

# CAUSES AND IMPACTS OF VARIATION ORDERS IN INFRASTRUCTURE PROJECTS

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## 1. INTRODUCTION

Variations are inevitable in any construction project. Variation orders, which are contractual documents issued to accommodate the additional work in a contract, are generally due to root causes such as design errors, unexpected site conditions, and weather conditions, and intermediate causes such as bidding characteristics (Ibbs, 2001). At the pre-award phase of project management, an improved understanding of the factors that are associated with variation orders will be of value and also can serve as a basis for taking steps to reduce concomitant contractual aberrations such as time delay and cost overruns.

Needs of the owner may vary in the course of design or construction, market conditions may impose variations to the parameters of the project, and technological developments may alter the design and the choice of the engineer. The engineer's review of the design may bring about variations to improve or optimize the design and hence the operations of the project. Furthermore, errors and omissions in engineering or construction may force a variation (Hsieh, 2004; Wu, 2005). All these factors and many others necessitate variations that are costly and generally un-welcomed by all parties. This study will review and synthesize the existing research efforts in order to establish state of the art collective knowledge in relation to construction project variation causes and effects in Iran.

## 2. RESEARCH METHODOLOGY

It is clear that variation orders in construction projects are largely causing time/cost overrun, which required detailed analysis in a form of field survey. The questionnaire was one of the tools used to obtain feedback from the clients, consultants, and contractors for the causes, effects and suggested remedies to variations issued in construction projects implemented in Iran. A questionnaire was developed to assess the perceptions of clients, consultants, and contractors on the relative importance of causes and effects of variation orders in Iranian construction industry. The questionnaire included 28 statements, which were divided into two sections. The first part dealt with the causes and second part sought the opinion of the respondents on effects of the variations on construction projects, respectively.

A five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was adopted to capture the opinion of respondents on the causes and effects. The causes were categorized into four groups: client-related, consultant-related, contractor-related, and others.

## 3. DATA ANALYSIS

The questionnaire listed 28 causes and effects of variation orders for construction projects in Iran. Each respondent was asked to rate each issue according to his/her professional judgment. The list of causes and effects of variation orders were analyzed and ranked according to their responses.

Kometa et al. [11] used the relative importance index method to determine the relative importance of the various causes and effects of variations. The same method was adopted in this study. The relative importance index (RII) was calculated using the following equation. This equation was used to calculate the importance of factors according to survey responses:

$$RII = \frac{\sum W}{HS} \quad (1)$$

Where W=weighting of each factor by respondents ranging from 1 to 5; H=highest weight (i.e., 5 in this case); and S=sum of all respondents from strongly disagree to strongly agree.

### 3.1 Causes of variation orders

The data collected from the first part of the questionnaire was analyzed from the perspective of respondents. Each individual cause's RII perceived by all respondents was computed for overall analysis. The relative importance index, RII, was computed for each cause to identify the most significant causes. The causes were ranked based on RII values. From the ranking assigned to each cause of variation orders, the most important factors or causes of variations in Iranian construction industry were identified. Based on the ranking, the five most important causes of construction variation orders were: (1) Variation of plans or scope by owner (RII = 0.76); (2) Errors and omissions in design (RII = 0.73); (3) Replacement of materials/procedures (RII = 0.70); (4) Owner's financial problems (RII = 0.69) and (5) Unavailability of equipment (RII = 0.68). Most of the disputes that arise in the construction industry in Iran are between clients and contractors, most often, one party blaming the other.

Keywords: : Variation orders, Delay, Cost overrun, Variation orders causes and effects

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The variations of plan by owner were ranked the most significant causes of variation orders in which the respondents

ranked this as the most significant factor. This variations result may be because of insufficient planning and also lack of involvement of client during design stage.

### 3.2 Potential effects of variation orders

The data collected from the second part of the questionnaire was analyzed from the perspective of respondents. The calculation of RII and ranking were done as explained in the previous section.

Based on the ranking, the important effects of construction variation orders as perceived by respondents were: Increase in project cost and overhead expenses (RII = 0.62), Delay in payment (RII = 0.59), Adversely affect work quality (RII = 0.58), Lost productivity and efficiency (RII = 0.57), Most contractors incur additional costs due to variation orders (RII = 0.57), and Rework and demolition (RII = 0.53).

According to the survey findings, the most frequent effect of variation orders was the increase in project cost. It was not unexpected for the project cost to increase due to frequent variations in the project.

### 3.3 Comparison with Previous Results

Table 1 comparison of causes of variation orders between the results found in this research and those found in Malaysia (Sambasivan and Soon 2007).

Table 1: Variation order causes' comparison between Iran and Malaysia

Rank	Causes(Iran)	Causes (Malaysia)
1	Variation of plans or scope by owner	Improper planning by contractor
2	Errors and omissions in design	Site management by contractor
3	Replacement of materials/procedures	Inadequate contractor experience
4	Owner's financial problems	Finance and payment of completed works
5	Unavailability of equipment	Subcontractors

It is clear that the first two reasons in Iran are owner and consultant related, while the first three reasons in Malaysia are contractor related. This shows that higher attention should be given to projects during feasibility and design stages by clients in Iran. Problems highlighted in Iran are different from those in Malaysia due to experience differences in construction industry. Wu et al. (2005) found similar results to those of Iran.

## 4. CONCLUSIONS

This paper presented the developers' views of the causes and effects of variation orders in construction projects in Iran. Through the questionnaire survey and in-depth interviews with the professionals who were involved with the construction projects, the frequent variations and effects of variation orders for these projects were identified. The study will benefit the professionals involved with construction projects. From this study, it was determined that the main causes of variation orders are those which are related to the client. The involvement of the professionals in the design phase would assist in clarifying the project objectives and in identifying the noncompliance with their requirements at the early stage. Eventually, this may help in eliminating the occurrence of variations, arising from errors and design discrepancies, during the construction stage where the impact of the variations can be severe.

Continuous coordination and direct communication will not only eliminate design discrepancies and errors as well as omissions in design but also provide an opportunity for professionals to review the contract documents thoroughly that would help in eliminating the variations arising because of conflicts in contract documents. Clearer view of the impacts on the projects will enable the project team to take advantage of beneficial variations when the opportunity arises without an inordinate fear of the negative impacts. Eventually, a clearer and comprehensive view of the potential effects of variations will result in informed decisions for effective management of variation orders. Furthermore, considering the fact that the variations are common in all types of construction projects, this study also contributed to effective management of variation orders as the in-depth analyses of the frequent effects of variations can be used by professionals to take proactive measures for reducing and controlling variation orders in various other types of residential and commercial projects, etc.

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