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THE POTENTIAL EFFECTS OF VARIATION ORDERS IN CONSTRUCTION PROJECTS

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Abstract
The main purpose of this paper is to provide a comprehensive analysis of the potential effects of variation orders in construction projects in Malaysia, which will be helpful for professionals in the construction industry to assess and take proactive measures to mitigate the adverse impacts of variation. This paper objective was achieved by carrying out a questionnaire survey to collect information on the potential effects of variations. Analysis was done to the 33 responses that were collected from professionals that are working with the developers in Penang. Form the results, the most frequent effects of variations were increase in project cost, additional payment for contractor, increase in overhead expenses, completion schedule delay and rework and demolition. Then, recommendations were suggested based on the findings of this paper and previous researches. This paper only touches on the developers' view of the effects of variation orders in construction projects. Further researchers on effects of variation can be from the consultants' and contractor's view on the effects of variation instead.
Keywords
Potential effects, variation, orders, developers' view, construction projects, Malaysia.

1. INTRODUCTION

The construction industry in Malaysia has been on a robust mode. With the announcement of the Ninth Malaysia Plan in 2006, the construction industry is said to be the most beneficial sector as there a lot of projects being rolled out by the government and to be carried out by the next five years. With implementation of the Ninth Malaysia Plan (9MP) projects, the construction sector is said to be increasing significantly by 4.4% in the first half of 2007 (January –June:-1.2 %). The construction sector is envisaged to register a growth of 5.2 % (2006: -0.5%) for the whole year. The implementation of projects such as the Iskandar Development Region projects, the Klang Valley flood mitigation project and the RM 1.4bil Asia Petroleum Hub in Tanjung Bin, Johor are expected to provide further thrust to the construction sector in the country. Projects such as Iskandr Development Region and the Asia Petroleum Hub do have an effect on the country's economy. Therefore, it is at the utmost importance to ensure these projects are being implemented successfully without any major problems while minimizing the delays and cost overruns that will badly affect the project outcome. However, it is also important for other types of construction projects such as residential or commercial, big scale of small scale projects to be implemented without the problems of delays and cost overruns as it will have negative effects on the clients which will pass on the problems to the property buyers as well. Variations or change orders have been branden as a negative effect to construction projects. This is due to the various adverse effects that it has on a construction project. Variation continues to pose a serious treat to parties that are involved in construction. On one hand, variation or change orders provide an essential mechanism for (1) satisfying owner's construction needs throughout the project delivery process, and (2) responding effectively to errors and/or omissions in design, construction methods, and contact documents (Moselhi *et al.,* 2005). This is particularly true in fast-track construction, where construction starts prior to design completion and the project scope of work is adjusted along the way. On the other hand, variations or change orders frequently pose serious problems to owners and contractors, leading to cost overruns and costly disputes (Moselhi *et al.,* 2005). This could be attributed, at least in part, to inadequate understanding and lack of appreciation of the impact of these changes to project performance (Moselhi *et al.,* 2005). This paper is attempting to answer the following objectives:

1. Identify and study the potential effects of variations in construction projects in Malaysia.
2. Provide solutions and recommendations to reduce the adverse effects of variation orders for construction projects in Malaysia.

