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## INVESTIGATION ON THE CAUSES OF VARIATION ORDERS IN THE CONSTRUCTION OF BUILDING PROJECT – A STUDY IN THE STATE OF SELANGOR, MALAYSIA

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### Abstract

This paper investigates the most significant causes contribute to the variation orders in the construction of building projects in the States of Selangor Malaysia. Data was collected from questionnaires survey which is based on the literature reviews and also provisions in the ‘Persatuan Akitek Malaysia’ (PAM 1998) standard form of building contract that are associated with the variation orders. The data were analyzed by using mean score method and rank to formulate the findings. The result from questionnaires survey revealed three most significant causes variation orders which are: ‘Change of plan by owner’, ‘Substitution of materials by owner’, and ‘Changes of design by consultant’. The finding concludes that owner is the major source of the variation orders in construction of building projects and suggested that owner should have adequate planning and recourses before initiating a project in order to avoid variation order during the construction stage.

**Keywords:** Standard form of building contract, Owner, PAM 1998, Variation Orders.

### Introduction

The Malaysian construction industry plays an instrumental role in the country development. The construction industry is a strong growth push to the nation economy because of its excessive linkage with other sector such as manufacturing and electrical, unfortunately the industry did not prepare for the related project management problem. One of the major problems facing the construction project is issue of variation order by during the construction phase. (Ibb,2001). These changes are inevitable in any construction project. The problem could become worse when there is a series of variations, when the programme is affected and when the time spent by the contractor’s head office staff becomes totally disproportionate to the value of the contract.

There are many reasons why variations occur. They may be due to extra work caused by subsurface conditions, errors in contract documents, additional quantities of works or materials, reduction of work, or lack of proper communication between the parties. Needs of the owner may change in the course of design or construction, market conditions may impose changes to the parameters of the project, and technological developments may alter the design and the choice of the engineer. The architects review of the design may bring about changes to improve or optimize the design and hence the operation of the project. All these factors and many others necessitate changes that are costly and generally unwelcomed by all parties.

### Definition

There is no single definition of what constitutes a variation. Usually, any standard form of building contract will contain a definition of a variation in terms of specific actions and activities. Persatuan Akitek Malaysia standard form of contract (PAM 98) in clause 11, define variation as an alteration or modification of the design, quality or quantity of the works as shown in the contract drawings and described by or referred to in the contract bills.

## Classification of Variation Orders

Variation orders can be classified in many different ways depending on the basis and the purpose of classifications. In this review, the most common classifications are presented. Changes in a construction project can be classified based on the cause that forced them. Burati et al. (1992) stated that changes in constructions are caused by design, construction, fabrication, transportation or operability. Design changes, were found to constitute 52.5% of total changes, fall mainly into three categories:

- Design changes caused by improvement through design process (DCI). Examples are changes resulting from design reviews, technological advances or constructability reviews.
- Design changes originated by Owner (DCO). Examples are scope changes.
- Design changes initiated by Engineer or Consultant familiar with the process (DCP). Examples are additions of pumps, valve or instrumentation that affect the operation of the facility.

## Nature of Variation Order

The nature of a variation order can be determined by referring to both the reasons for their occurrence and subsequent effects. Arain and Pheng (2005) distinguished two types of variation orders namely: beneficial and detrimental variation order which is shown in Figure 1.

### Beneficial variation orders

A beneficial variation order is one issued to improve the quality standard, reduce cost, schedule, or degree of difficulty in a project. A beneficial variation order eliminates unnecessary costs from a project as a result; it optimizes the client's benefits against the resource input by eliminating unnecessary costs.

### Detrimental variation orders

A detrimental variation order is one that negatively impacts the client's value or project performance (Arain and Pheng, (2005). For example a client who is experiencing financial problems may require the substitution of quality standard expensive materials to sub-standard cheap materials.

## Causes of Variation Order

Variations order arises for a variety of reasons. Some are foreseeable, others are not. Some result from a genuine change of circumstances and others from the design team's own inadequacies. Arain and Pheng (2006) identified four origin agents of variation orders. These included client, consultant, contractor and other changes. This is shown in Figure 2.

