

Causes and Effects of Variation Orders in the Construction of Terrace Housing Projects: A Case Study in the State of Selangor, Malaysia

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Abstract— This paper investigate the most significant causes and effects contribute to the variation orders in the construction of housing projects in the States of Selangor Malaysia. Data was collected based on the existing literature reviews and also contract documents from a total of 61 housing project located at nine district in the state of Selangor. The data were analysed and formulate the findings. The result from revealed four most significant causes variation orders which are: ‘Change of scope by owner’, ‘Substitution of materials by owner’, ‘Changes of specification by owner’ and ‘Changes of design by consultant’. Meanwhile the effects of the variation orders are time and cost overrun. 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— Variation Orders, Causes, Effects, Construction of housing projects

1. 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 [1]. 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 several studies been carried out worldwide on the causes and effect of the variation order.

The causes of variations and change orders have been surveyed in the literature review, a total of 18 causes were identified as discussed below.

- i. Change of scope: Change of plan or scope of the project is one of the most significant causes of variation in construction projects [2] and is usually the result of insufficient planning at the project definition stage, or because of lack of involvement of the owner in the design phase [3].
- ii. Owner’s financial problems: The owner’s financial problems can affect project progress and quality [4], [5]. This problem can lead to changes in work schedules and specifications, affecting the quality of the construction.
- iii. Inadequate project objectives: Inadequate project objectives can cause variation in construction projects [6], leading to the designer being restricted in designing a suitable design that may lead to variations at a later stage of the construction process.
- iv. Replacement of materials or procedures: The replacement of materials or procedures may lead to variations during the construction phase. The substitution of procedures includes variations in application methods [7].
- v. Impediment to prompt decision-making process: Prompt decision making is an important factor for project success [8], [9]. Failure to efficiently address decisions may result in delay, causing the need for the change order due to cost increments.

- vi. Obstinate nature of owner: A building project is the result of the combined efforts of the professionals involved, who have to work at the various interfaces of a project [10], [3]. If the owner is obstinate then this could cause major variations at the later stages of a project.
- vii. Change in specifications by the owner: Changes in specification are frequent in construction projects with inadequate project objectives [5]. Should the owner decide to change the specification of a design or requirement, then this may lead to variations in the construction phase.
- viii. Change in design by the consultant: A change in design for improvement by the consultant is a norm in contemporary professional practice [3]. Changes in design are frequent in projects where construction starts before the design is finalized [10]. Such changes can affect the project in various ways depending on the timing of the change.
- ix. Errors and omissions in design: Errors and omissions in design are a significant cause of project delays [3]. Dependent upon the timing of the errors in the project, delays and variations may occur
- x. Conflicts among contract documents: Conflict between contract documents can result in misinterpretation of the actual requirement of a project [12]. It is essential that contract documents are clear and precise.
- xi. Insufficient details in the contract documents may result in delays to the project completion or cause variations in cost.
- xii. Technology changes: Changes in technology could potentially result in variations on a project. Project planning should be flexible for accommodating new beneficial variations [13]. Emergence of new technology can affect construction methods and processes.
- xiii. Value engineering: Value engineering should ideally be carried out during the design phase [14]. Value engineering carried out during the construction phase can become an extremely costly exercise and may result in variations.
- xiv. Lack of coordination: A lack of coordination between parties may cause major variations with adverse impact on the project [3], leading to dissatisfaction of the owner,
- xv. Design complexity: Complex designs require unique skills and construction methods [3]. Complexity affects the flow of construction activities, whereas simpler and linear construction works are relatively easy to handle [11]. This would suggest that the more complex a construction design is, the more there is a chance that variations may occur.
- xvi. Inadequate working drawing details: To convey a complete concept of the project design, the working drawings must be clear and concise [15]. Insufficient working drawing details can result in misinterpretation of the actual requirements for the project [3], causing variations in the project.
- xvii. Poor knowledge of available materials and equipment: Knowledge of available materials and equipment is an important factor for developing a comprehensive design [15]. If the consultant has a poor knowledge of available materials or equipment that can be used in the construction process, variations are more likely to occur during the construction phase.
- xviii. Consultants' lack of required data: A lack of data can result in misinterpretation of the actual requirements of a project [16]. If there is not enough data available to the consultant then the design is based more on the consultants' own perception of the requirements of the project. Should these perceptions be wrong, then variations will occur.
- xix. Ambiguous design details: A clearer design tends to be comprehended more readily [5]. Ambiguity in design may cause misinterpretations and the need for rework leading to delay and increased cost.
- xx. Inadequate design: Inadequate design can be a frequent cause of variations in construction projects [11], [17].
- xxi. Change in specification by the consultant: Changes in specification are frequent in construction projects with inadequate

project objectives [5]. Changes in specification may result in variations to the project, leading to delay and increased overall cost.