2. PROBLEM STATEMENT

Variations are inevitable in any construction projects (Ibbs *et al.,* 2001). Reasons such as changes to the market conditions may change the clients' needs and requirements on projects whether during design or construction. New technologies also affect and change how projects are developed. Both reasons above may have an effect on the architectural designs which in turn may result in changes to the engineering design which bring about variations. Blunders in design by engineers and during construction will also force changes to projects. The contract price is also affected when there are variations in drawings and contract document. The possibilities of contractual disputes also increase due to variations (O'Brien, 1998). Basically, variations will cause problems for everyone that is involved in the project. Variations can be originated from numerous factors pertinent to the construction projects (Arain and Low, 2005). The construction process can be influenced by highly changing variables and unpredictable factors that could result fro different sources. These sources include the performance of construction parties, availability of resources, environmental conditions, involvement of other parties and contractual relations. As a consequence of these sources, the construction of projects may face variations that could cause delay in the project completion time (Clough and Sears, 1994). Kumaraswamy *et al.,* (1998) studied claims for extension of tie due to excusable delays in Hong Kong's civil engineering projects. From their findings, inclement weather was mainly the cause for 15-20 percent in delays. While, a total of 50% of the projects surveyed were delayed because of variations. As Malaysia is I the tropical zone, construction projects in Malaysia would also be experience similar delays. Kaming *et al.,* (1997) studied the factors influencing construction time and cost over runs for high-rise projects in Indonesia where 31 project managers, working in high-rise buildings were surveyed. Kaming *et al.,* (1997) pointed out that the major factors influencing cost over run were material cost increase due to inflation, inaccurate material estimating and the degree of project complexity. As for the time over run, it was caused by a few important factors such as design changes, poor labour productivity, inadequate planning, and resource shortages. Although, the impact of variations varies from one project to another but it is generally accepted that variation can affect construction projects with unpalatable consequence in time and cost (Ibbs *et al.,* 1998; Ibbs *et al.,* 2001). There are two types of variations, which are beneficial variations and detrimental variations. Beneficial variations are those variations that bring good to the projects such as help to improve quality, reduce cost, schedule, or degree of difficulty in the project. Detrimental variations are those that reduce owner value or have a negative impact on a project (Ibbs et al., 2001). The project team should be able to take advantage of beneficial variations when the opportunity arises. The need to make changes on a construction project may necessitate changes due to various factors. The variations can be minimized when the problem is studied collectively as early as possible, since the problems can be beneficial variations can be made (Arain and Low, 2005). Variations are common in all types of construction projects (Fisk, 1997; O'Brien, 1998; Ibbs *et al.,* 2001). Variations in construction projects can cause substantial adjustment to the contract duration, total direct cause and indirect cost, or both (Ibbs, 1998). The variations and variation orders can be deleterious in any project, if not considered collectively by all participants (Arain and Low, 2005). Fro the outset, project controls should take advantage of lessons learned from past similar projects (Ibbs *et al.,* 2001). Project management teams must have the ability to recognize potential effects of variations in order to minimize their adverse impacts to the project (Arain and Low, 2005). Therefore, it is at the utmost importance that potential effects of variations are identified.

3. VARIATIONS AND VARIATION ORDERS

Any deviation from an agreed well-defined scope and schedule can be called as variations. Stated in a different way, this is a change in any modification to the contractual guidance provided to the contractor by the owner or owner's representative. This includes changes to plans, specifications or any other contract documents. A variation order is the formal document that is used to modify the original contractual agreement and becomes part of project's documents (Fisk, 1997; O'Brien, 1998). Furthermore, a variation order is written order issued to the contractor after execution of the contract by the owner, which authorize a change in the work or an adjustment in the contract sum or even the contract time (Clough and Sears, 1994). Naoum (1994) felt the common drivers for variations are lack of timely and effective communication and increasing project complexity. An intensive amount of research exists for the general subject of variations and much of the discussion is qualitative or sweeping, categorical ways because of difficulties in obtaining accurate and consistent quantitative

data (lbbs, 1997). Ibbs (1997) also citied that previous researchers such as: Diekmann and Nelson (1985); Jacobs and Richter (1978); and Clark (1990) had classified variations according to causes and type of change. They suggested that the major causes of variations falls into 3 broad categories:

1. Design errors and omissions (65 percent);
2. Design changes (30 percent)
3. Unforeseen conditions (5 percent).

According to Fish (1997), there are two basic types of variations: directed and constructive changes, which are discussed in detail below:

I. Directed Changes

Directed changes are easy to identify. A directed change occurs when the client directs the contractor to perform works that are different from the specified in the contract or an addition to the original scope of work. A directed change can also be deductive in nature, that is, it may reduce the scope of work called for in the contract. Disagreements tend to center on questions of financial compensation and the effect of the change on the construction schedule for directed changes (Fisk, 1997).

II. Constructive Changes

A constructive change is an informal act authorizing or directing a modification to the contract caused by an act or failure to act. In contrast to the mutually recognized need for change, certain acts or failure to act by the client that increases the contractor's cost and/or time of performance may also be considered grounds for a variation order. This is termed as a constructive change and must be claimed in writing by the contractor within the time specified in the contract documents in order to be considered.

4. EVALUATING THE NEED OF VARAITION ORDERS

The usage of a variation order is to effect a change in the contract. As mentioned previously, such changes should always be in writing to avoid unnecessary disputes among the owners and the contractors. The following are some of the purpose served by variation orders (Fisk, 1997):

1. To change contract plans or to specify the method and amount of payment and changes in contract time there from.
2. To change contract specifications, including changes in payment and contract time that may result from such changes.
3. To effect agreements concerning the order of the work, including any payment or changes in contract that may result.
4. For administrative purpose, to establish the method of extra work payment and funds for work already stipulates in the contract.
5. For administrative purposes, to authorize an increase in extra work funds necessary to complete previously authorized change.
6. To cover adjustments to contract unit prices for overruns and under runs, when required by the specifications.
7. To effect cost reduction incentive proposal (value engineering proposals).
8. To effect payment after settlement of claims.

