

## MINIMISING VARIATIONS IN LUMP SUM CONTRACTS

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### ABSTRACT

*Construction industry is large, complex and uncertain in nature. Thus, variations have become an inevitable situation in construction projects irrespective of the type, size and complexity. This research therefore focuses on lump sum projects which account for a significant amount of variations in Sri Lanka. The research aimed at investigating the nature of variations in lump sum projects, significant effects of variations and the means of minimizing variations.*

*Semi-structured interviews and questionnaire survey were carried out to investigate the research phenomena. The professionals who involved in variation handling of lump sum projects were taken for collecting data. The results through questionnaires were analyzed using RII and interviewee outcome were analyzed using content analysis. It was found that there are a number of factors contributing to variations in lump sum contracts. The variations occur very often during the design stage of projects. The research findings revealed that delay in completion of project, increase in project cost, rework and demolition, quality standards enhancement and delay in payments are the most significant effects of variation. The research emphasized that identification of client's requirements is essential to minimize variations within the project.*

*The research recommended freezing design, preparation of detailed project brief, conducting comprehensive site investigations, involving owner at planning and design stage and reducing contingency sum could minimize the occurrence of variations. Further, the current study enables the professionals to assess and take proactive measures to mitigate the adverse impacts of variations through the identified controls for variations.*

**Keywords:** Effects; Lump Sum Contracts; Minimize; Variation.

### 1. INTRODUCTION

Construction projects are multidisciplinary in nature (Egan, 1998). Thus, construction projects involve many human and non-human factors, long duration, various uncertainties and complex relationships among the participants (Arain *et al.*, 2004). The construction industry embraces a wide range of loosely integrated organisations that collectively construct, alter, refurbish and repair a wide range of different building and civil engineering structures. The industry has certain unique characteristics, stemming mainly from the physical nature of the construction product and its demand (Balchin and Bull, 2006). Most of the time outcomes of the construction industry are buildings or other related civil engineering structures. To obtain those outcomes it needs a proper management structure defined as a procurement system.

The need to make changes in a construction project is a matter of practical reality and even the well planned projects are experiencing variations in the construction industry (Arian and Pheng, 2007). Variation means any change to the work, which is instructed or approved as a variation (Jaeger *et al.*, 2009). The definition of the term variation indicates the broad scope for the exercise of the architect's influence to vary the works (Ramus *et al.*, 2006). According to Baxendale and Schofield (1986), variations are any revolutionize to the source on which the contract was signed. Even the most considerably planned project may demand changes due to a range of factors (Arain and Pheng, 2007). Then those changes are subjected for the variations in construction projects. A variation is any deviation from an agreed well-defined scope and schedule. Stated differently; this is a change in any modification

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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 (Arain and Pheng, 2005). Variations are inevitable on major construction projects particularly where the project is complex (Keith, 1995). Building and civil engineering contracts are of such a nature that it is almost impossible, especially where work has to be carried out in the ground, design and construct a project so that the final product is identical in every way to the original design which formed the basis of the contractor's tender (Thomas, 1993).

Variations effect on project in means of changes to cost time and quality of the project. The effect can be tangible and/or intangible. The omission may disrupt the continuity of work type of labour and plant, both of which may become idle due to a disruption of the project programmed or sequence activities (Oxley and Poskitt, 1996). Variation has become so prevalent in construction. Hardly possible to complete a project without changes to the plans or the construction process itself. Variations are common in all types of construction projects. The client releases the design and documentation, the contractor submits the price and undertakes the work. Any change to the documentation may entitle the contractor to request for extra payments through variations (Oladapo, 2007). Furthermore, it is revealed that "In a perfect world, changes will be confined to the planning stages. However, late changes do occur, often during construction, these frequently cause serious disruption to the project". Proper management of variations and case related issues are very significant for all types of construction projects including lump sum projects.

A contract is a written agreement that clearly defines the responsibilities and obligations of each included party, is legally enforceable, and is dated and signed by authorized representatives of each party (Werremeyer, 2006). Construction contracts do not differ fundamentally in nature from other types of contracts (Turner and Turner, 1999). Under the lump sum contract each contractor is required to estimate the quantities and value the works, based on the client's designer's drawings and specifications, using whatever methods considered as suitable. Bill of quantity items, quantities and metaphors are at contractor's risk. On completion of the works, the lump sum contract price would be paid in full to the contractor subject to the approved variations (Turner, 1993). Contractors could then either be required to submit one lump sum for the whole works, or to give a breakdown of the total sum against major activities or sections of the work. Payment is usually on a monthly basis and can be linked to the achievement of progress milestones (Potts and Patchell, 1995). Although there are number of variations and cases related to lump sum contracts, there is no critical solution to minimize those issues and variations. A lump sum contract is one in which a stated sum is totally paid at the completion of whole works. This is operable for both very minor and major works but it is usually necessary to make provision for variations in the work (Jayalath, 2010).