### Client related changes

Client related changes the causes of variations that were initiated by the owner. In some cases, the owner directly initiates variations or the variations are required because the owner fails to fulfil certain requirements for carrying out the project. The changes initiate by client are:

- Change of scope
- Change of project schedule
- Owner's financial problems
- Inadequate project objectives
- Replacement of materials

- Change in specifications

#### Consultant related changes

In some cases, the consultant directly initiates variations or the variations are required because the consultant fails to fulfil certain requirements for carrying out the project. The changes initiate by consultant are as follows:

- Change in design
- Errors and omissions in design
- Conflicts between contract documents
- Inadequate scope of work for contractor
- Design complexity
- Inadequate shop drawing details
- Lack of consultant's knowledge of available materials and equipment

#### Contractor related changes

In some cases, the contractor may suggest variations to the project or the variations may be required because the contractor fails to fulfil certain requirements for carrying out the project. The contractor related changes are as follows:

- Lack of contractor's involvement in design
- Unavailability of equipment
- Unavailability of skills manpower
- Contractor's financial difficulties
- Defective workmanship

#### Other changes

Other changes refer to the causes of variations that were not directly related to the participants. These changes are as follows:

- Change in government regulations
- Weather changes
- Change in economic conditions
- Unforeseen problems

#### **Provision of Variation Order According to The “Persatuan Akitik Malaysia” (PAM1998) Condition of Contract.**

Generally construction contracts require the contractor to notify the owner within a specific period of time of the occurrence event for which the contractor will seek additional reimbursement in the form of a variation order. Many contracts have stipulate the various methods by which the contractor will be reimbursed either by pre established unit prices, negotiated lump sum, or by time and material. Every contract has a specific procedure covering the process of handling change to the work. Similarly, there is also a provision of variation orders stated in the PAM 1998 general conditions of contract in clause 11, and also clause 2. Figure 3 summarizes the clauses related to the variation order as stated in the PAM 1998 standard for of building contract.

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Rajoo (1998) summarizes the related clauses as adapted from PAM 98 form of contract, Clause 11.0 which is briefly as explain as followings:

- Clause 11: Generally explain on the definition of the term of variation order, instruction regarding the provisional sum, valuation of variations, rules of variation and also valuation of variation order claim by the contractor.
- Clause 11.1 (i) - 11.1(vi): Explain in details the definition of variations which intend a tangible change in the works and also excludes any default and/or breach of contract by the from contractor being a variation.
- Clause 11.2: Stated the power of architect to issue instruction in regards with the variation orders. This provision is only applicable as when the employer gives direct instruction to contractor. It's also stated that the instruction must be in written and also signed by the architect.
- Clause 11.3: This clause required the architect to issue instruction for the expenditure of any prime cost and provisional sum included in the contract bill.
- Clause 11.4: Provides for the measurement and valuations of variations.
- Clause 11.5: Explain the rules for valuation. It set out several method of valuation based on types of the variations order.
- Clause 11.6: This clause deals with the issue of direct loss and /or expense arising from variations.
- Clause 11.7: Stated the requirement for the contractor to submit necessary detail for the claim made by the contractor.

### **Research Objectives**

The objectives of this study are to: (i) to carry out an in-depth investigation on the factors that contribute to the causes of variation orders in the construction building project in the States of Selangor (ii) to relate these academic studies for an effective solution to minimize the mentioned variation orders

### **Research Methodology**

This research was carried out in two stages. In the first stage the causes of the excusable and compensable delays were established through existing literature on variation orders .These causes of variation orders were used as the basis of questionnaire. In the second stage, a questionnaire set was developed. The questionnaire was divided into two sections. Section A is to obtain demographic information of the respondent. Section B was focused on the identified causes of variation orders based on the existing literature on variation orders .The respondent were ask to rank the significant causes of variation orders based on their working experience in the construction industry for completed project between year 2000 to 2005. The author adopted five point scale of 1-5 for ranking purposes. To facilitate the analysis the following numerical values were assigned to the respondents ranking: 'Extremely significant' – 5, 'Very significant' – 4, 'Moderately significant' - 3, 'Slightly significant' – 2, 'Not significant' – 1.