A variation order is used in most instances when a written agreement by both parties to the contract is either necessary or desirable. Such use further serves the purpose of notifying a contractor of its right to file a protest if it fails to execute a variation order (Fisk, 1997).

In Malaysia, the construction industry uses three form of contract documents; P.W.D FORM 203A, PAM 1998 and CIDB 2000. The P.W.D FORM 203A is being used in public sector projects while PAM 1998 and CIDB 2000 are being used in private sector projects. The clause 15 of the P.W.D FORM 203A states "The Contractor shall have be deemed to have inspected and examined the Site and its surroundings and to have satisfies himself before submitting his tenders as to the nature of the ground and subsoil, the form and nature of the Site, the extent and nature of the work, materials and goods necessary for the completion of the Works, the means of communication with and access to the Site, the accommodations he may require and in general to have obtained for himself all necessary information as to risks contingencies and all circumstances influencing and affecting his tender. Any information or document given or forwarded by the Government to the Contractor shall not relieve the Contractor of his obligations under the provisions of this clause. The Government gives no warranty for the information or document either as to the accuracy or sufficiency or as to how the same should be interpreted or otherwise howsoever and the Contractor shall make use of and interpret the same entirely on his own risk". As for the other two forms of contract documents, The PAM 1998 and CIDB 2000, both do not have this type of clause in the respective form of contract.

5. POTENTIAL EFFECTS OF VARIATION ORDERS

Research on the effects of variation orders were done by many researchers (Clough and Sears, 1994; Thomas and Napolitan, 1995; Fisk, 1997; Ibbs, 1997; Veenendaal, 1998; Reichard and Norwood, 2001; Arain and Low, 2005; Moselhi *et al.,* 2005). Changes that occuir during construction will affect any project (Reichard and Norwood, 2001). Lewis (1991) indicated that change orders have its ripple effects as a contractor does not work in a vacuum; rather must properly allocate his limited resources within projects and between actual and potential projects. Thus, whenever a change occurs, a contractor must make adjustments to work under the contract and reallocate time, material and labour resources. Arain and Low (2005), identified 16 potential effects of variation orders on institutional building from the research they did in Singapore. The effects that were determined are discussed further below.

5.1 PROGRESS IS AFFECTED BUT WITHOUT ANY DELAY

Project progress and quality may be affected by variations (Assaf *et al.,* 1995). During construction, time is of the essence. However, according to Arain and Low (2005), only major variations during the project may affect the project completion time because the contractor would usually try to accommodate the variations by utilizing the free floats in the construction schedules. Therefore, variations will affect the project progress but without any delay in the project completion date.

5.2 INCREASES IN PROJECT COST

During the construction phase, the most common effect of variations is the increase in project cost (CII, 1990). The increase in the project cost is caused by any major additions or modifications to the design (Clough and Sears, 1994; Assaf *et al.,* 1995). Therefore, contingency sum will usually be allocated in every construction project to cater for any possible variations in the project, while keeping the overall project cost intact.

5.3 HIRING NEW PROFESSIONALS

CII (1995), variations often occur in complex technologies projects, this may be caused by something was overlooked by the architect/engineer during the design stage. Complex technologies projects need specialists to get the job done (Fisk, 1997). Depending on the nature, occasionally, new professional need to be hired or the entire project team is replaced to execute the variations (Arain and Low, 2005). Hiring the new professionals takes time and thus affecting the project progress.

5.4 INCREASES IN OVERHEAD EXPENSE

Variations need to go through a few stages of processing procedures as mentioned earlier and require to be evaluated before they can even be implemented (O'Brien, 1998). Because of this, the overhead expense for all the parties involved will increase as there is a lot of work and paperwork need to be done. However, normally these overhead charges are provided for from the contingency fund allocated for the construction projects (Arain and Low, 2005).

5.5 DELAYS IN PAYMENT

Delay in payment occurred frequently due to variations in construction project (CII, 1990). CII (1995), variations may hinder the project progress as mentioned before thus leading to delays in the construction works done which will eventually affecting payments to the contractors. If the main contractor does not have enough funds to pay the subcontractors then this may cause severe problem to both the main contractor and the subcontractor as well. This can happen because some main contractor depends on the payment from client to pay the subcontractors.

5.6 QUALITY DEGRADATION

Frequent variations may affect the quality of work adversely (Fisk, 1997). This maybe because of frequent variations may cause the contractors to compensate their losses by cutting corners.

