead>
<tr>
<th></th>
<th>CSM</th>
<th>DDF</th>
<th>FIN</th>
<th>ICT</th>
<th>LAB</th>
<th>MME</th>
<th>PMCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSM</td>
<td>0.783*</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>DDF</td>
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<td>0.822*</td>
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<tr>
<td>FIN</td>
<td>0.638</td>
<td>0.536</td>
<td>0.710*</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>ICT</td>
<td>0.755</td>
<td>0.524</td>
<td>0.455</td>
<td>0.908*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAB</td>
<td>0.603</td>
<td>0.464</td>
<td>0.627</td>
<td>0.501</td>
<td>0.714*</td>
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<tr>
<td>MME</td>
<td>0.525</td>
<td>0.426</td>
<td>0.517</td>
<td>0.497</td>
<td>0.533</td>
<td>0.795*</td>
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<tr>
<td>PMCA</td>
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<td>0.725</td>
<td>0.523</td>
<td>0.703</td>
<td>0.545</td>
<td>0.467</td>
<td>0.737*</td>
</tr>
</tbody>
</table>

Note: * square root of the AVE

Appendix E. Results of Inner Model

![Diagram of Inner Model](image-url)