The questionnaires were sent to one hundred engineering consultant namely architect, civil/ structural engineering consultant, mechanical and electrical consultant and also quantity surveyors within the States of Selangor. Random sample was chosen from a listing approximately 600 consultant companies from data registration selected based on information obtained from Persatuan Akitek Malaysia (PAM), Board of Engineers Malaysia (BEM), and Public Work Department (PWD) and also through personal networking and contacts.

## Method of Data Analysis

The data was analysed by using mean score method that had been adopted from Assaf et al (1995) In this method weighting scale of 1 to 5 was adopted in the view of its simplicity and suitability for evaluating each factor, significant based on the respondent own judgment and working experience in the construction industry. This five point scale is used to calculate the mean score for each factor and element, which is then used to determine the relative ranking of each factor by assigning ranking to mean score, with low mean score assigned low ranks and high scores allocated high ranks. The mean score (MS) for each factor is computed by using the following formula:

Where  $s$  is the score given to each factor by respondents and ranges from 1 to 5 in which "1" is not significant and "5" is extremely significant;  $f_i$  is frequency of responses to each rating (1 - 5), for each factor; and  $N$  is the total number of responses concerning that factor.

## Analysis of Survey Result

One hundred questionnaire were distributed to the engineering consultant namely architect, civil/ structural engineering consultant, mechanical and electrical consultant and also quantity surveyors within the States of Selangor. The total organisation that has returned the survey questionnaire form was 46.

This gives a response rate of 43 %. Table 2 shows the respondent response rate.

Respondent experience has to be taken into account in analyzing the data as this information is the root source of the reliability of the data. The profile of the respondents' working experience in the construction industry is illustrated in Figure

From the data collected it was found that 65 % of the respondent has been working for more than 10 years and has been experience working for the project cost more than 10 million ringgit. Therefore the information regarding the causes of variation orders is reasonably reliable and falls within the scope of this research.

Respondents profession were also been taken into account in analysing the data. From the survey results 60 % of the respondents are architect followed by the Civil and Structural Engineers (18%), Quantity Surveyors (13%) and Mechanical and Electrical Engineers (9%). Figure 4 shows the distribution of the respondent various job functions.

Respondents experience, contract value and also job function factor have to be taken Table 3 tabulates the mean scores and ranks the most significant factors of variation orders

## Discussion of the Results

It was observed that it was observed that most of the causes of variation orders were initiated by the client in which 65% of the respondents ranked that change of plan by client are the most significant factor. This followed by substitution of materials by the client in which 47 % of the respondent ranked this factor as the second most significant factor of the causes of variation order. Meanwhile changed in design by the consultant were ranked the third most significant causes of variation orders in which 30% of the respondent have rank this factor as a significant causes for the variation orders. The following is a brief discussion of the causes of variation orders as deduced from Table 3.

### **Change of Plan by Owner**

The changes of plan by owner were ranked the most significant causes of variation in which 65 % of the respondents ranked this as the most significant factor. This changes result may be because of insufficient planning and also lack of involvement of client during design stage. The example of these changes is the increase of building area, additional fittings, changes in building facade design and also omission of part of the works.

### **Substitution of Materials by the Owner**

Substitution of materials by the owner was rank the second most significant causes of variation in which 65 % of the respondents ranked this as the most significant factor. The Substitution of materials by the owner could be due to inability of client to make decision on the selection the appropriate type of materials to be used for construction. The common type of substitution of materials by the owner is change of wall and flooring finishes, ironmongery, and also painting works. This type of changes normally results in additional time and claims by the contractor the respondents ranked this as the most significant factor. The Substitution of materials by the owner could be due to inability of client to make decision on the selection the appropriate type of materials to be used for construction. The common type of substitution of materials by the owner is change of wall and flooring finishes, ironmongery, and also painting works. This type of changes normally result in additional time and claim by the contractor.

The respondents ranked this as the most significant factor. The Substitution of materials by the owner could be due to inability of client to make decision on the selection the appropriate type of materials to be used for construction. The common type of substitution of materials by the owner is change of wall and flooring finishes, ironmongery, and also painting works. This type of changes normally result in additional time and claim by the contractor.