5.7 PRODUCTIVITY DEGRADATION

Variation orders often associated with interruption, delays and modification of work do have a negative impact on labor productivity. Hester *et al.,* (1991), feels that the productivity of workers was expected to be seriously affected in cases where they were required to work overtime for prolonged periods to compensate for schedule delays. Thomas and Napolitan (1995), concluded from their research that variations normally led to disruptions and these disruptions' were reasonable for labor productivity degradation and on average, there is a 30 percent loss of efficiency when changes are being performed. Thomas and Napolitan (1995), also feel that the most significant types of disruptions were due to the shortage of materials and lack of information as well as the work out of sequence and these disruptions result in daily loss of efficiency in the range of 25 to 50 percent. Reichard and Norwood (2001), found out from their research that if variations reach 10 to 15 percent of the originally planned labor hours, productivity of the remaining unchanged work will decreased due to the extra labor hours spent on executing the variations. According to Moselhi *et al.,* (2005), the few factors that were found to influence the impact of variation orders on labor productivity are as follows:

i. Variation orders' intensity (numbers and frequency)
ii. Variation orders' timing (during which phase of the project)
iii. Variation orders' work type (architectural, civil, electrical or mechanical)
iv. Type of impact
v. On-site management

5.8 PROCUREMENT DELAY

Revised procurement request may be required when variations occur during the construction phase of the project (O'Brien, 1998). Arain and Low (2005), feels that variations that require new materials and specialized equipment are the cause for frequent procurement delays. Procurement delays were common effects of variations related to new resources for construction projects (Hester *et al.,* 1991).

5.9 REWORK AND DEMOLITION

Rework and demolition are common and frequent due to variations in construction projects (Clough and Sears, 1994). The main effects when variations occur during the construction phase are rework and delays in project completion. Time and resources are wasted when rework and demolition occurs. However, it do depends on the timing of the variations as if variations occur during the design phase, no rework or demolition is required on construction sites as things are not constructed yet (Arain and Low, 2005)

5.10 LOGISTICS DELAYS

Most of the researchers (Hester *et al.,* 1991; Fisk, 1997; Arain and Low, 2005) believe that variations that require new materials and equipments may result in logistics delay in construction projects. This happen because time is needed for the ordering/booking and transportation of the materials and equipments on site.

5.11 DAMAGE TO FIRM'S REPUTATION

Fisk, (1997) and Kumaraswamy *et al.,* (1998) felt variations are referred to as a major source of construction claims and disputes among the parties involved. The firm's reputation may be affected adversely by the claims and disputes which can lead to insolvency if the case is severe. The possibility of professional disputes also increases if variations occur. It is unquestionable that variations present many problems to all the parties which are involved in the construction project (Arain and Low, 2005).

5.12 POOR SAFETY CONDITIONS

The safety conditions in construction projects may be affected by variations (O'Brien, 1998; Arain *et al.,* 2004). Arain and Low (2005), this may be caused by the additional safety measures that may be required during construction because of variations.

5.13 POOR PROFESSIONAL RELATIONS

As mentioned before, construction changes are a major source of construction dispute (Fisk, 1997). Eventually, variations may affect professional relations, leading to disputes.

5.14 DISPUTES AMONG PROFESSIONALS

As discussed above, major construction changes usually leads to disputes. Therefore, clear procedures must be presented in the contract and fair allocation of risks among parties involved can help in resolving disputes through negotiation rather than litigation (CII, 1986; Arain *et al.,* 2004). Hanna (2007) suggested some strategies that both the client/developer and the contractor can undertake whenever there are variations which have cumulative impacts to the project to reduce disputes.

5.15 ADDITIONAL PAYMENTS FOR CONTRACTOR

Arain and Low (2005), observed that one of the most common potential effects of variations in construction projects is additional payments for the contractor. This is because variations are normally considered to be a common source of additional works for the contractor (O'Brien, 1998). Due to additional payments, the contractor looks forward to variations in the construction project. Some contractors even look for ways and excuses to initiate variations during construction just to obtain additional payments and increase their profit.

5.16 COMPLETION SCHEDULE DELAY

Completion schedule delay is a frequent result of variations in construction projects (Ibbs, 1997b). The magnitude of the schedule being delayed due to variations was reported to be 9 percent of the original schedule for 71 fixed price projects studied (Zeitoun and Oberlender, 1993). Kumaraswamy *et al.,* (1998), studied claims for extension of time dye to excusable delays in Hong Kong's civil engineering projects. Their findings suggested that half of the projects surveyed were delayed because of variations. Delays in projects occur mainly because not only time is needed in evaluating and imposing variations but also due to the fact that variations have cumulative impacts on construction projects as reported by Reichard and Norwood (2001). All the potential effects of variations are also correlated, resulting in the completion schedule delays in construction projects.