There are number of researches addressed on "variations". However none of them have focused on variations in lump sum contracts. The variations in lump sum contracts could be more critical compared to other types of contracts. Therefore, there is a necessity to fill this potential research gap. The research tends to investigate the ways of minimising variations in lump sum contracts through identifying the prevailing practices related to variations in Sri Lanka. Further the research investigates the effects of variations in a lump sum contract and the ways of minimising the variations.

## **2. LITERATURE REVIEW**

### **2.1. VARIATIONS IN CONSTRUCTION PROJECTS**

Construction projects are complex because they involve many human and non-human factors and variables. They usually have a long duration, various uncertainties and complex relationships among the participants. The need to make changes in a construction project is a matter of practical reality. These changes are identified as the variations. A variation is any deviation from an agreed well-defined scope and schedule. Stated differently; this is a change or 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 (Arain and Pheng, 2007).

Variation, according to Baxendale and Schofield (1986), is any change to the basis on which the contract was signed. The variation clauses will provide power for the employer to call for varied or additional work including additions, omissions, substitutions and alterations, changes in the quality, form, character, kind, position, dimension, level or line. Some of the contracts go even further. In the JCT 1998 contracts provision is made for the addition, alteration or omission of any restriction imposed in the contract such as access to the works, limitation of working space, limitation of working hours and the execution of work in any order. However, what constitutes a variation in a contract is not only found in one clause, but also in a range of clauses such as procedure of claims, time extension and other causes related to project changes. It is hardly possible to complete a project without changes to the plans or the construction process itself. Even if carefully planned, it is likely that there will be changes to the scope of the contract as the work progresses (Singh, 2003). In common, variation is defined as additions, omissions and substitutions to the original work agreed. The nature of variations is usually defined by a variation clause in the contract (O'Brien, 1998). Furthermore, nature of variations had been identified by studying variations in different projects.

### **2.1.1. VARIATION PROCEDURES**

As mentioned in the conditions of contract in Standard Bidding Document, if the Engineer request a proposal, prior to instructing a variation, the contractor shall respond in writing as soon as practicable, either by giving reasons why he cannot comply or by submitting.

- a. A description of the proposed work to be performed and a program for its execution.
- b. The contractor's proposal for any necessary modifications to the programme according to the time for completion.
- c. The contractor's proposal for evaluation of the variation. Otherwise the engineer can issue an instruction without asking for a proposal.

### **2.1.2. VALUATION OF VARIATIONS**

There are several ways of valuing variations (Ramus *et al.*, 2006), they are;

- a. By the inclusion in the variation, accounts of a lump sum in accordance with a quotation submitted by the contractor and accepted by the architect.
- b. By pricing measured items in the variation accounts
- c. By ascertaining the total prime cost of additional work and applying appropriate percentage additions.

The each work item can be measured using existing rates or new rates. If there are similar work items for varied work item, the prevailing rates can be used. Otherwise some adjustment can be done. If the new rates are going to be applied, following three requirements should be fulfilled. If there is a new item, this is not applicable.

- The amount of changes of the quantity > 10% of the Quantity of item in the BOQ
- Amount change due to the variation > 0.01% of the accepted contract amount
- New value of cost per unit quantity  $\times 100 > 1\%$

### **2.1.3. VARIATIONS IN LUMP SUM CONTRACTS**

In lump sum contract the contractor undertakes to carry out a defined amount of work in return for an agreed sum. This can be a fixed amount not subject to recalculation, in which case there would be no opportunity for the employer to make variations (Davis *et al.*, 2008). Contract sum is agreed before the construction starts and risk is very high to the employer. These contracts render maximum price certainty before the start, provided that client's requirements are fully specified (Turner, 1997).

Most of the time any type of contract may contain any type of variations as identified earlier. In this scenario client gives his idea through a checklist. To have a clear idea about the variations it is essential to refer to the variation clauses under the lump sum contracts and general clauses in SBD. For the project success, the project scope must be defined and understood by all parties (Songer and Molenaar, 1996). Ling and Poh (2004) suggested that the experience of the contractor is crucial to lump sum projects.