### **Change in Design by Consultant**

This factor was ranked the third most significant factor causing variation to the contract by the respondents with 30% has rank this factor as the most significant factor. This may happen when the design is reviewed by the consultant who may have different opinion on the design or also it happen due to postponement or suspension of work which normally occurs during the piling stage or laying of the utility services such as sewerage and drainage works in which consulting engineers are required to redesign the foundation to suit the existing ground conditions.

### **Errors and Omissions in Design**

This factor was also ranked low by the respondent in which 37 % of the respondents have ranked this factor as the non - significant factor.

### **Owner's Financial Problems**

This factor was also ranked low by the respondent in which 30% of the respondents have ranked this factor as the non - significant factor.

### **Weather Conditions**

This factor was rank lowest by the respondents in which 93% of the respondent has ranked it a non-significant factor. These factor of delays were ranked low by all the respondent as shown Table 3. This is may be because of the moderate weather in Malaysia thus the factor has no great effect on the construction project.



## Conclusion

Based on the results carried out within the scope stated, several conclusions can be drawn, which may help to improve the time performance and provide a better understanding on the actual causes of variation orders in construction of building projects. Based on the survey results it was noted that the client related changes is the most significant causes of the variation orders in the construction of building projects in the State of Selangor. Generally this finding is similar to several finding from developing countries which have confirm that most of the project abroad face similar problems as the changes initiated by the client as the most significant causes of the variation orders in the construction of building projects. As such by foreseeing the common problems identified in this paper the author hope that the construction participant can avoid this problem.

## Acknowledgements

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## References

- Arain and Low Sui Pheng. ( 2005). The potential effects of variation order on institutional buildings projects. *Facilities*. 23(11/12). 496-510.
- Arain and Low Sui Pheng. (2006). The potential effects of variation orders on institutional building buildings projects. *The Emerald Research*. FAC 23, 11/12, 496-510.
- Assaf S.A., Al-Khalil and Al-Hazmi. M.1995. causes of delay in large building construction projects. *Journal of Management in Engineering ASCE* 112: 45-50.
- Burati, Wong and Thomas (1992). Causes of Quality Deviation in Design and Construction, *Journal of Construction Engineering and Management*, 118 (1).
- Chan and Yong. (1995). *Variations in Construction Contracts*. CR Lim Construction Lawyers, Melbourne
- Hanna, A.S, Calmic, P. E, Peterson, R.(2002). Quantitative Definition of Projects Impacted by Change Orders, *Journal of Construction Engineering and Management*, 128(1), 57-64
- Ibbs, C.W. (2001). Quantitative Impacts of Project Change: Special Issues, *Journal of Construction Engineering and Management*, 123 (3). 308-311
- Sundra Rajoo. (1998). *The Malaysia Standard Form of Building Contract (The PAM 1998 Form)* Ed. ke-2. Malaysia: Malayan Law Journal Sdn Bhd.