6. RESEARCH METHODOLOGY

The data collection is based on the questionnaires sent to a wide spectrum of property developers which mainly operate in the northern state of Malaysia, Penang. The questionnaires are devised as a means for the systematic gathering of field data. A total number of 33 sets of questionnaires were received from the targeted respondents and found suitable for data analysis after checking through all the questionnaires collected. The data were entered into the SPSS software variable spreadsheets and then were sorted out by the SPSS Data Editor. Generally there are 3 sections of the questionnaire; these 3 sections are close-ended questions. Therefore, all of the questions were analyzed by using the SPSS version 14 software.

The highlighted respondent's background variables include the respondent's gender, age, working experience, designation and working duration in the company. The summary of the responses for Respondents Background is shown in (Table 1) for a detailed respondent's background.

Table 1: Respondent's Background

Question	Respondent's Background	Category	Frequency (N=33)	Percentage (%)
A (1)	Gender	Male	26	78.8
		Female	7	21.2
		Total:	33	100.0
A (2)	Age	≤ 30 years old	5	15.2
		31-35 years old	11	33.3
		36 – 40 years old	9	27.3
		41 – 45 years old	5	15.2
		≥ 46 years old	3	9.1
		Total:	33	100.0
A (3)	Working Experience	≤ 5 years	4	12.1
		6 – 10 years	10	30.3
		11 – 15 years old	14	42.4
		16 – 20 years old	2	6.1
		≥ 20 years	3	9.1
		Total:	33	100.0
A (4)	Designation	Project Manager	26	78.8
		Engineer	3	9.1
		Architect	0	0.0
		Quantity Surveyor	4	12.1
		Total:	33	100.0
A (5)	Working Duration in Company	≤ 5 years	17	51.5
		6 – 10 years	10	30.3
		11 – 15 years old	6	18.2
		16 – 20 years old	0	0.0
		≥ 20 years	0	0.0
		Total:	33	100.0

7. ANALYSIS AND DISCUSSION

The objective of this section is to gather more information on the projects that were handled by the respondents during their working experience in the construction industry. There are two (2) segments in this section; the first is the numbers of projects with net addition or net omission or no variations and the second is the type of projects that have been handled by the respondents during their whole working experience in the construction industry.

7.1 NUMBER OF PROJECTS WITH NET ADDITION, NET OMISSION OR NO VARIATIONS

A study on 15 different projects in Kuwait by Duaij *et al.,* (2007) showed that no construction projects were completed without variation orders; only one (1) project was completed with net omission in variation. As shown in Table 2 below, most of the projects handled by the respondents have variations as about 95% of the respondents have never handled projects that have no variations. This result is in line with most of the previous researchers' statements that no projects can be completed without variations as discussed in the previous chapters. Furthermore, all of the projects that the respondents handled have variation: net addition. This shows that variations usually cause the construction cost to inflate due to the additional works that are required to be carried out by the contractor. From the data, more than 60% of the projects handled by the respondents resulted in net omissions.

Table 2: Number of Projects with Net Addition, Net Omission and No Variation

Project	Number of Projects					Total
	0	1-5	6-10	11-15	> 15	
Net Addition	0	15	7	3	8	33
Net Omission	13	13	4	0	3	33
No Variation	31	2	0	0	0	33

7.2 TYPES OF PROJECTS THAT THE RESPONDENTS HAVE TAKEN PART IN

As shown in Table 3 below, the type of project that all of the respondents have taken part in are housing schemes. This is because of the targeted respondents are attached to property developers. From the data, more than half of the thirty three (33) respondents have not taken part in infrastructure projects, while 45.5% of the respondents have not taken part in industrial buildings and 18.2% of the respondents have not taken part in high rise buildings and commercial development respectively. The number of projects for all types for all types of projects that most of the respondents have taken part in is from 1 to 5 projects; Industrial Building 39.4%, High rise/Condominiums 66.7%, Commercial developments 60.6%, Housing Schemes 54.6% and Infrastructure Projects 24.2%.