Numerous researchers [4], [5], [11], [12], [18], [19] have highlighted the effects of variation order. The review of these studies resulted in identifying 9 effects as discussed below.

- i. **Delay in completion:** Variations often hinder the project progress, leading to delay in achieving the targeted milestones during construction [6], [20]. [21] reported that a variation may delay the projects by 9% of the original scheduled time duration for projects. [22] studying delay problems in construction projects of Hong Kong summarized that 50% of the projects surveyed were delayed because of variations.
- ii. **Increase in project cost:** is regarded as the most common effect of variations [18]. Any alteration or addition in the design during execution of the project may result in demolition or rework of any project component and eventually increase the project cost [4].
- iii. **Quality of projects:** Variations affect the quality of work adversely [11]. [17] reported that the quality of work is frequently affected by frequent variations because contractors have to compensate for the losses by cutting corners.
- iv. **Causes rework:** Variations in construction often result in rework and demolition [4], if the variations are occurred during the construction is underway or even completed [24]. This effect is to be expected due to variations during the construction phase while variations during the design phase do not require any rework or demolition on construction sites.
- v. **Logistics delays:** Variation may cause requirement of new or additional amount of material and equipments which results in logistics delays [11], [25]. [26],

mentioned that logistics delays are among the significant effects of variations in construction projects.

It is clear from the above literature and others that change orders are a major cause for cost and time overruns. However, the reasons for change orders differ from one country to another or even between one project and another. This research investigated the causes and effects of variation order in the construction of terrace housing projects in the state of Selangor.

2. Research Methodology

This research was carried out in two stages. In the first stage the causes and effect of the variation orders established through existing literature on variation orders. These causes and effect of variation orders were used as the basis of case studies. A qualitative case study approach has been applied where terrace houses projects have been followed. The data collection in the case studies consist of interview with the relevant persons involved in the construction of terrace houses project and also reviewing archived project documents. Both with the focus on identifying and analysing the causes and effect of variation order. The analysis was carried out by examining and taking notes of the monthly progress reports, design reports and project completion reports of these projects, exchange of correspondence between client, consultant and contractor and various meetings recorded in the form of minutes of meeting which indicated the causes and effects/impacts of variation on projects.

3. Case Study Finding: The construction project for the construction of 230 units of double storey terrace houses located in Petaling district, Selangor

This section presents a summary of causes and effect of variation order analysis based case studies of selected terrace housing projects in the district of Selangor with different capacities, which were executed by the private sector. Housing projects for

the case study is a project to build 230 units of double storey terrace houses located in the Petaling district of Selangor. The tender for this project is RM14,800,000.00 and time for completion is 18 months. There were 23 variation order was issued during the construction of these housing projects. Of this amount the client found 12 variation order

has been issued by the client, one of the architects, five by the Civil Engineer, two by the Mechanical and Electrical Engineers, two directives by the Quantity Surveyor and another directive issued by etc. other party. The breakdown of the distribution of the number of variation orders are as shown in Table 1.

Table 1. Breakdown of the number of variation order for terrace housing project in District of Petaling, Selangor

District	Total (VO)	Numbers of variation order						Total
		Client	Architect	Civil engineer	Mechanical engineer	Quantity surveyor	Others	
Petaling	23	12	1	5	2	2	1	23

From Table 1, it appears that the client has contributed a total of nine changes to working together with 52.17% of the work on this project. Among the reasons for the instructions issued by the client are as follows:

- i. Run the scope of the work by the client
- ii. Building materials conversion instructions by the client.
- iii. Instructions specification changes by the client.
- iv. Changes in building design by the consultant.