## Appendix

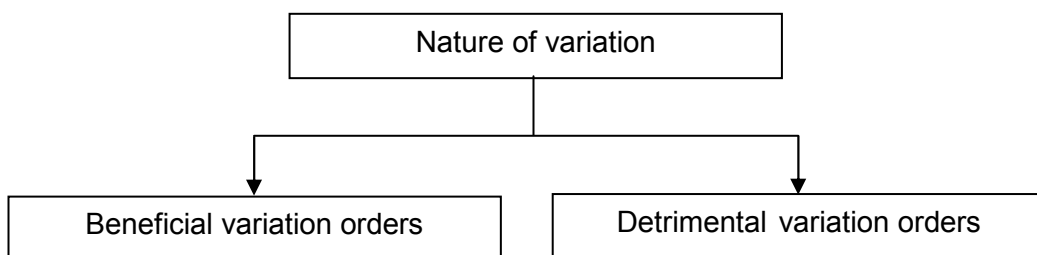


Figure 1: Nature of variation order

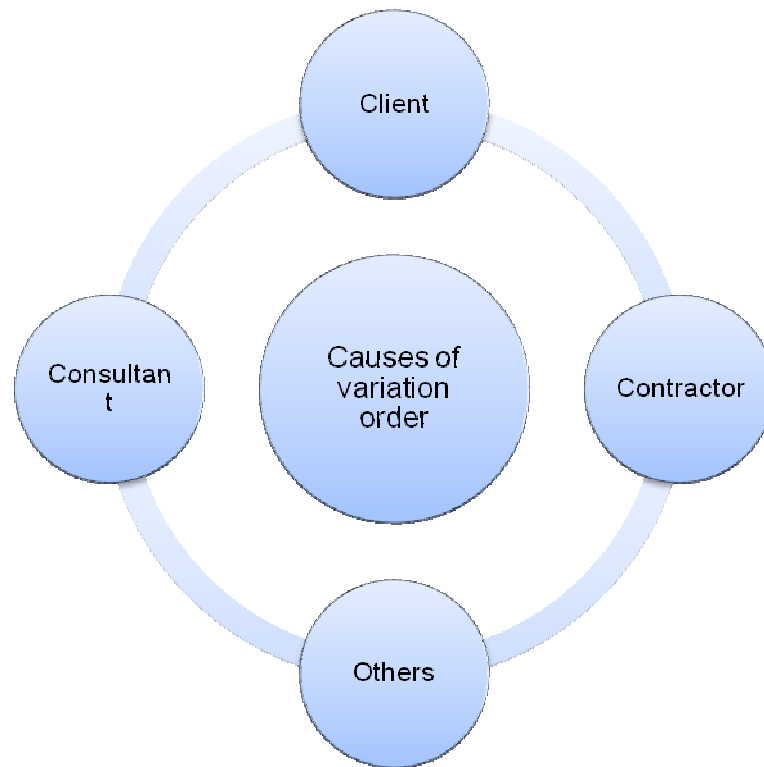


Figure 2: Causes of variation order

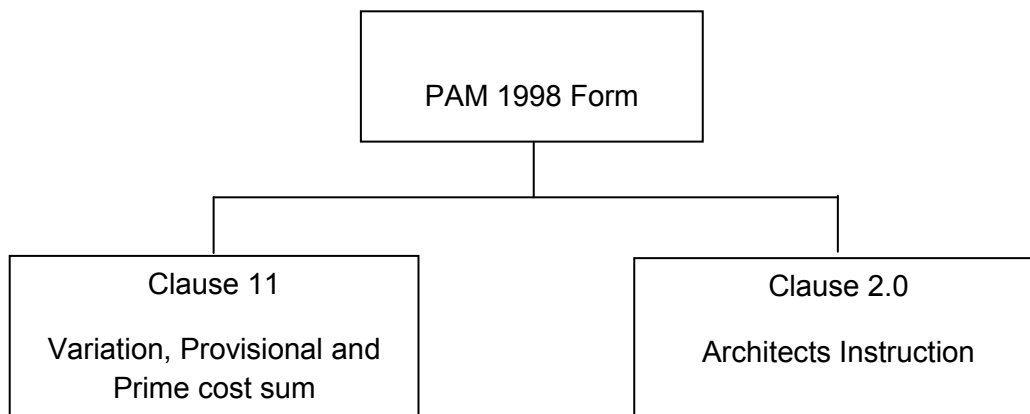


Figure 3: Summary of the clauses related to the variation order as stated in the PAM 1998 standard for of building contract

Table 2: Respondent response rate.

Number of questionnaires sent	100
Number of questionnaires replied	43
Response rate (%)	43%