Table 3: The type of projects that the respondents have taken part in

Type of Project:	Number of Projects					Total
	0	1-5	6-10	11-15	> 15	
Industrial Buildings	15	13	3	0	2	33
High rise/ Condominium	6	22	4	0	1	33
Commercial Development	6	20	5	0	2	33
Housing Scheme	0	18	7	2	6	33
Infrastructure	19	8	3	0	3	33

7.3 THE POTENTIAL EFFECTS OF VARIATION ORDERS

A total of 33 professionals responded to this research. The main section of the questionnaire listed 16 effects of variation orders to construction projects in Malaysia. However, due to the time and resource constraint, the whole of Malaysia was not covered but customized to focus on the developers the northern region particularly in Penang. Below are the effects of variation issues that all the respondents were requested to rate according to their professional judgments and experience in the construction industry:

1. Progress is affected but without any delay;
2. Increase in project cost;
3. Hiring of new professional;
4. Increase in overhead expenses;
5. Delay in payment;
6. Quality degradation;
7. Productivity degradation;
8. Rework and demolition;
9. Procurement delay;
10. Logistic delay;
11. Damage to firm's demolition;
12. Poor safety conditions;
13. Poor professional relations;
14. Additional payment for contractor;
15. Dispute among professional;
16. Completion schedule delay

7.3.1 EFFECTS OF VARIATIONS – DESCRIPTIVE ANALYSIS

All of the above potential effects of variation orders were measured based on a 5-point Likert scale. Analyses and rankings were done to the list of potential effects of variation orders according to their responses. Table 4 highlights the results of the descriptive analyses in terms of means and standard deviations.

7.3.2 EFFECTS OF VARIATIONS – CORRELATIONS

As mentioned before, the main objective of computing the correlation of the sixteen (16) potential effects of variation orders is to determine whether these effects were correlated. From the results obtained, some of these effects can be considered to be quite correlated as the highest correlation coefficient is 0.669 for delay in payment and poor professional relations. The effects of variations with the top five (5) are shown in Figure 1 below. Therefore, further categorization of the 16 effects of variation orders into a small number of factors or groups are deemed not necessary.

Table 4: Means and Standard Deviation of Potential Effects of Variation Orders

No.	Potential Effects	Mean	Std Dev
1	Progress is affected but without any delay	2.88	1.053
2	Increase in project cost	4.00	0.791
3	Hiring of new professional;	3.09	0.914
4	Increase in overhead expenses;	3.61	1.088
5	Delay in payment;	3.24	0.936
6	Quality degradation;	2.76	0.867
7	Productivity degradation;	2.85	0.972
8	Rework and demolition;	3.21	0.927
9	Procurement delay;	3.58	0.936
10	Logistic delay;	3.33	1.021
11	Damage to firm's demolition;	2.88	0.992
12	Poor safety conditions;	2.42	0.708
13	Poor professional relations;	2.58	0.867
14	Additional payment for contractor;	3.97	0.883
15	Dispute among professional;	3.18	0.882
16	Completion schedule delay.	3.64	0.859

7.3.2.1 HIRING OF NEW PROFESSIONAL – INCREASE IN OVERHEAD EXPENSES

There was a moderate correlation between hiring of new professional and increase in overhead expenses; this was because both these effects are resulted by similar causes, for example; changes to the design or complexity of the designs which require new or change of technology, and etc. In some of the cases, the project teams may have to employ more people for the project to tackle the project. This will result in an increase in overhead expense. However, in most construction projects, developers will tend to look at the past experience and the performance of contractors other than the tender pricing before awarding the contract to the contractor to ensure that the contractor are more than competent to handle and complete the project. Only clients who only award jobs solely by pricing may have this problem if the contractor is not experienced or competent enough to complete the project. Hence, both of these effects can be considered to be least important effects of variation orders (Arain and Low, 2005).

		Hiring of new professional	Increase in overhead expenses
Hiring of new professional	Pearson Correlation	1	0.603**
	Sig. (2 tailed)	.	0
Increase in overhead expenses	Pearson Correlation	0.603**	1
	Sig. (2 tailed)	0	.
		Quality degradation	Productivity degradation
Quality degradation	Pearson Correlation	1	0.622**
	Sig. (2 tailed)	.	0
Productivity degradation	Pearson Correlation	0.622**	1
	Sig. (2 tailed)	0	.
		Delay in payment	Poor professional relations
Delay in payment	Pearson Correlation	1	0.669**
	Sig. (2 tailed)	.	0
Poor professional relations	Pearson Correlation	0.669**	1
	Sig. (2 tailed)	0	.
		Poor safety conditions	Poor professional relations
Poor safety conditions	Pearson Correlation	1	0.556**
	Sig. (2 tailed)	.	0.01
Poor professional relations	Pearson Correlation	0.556**	1
	Sig. (2 tailed)	0.01	.
		Rework and demolition	Additional payment to contractor
Rework and demolition	Pearson Correlation	1	0.551**
	Sig. (2 tailed)	.	0.01
Additional payment to contractor	Pearson Correlation	0.551**	1
	Sig. (2 tailed)	0.01	.