- v. Discrepancies occur between contract drawings and specifications.
- vi. lack of coordination
- vii. Low knowledge about construction materials
- viii. The consultant does not have sufficient design data

Where the client has instructed the contracting parties to increase the scope of work to change the type of home interior packaging, increasing the number of pipeline, adding the work of garden art, add the installation of automatic gates and also change the specification window frames. The breakdown of the causes of the variation order is shown in Table 2.

Table 2 Causes of variation order for terrace housing project in the district of Petaling, Selangor

Item	Causes of variation order	Client	Architect	Civil Engineer	Mechanical Engineer	Quantity surveyor	Others
1	Changes of scope by client	5					
2	Owner financial problem						
3	Inadequate project objective						

4	Replacement of material by client	4					
5	Impediment decision making process						
6	Obtinate nature of client						
7	Changes of specification by client	3					
8	Changes in design by consultant			3			
9	Error and ommisoin in design			1	1		
10	Conflict among the contract document					2	
11	Technology changes						1
12	Value Engineering						
13	Lack of coodination				1		
14	Design complexity						
15	Inadequate working drawing		1				
16	Poor knowledge of available material						
17	Consultant lack of data			1			
18	Ambiguous in design detail						
Total variation order		12	1	5	2	2	1

4. Effects of Varition Order

Quantity Surveyors of RM150,000.00 etc. party of RM100,000.00.

4.1 Delays in completion

The main effect of the changes is the delay in the completion of the housing project. The contractor had to apply for the duration of the contract is extended for 11.3 months. The extension was requested because some of the building materials had to be booked and took a long time to complete .This led to a new period for the completion of these projects is 30.6 months. This extended period of time resulting in an increase of 63% from the original time

4.2 Increase of project cost

While due to changes in the work, the project cost has increased by 14% from the original cost of which is equivalent to RM1,625,000.00. The client is found to have contributed to the project cost of RM925,000.00, the architect of RM60,000.00, the Civil Engineer of RM250,000.00, the Mechanical and Electrical Engineers of RM140,000.00, the

4.3 Logistic delay

A delay caused by the delay in the delivery of construction materials ordered. Logistics delays occur for the following items:

- i. Supply of new tiles.
- ii. Supply of toilet accessories.
- iii. Supply of iron reinforcement of varying sizes.
- iv. Running additional piling work.
- v. Carry out research work of the new land.

All of the work order and supply of new building materials such as the above requires the delivery time for about three months to the project. These delays contributed to an additional period of 16% of the original time.

4.4 Effect on the quality of work

Found that changes during the construction work has an impact on the quality of work in which as many as five of the 19 available

work orders issued by the architect is associated with instructions to repair defects of construction projects. This represents 21% of all work orders.

4.5 Demolition and re work

From the data obtained three orders issued by the architect relating to rebuild. This contributed to 15.7% of the work orders issued by the architect.

5 Conclusion and Recommendation

The 18 causes of changes that are identified through a literature review were used as a guide or foundation in gathering data to identify the causes of changes in working in strip Selangor, found that only 10 causes of employment changes are related to changes in work for the terrace houses in the district of Selangor. From the results of case studies there are five main causes that led to the introduction of changes in the housing projects in the state. The causes are as follows:

- i. Changes in the scope of the work by the client.
- ii. Exchange of construction materials by the client.
- iii. Specification changes by the client.
- iv. Changes in building design by the consultant.
- v. Discrepancies between the contract documents and drawings.

Among the main effects were identified and investigated in connection with variation order are as follows:

- i. Increase project time
- ii. The increase in the project cost.
- iii. delay logistics
- iv. The impact on the quality of the project
- v. Demolition and rebuilding

This research has the potential to be developed and extended since not a lot of research carried out in connection changes in working for terrace housing projects in the state. The proposal is expected to help improve the performance of housing projects in the state. Here are suggestions for improvement as appropriate:

- i. The client must provide in detail the requirements that are required and the documents related to construction projects to be built before the design stage of implementation. This is to prevent change in the scope of work by the client. This can be done by conducting a comprehensive feasibility study before a project is implemented.
- ii. The client must appoint an experienced project manager and technical staff who can advise management on the processes involved in the construction before any decision is taken.
- iii. Continuous coordination and direct communication between the project team as the client and consultants involved in the construction of which must be implemented to reduce discrepancies in the drawings, contract documents and errors in the design.

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