$$MS = \frac{\sum (f \times s)}{N} \quad \text{----- (1)}$$

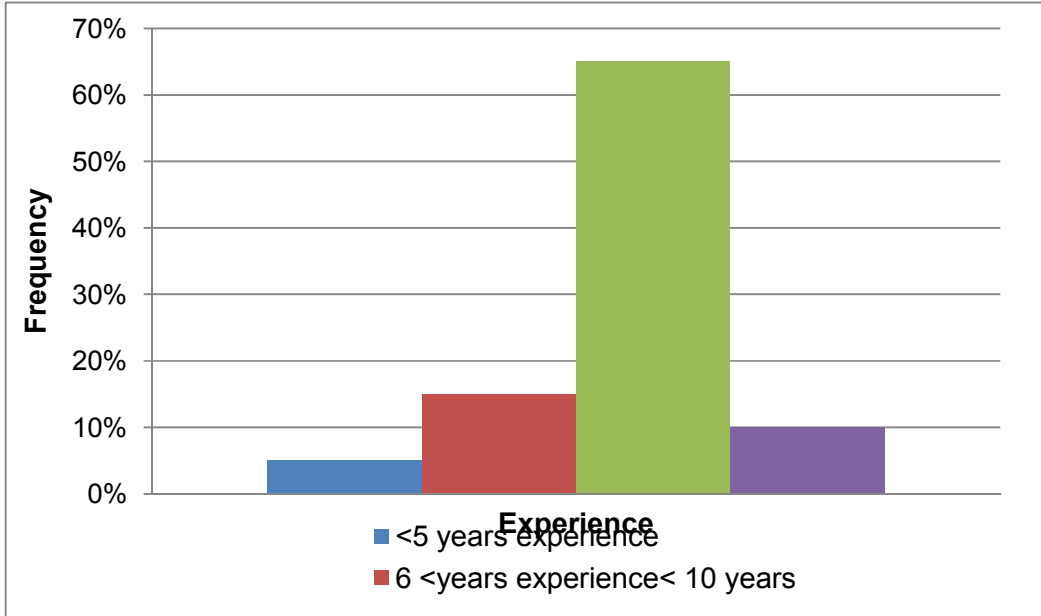


Figure 3: Respondents working experience

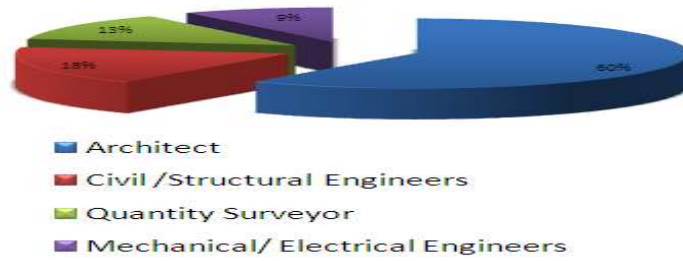


Figure 4: Respondents profession

Table 3: Result for significance causes of variation order

Variation order factors	Number of respondent scoring (N= 43)					Mean	Rank
	5	4	3	2	1		
Change of plan by owner	28 (65%)	9 (20.9%)	6 (13.9%)			4.41	1
Substitution of materials	20 (47%)	14 (32.5%)	9 (20.9)			4.24	2
Change in design by consultant	13 (30%)	19 (44%)	10 (24%)			4.14	3
Errors and omissions in design	3 (5%)	9 (20%)	9 (20%)	7 (16.2%)	16 (37.2%)	2.16	4
The scope of work for the contractor is not well defined		3 (7%)	13 (30%)	12 (27%)	15 (35%)	2.06	5
Conflict between contract documents			12 (28%)	15 (35%)	18 (42%)	1.93	6
Differing site conditions	5 (12%)	6 (14%)	10 (23%)	12 (28%)	19 (44%)	1.88	7
Change of plan by client			8 (18.6%)	20 (46.5%)	15 (34.8%)	1.82	8
The lack of coordination between contractor and consultant				35 (82%)	8 (19%)	1.80	9
The contractor's financial difficulties				30 (70%)	13 (30%)	1.70	10
Owner's financial problems				30 (69.7%)	13 (30%)	1.69	11
Workmanship or material not meeting the specifications			5 (12%)	20 (47%)	18 (42%)	1.68	12
Contractor's desire to improve his financial situation				18 (42%)	25 (58%)	1.41	13
The required labour skills are not available				8 (19%)	35 (82%)	1.25	14
The required equipment and tools are not available				5 (12%)	38 (88%)	1.1	15
New government regulations				3 (6%)	40 (93%)	0.99	16
Weather conditions				6 (14%)	37 (86%)	0.8	17