Note: N = 33. Correlation is significant at the 0.05 level (2 tailed)

Figure 1: Effects of variation orders that are quite strongly correlated

7.3.2.2 QUALITY DEGRADATION – PRODUCTIVITY DEGRADATION

Quality degradation and productivity degradation can be considered to be relatively correlated. However, Arain and Low (2005) identified that quality degradation and productivity degradation were strongly correlated in their research which was carried out in Singapore in 2005. Arain and Low (2005), believes that this shows that both of these are frequent effects of similar causes of variation, for instance, vague design details, design discrepancies and change in design and specification and etc. Both of these effects are correlated because in some cases, quality degradation may cause the loss of productivity, similarly, the productivity degradation may result in low quality. However, the professionals manage to achieve the quality required. Therefore, the developers considered both these effects as quite strongly correlated (Arain and Low, 2005).

7.3.2.3 DELAY IN PAYMENT – POOR PROFESSIONAL RELATIONS

Delay in payment and poor professional relations were relatively correlated. This shows that both of these effects have similar causes such as design discrepancies, design complex\city, change in design and specification and project team's lack of required data to name a few. Delay in payment occurs when variations occurs as the Quantity Surveyor will need more time to evaluate it. If the job scope is completely new and is not included in the schedule of rates, then the quantity surveyor and contractor may take a longer time agree on the rates. Hence, delay in payment may occur which may in turn bring about poor professional relations among the project team. Likewise, frequent changes in design by the Owner or Architect may result in poor professional relation among the project team which may eventually causes delay in payment. Hence, both these effect were moderately correlated.

7.3.2.4 POOR SAFETY CONDITION – POOR PROFESSIONAL RELATIONS

Poor safety conditions and poor professional relations are relatively correlated. Arain and Low also identified that poor safety conditions and poor professional relations were correlated in their research which was carried out in Singapore in 2005. Arain and Low (2005), believes that this was because these effect were caused by similar causes of variations such as, professionals' lack of judgment and experience, lack of coordination, design complexity and professionals lack of required data and etc. Several reworks, demolitions and delays in schedule because of the changes in specifications, changes in design, design improvements and etc. however, the professionals were able to achieve the level of safety required during construction. Hence, both these effects were considered as least important (Arain and Low, 2005).

7.3.2.5 REWORK AND DEMOLITION – ADDITION PAYMENT FOR CONTRACTOR

Rework and demolition and additional payment to contractor are relatively correlated. Change in design and specification, design discrepancies, lack of contractor's involvement during the design phase and lack of coordination were some examples of the similar causes of variations. Because of not well defined client's requirements and specifications during the initial phase, changes in specifications or changes in design will result in frequent reworks and demolitions. Additional payment to contractor occurs due to the rework and demolition done by the contractor as there is a high possibility that new materials and equipments have to be procured for the rework and demolition. Thus, both these effect were alleged to have a correlation relatively.

Table 5: Ranking of effects of variation orders for construction projects

No.	Potential Effects	Mean Rank	Rank
2	Increase in project cost	11.82	1
14	Additional payment for contractor;	11.68	2
4	Increase in overhead expenses;	10.56	3
16	Completion schedule delay.	10.55	4
9	Rework and demolition;	10.05	5
10	Logistic delay;	9.09	6
5	Delay in payment;	8.94	7
15	Dispute among professional;	8.41	8
8	Procurement delay;	8.32	9
3	Hiring of new professional;	8.09	10
1	Progress is affected but without any delay	7.32	11
11	Damage to firm's demolition;	7.09	12
7	Productivity degradation;	6.92	13
6	Quality degradation;	6.39	14
13	Poor professional relations;	5.67	15
12	Poor safety conditions;	5.11	16
*Chi-Square = 115.61			

7.4 NONPARAMETRIC FRIEDMAN TEST

The Nonparametric Friedman Test was performed to rank the effects of variations. The effects of variations were also categorized into the most frequent ones as shown in Table 5. The result of the research questionnaire showed that increase in project cost, additional payment to contractor, and increase in overhead expenses, completion schedule delay and rework and demolition were considered to be the top five (5) most frequent effects of variations for construction projects.

7.4.1. 1st – INCREASE IN PROJECT COST

The most frequent effect of variation orders was the increase in project cost according to the findings from this survey. This is widely expected as frequent variations to projects will cause the project cost to escalate. Arain and Low (2004), also found out that increase in project cost is the most frequent effect of variation orders as frequent variation orders may effect the project's total direct and indirect costs. It is very well known that any major addition or revision in the design may eventually increase the project cost. Even though, there is always a contingency sum in all construction projects which is usually allocated to cater for any possible variations in the project, while maintaining the overall project cost. Frequent major variations may result in cost overrun in the contingency sum (Arain and Low, 2004)

7.4.2 2nd – ADDITIONAL PAYMENT FOR CONTRACTOR

In this paper, additional payment for contractor is considered to be second most frequent effect of variation orders. This is because variations normally signify additional works which can be considered as common source of additional payment for contractors. Most contractors would consider variations in the project as another way to achieve their targeted project margins. This situation was frequently faced by clients in projects where the terms fro valuing the variations were not considered at the inception of the project (Arain and Low, 2004).

7.4.3 3rd – INCREASE IN OVERHEAD EXPENSES

From the findings, the third most frequent effect of variation orders was the increase in overhead expenses. Arain and Low (2004), believed this was because the process and implementation of variations in construction projects will increase the overhead expenses for all the concerned project team members. Normally these overhead charges are provided for from the contingency fund allocated for the construction project (Arain and Low, 2004).

7.4.4 4th – COMPLETION SCHEDULE DELAY

From the findings, the fourth most frequent effect of variation orders was the completion schedule delay. Arain and Low, (2004), believe that not only major variations may affect the project adversely but also minor variations depending on its timing of the occurrence of the variations which will lead to delays in the project completion. This is because the impact of a variation in design during the construction phase is be more severe than in the design phase as variations during the construction phase almost certainly in more rework and demolition.

7.4.5 5th – REWORK AND DEMOLITION

From the findings, rework and demolition were considered the fifth most frequent effect of variation orders by the respondents. This was because variations due to any addition or changes in design that occurred during the construction phase often result in rework and demolition on site. In addition to that, reworks and demolitions may affect the following construction activities, which may in turn delays in the project completion (Arain and Low, 2004). Therefore, the impact of a change in design during the construction phase is more serious than in the design phase simply because the designs are not built yet thus rework and demolition is not required.

8. CONCLUSIONS

The results of this study implies that top five most frequent effects of variations are increase in project cost, additional payment for the contractor, increase in overhead expenses, completion schedule delay and rework and demolition. The results obtained can be considered very relevant to the construction industry as whenever there are variations or additional works during the construction phase, it usually brings about extra work or demolition or rework to be carried out by the contractor which means more money for the contractor which in turn will result in project cost increase and may also affect the entire project's schedule. The recommendations made are based on the literature review, which includes the involvement of the contractor during the design phase, constant coordination and direct communication, proper management of variation orders, thorough design or design details and teamwork among all project team members to control variation orders. These recommended solutions may be helpful to reduce the adverse effects of variation orders. In addition the results of this study also implied that accurate and meticulous designs during the design stages by the consultants can reduce variations as it was mentioned in the previous chapter that the root causes for most variations occur during the design stages. The above is in line with suggestion by Kartam (1996) that conflicts will be minimized when a problem has been studied as early as possible. This study can be considered as very relevant as there are many major development projects that are currently underway in Malaysia. For example, in the northern region: The Northern Corridor Economic Region (NCER), The Penang Bridge widening, The Penang Times Square and etc. present-day issues that are relevant to the management of variation orders were discussed in this study. This study is about the comprehensive analyses of the developers' view of the effects of variations in

construction projects, with the assistance of this study, the professionals who are involved in the projects above can be more competent and effective in analyzing and managing variations. Thus, not only reducing the adverse effects of variations but also will be able to take advantage whenever beneficial variation arises during the project duration. Last but not least, bearing in mind that it is the fact the variations are present and very common in all types of construction projects no matter major projects or small projects, this is also can contribute to an effective management of variation orders as the in-depth analyses of the frequent effects of variations can be used by each and every professional in the construction industry to take proactive measures to reduce and control variation orders in all types of construction projects either major or small projects.

8. RECOMMENDATION

Recommendations are now suggested based on the results of this study, literature review and previous researchers.

1. The involvement of contractor's during the design phase would assist in clarifying the buildability of the designs by the design team at the early stage. Ultimately, this may help in eliminating variations which are caused by designs that are unable to be constructed due to site condition. Thus, reducing the adverse impact on the project.
2. Constant coordination and direct communication among the project team is the key to eliminate design discrepancies and errors as well as omissions in design. Pinto and Kharbanda (1995) suggested that good communication can lead to changes that have a positive effect on the project, as managers can learn valuable lesson from the conflict episode. With constant communication, it also provides thoroughly which may help in eliminating the variations that occurs because of conflicts in contract documents and discrepancies between the construction drawing and the Bills of Quantity.
3. Proper management of variation orders or project planning.
4. Variations can be minimized if the designs by the consultant are thorough and meticulously detailed.

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