## **2.2. POTENTIAL VARIATIONS AND ITS CAUSES**

An effective analysis of variations and variation orders requires a comprehensive understanding of the root causes of variations (Hester and Poh, 1991). Arain and Pheng (2007) stated four origin agents of variations as client, consultant, contractor and others. Variations can be categorized as follows.

### **2.2.1. UNAVOIDABLE VARIATIONS**

When there are unexpected events or circumstances, unavoidable variations are occurred and they are necessary in order to minimize adverse effects. They may be required to avoid health, safety or security problems. They do not result in a change to the scope of the work.

Examples of unavoidable variations include;

- A variation to minimize the increase in cost or other adverse impact of a latent condition (for example unanticipated ground conditions, hazardous materials or existing services)
- A variation to overcome a fault (for example an error, ambiguity or inconsistency other than an omission or lack of completeness which may be the responsibility of the Contractor) in the principle design or documentation which, unless it is remedied, could result in health, safety or security problems or prevent work from continuing.

### **2.2.2. VARIATIONS FOR THE CONVENIENCE OF THE CLIENT**

Due to a change in the client's requirements, some variations are requested by the client. Uyun (2007) remarked that it is sometimes very difficult to determine the exact requirements of the client. If the objectives of the project are inadequately defined, it is common that clients will tend to change their minds along the way. It is possible to complete the Contract without making the changes requested. This type of variations will change the scope of the work and usually increase the cost of the work. Even variations that appear to reduce the scope may increase the cost.

Change of plans or scope by the owner: This is significant cause to generate more and more variations and is usually the result of insufficient planning at the project definition stage. Uyun (2007) remarked that the principal reason for the client to initiate variation is a change in requirements. Furthermore, Arain *et al.*, (2004) stated that there is a lack of involvement of the owner in the design phase. These variations affect the project severely during the later phases.

Change of schedule by the owner: A change of schedule during the project construction phase may result in major resource reallocation, rethinking of the needs or change of the use of the anticipated future utilization of finished works (Fisk, 1997).

Owner's financial problems: The owner of the facility may run into difficult financial situations that force him to make changes in an attempt to reduce cost. Owner's financial problems affect project progress and quality (Clough and Sears, 1994). Proper planning and review of project cash flow would be effective in eliminating this problem.

Inadequate project objectives: Inadequate project objectives are important causes of variation in construction projects (Ibbs and Allen, 1995). If there were an inadequacy of project objectives, the designer would not be able to develop a comprehensive design. Therefore, it may be a cause to initiate a number of variations.

Replacement of materials or procedures: Replacement of materials or procedures may cause major variations during the construction phase. Chappell and Willis (1996) concluded that the substitution of

procedures includes variations in application methods. Therefore, if there is a change in procedures, an adjustment to the original contract value is required.

**Impediment in prompt decision-making process:** Prompt decision-making is an important factor for project success (Sanvido *et al.*, 1992). A delay in decision-making may hinder subsequent construction activities that may eventually delay the project progress.

**Obstinate nature of the owner:** A building project is the result of the combined efforts of the professionals. They have to work at the various interfaces of a project (Wang, 2000). If the owner is obstinate, he may not accommodate other creative and beneficial ideas. Eventually, this may cause major variations in the later stages and affect the project adversely.

**Change in specifications by the owner:** Changes in specifications are frequent in construction projects with inadequate project objectives (O'Brien, 1998).

### **2.2.3. VARIATIONS FOR THE CONVENIENCE OF THE CONSULTANT**

These types of variations are initiated by the consultant. However, in a design and build projects occurrence of these types of variations are limited since both design and construction is done by a single party. Therefore, only the causes are highlighted without giving explanations. Now most of construction projects are complex, therefore the responsibility on the consultant party is high. In some cases, the consultant directly initiates variations or the variations are required because the consultant fails to fulfill certain requirements for carrying out the project.

For those reasons, Acharya *et al.* (2006) suggested that consultants should aim at getting an understanding of the overall scope and goals of the project, make sure they understand deliverables and offer specific suggestions when it makes sense.

### **2.2.4. VARIATIONS FOR THE CONVENIENCE OF THE CONTRACTOR**

Variations for the convenience of the Contractor are variations that are requested by the Contractor. There is no obligation on the Principal to agree to a variation for the convenience of the Contractor.

To maintain good contractual relationships, when a request is made, it should be considered. Then it may be beneficial to the project. Levy (2002) indicated that general contractors or their subcontractors might discover an obvious discrepancy, omission, error or conflict in the contract document and request that the architect review that problem, discuss the additional costs to correct the situation, agree on a price and authorize the variation order.

**Lack of contractor's involvement in design:** Involvement of the contractor in the design may assist in developing better designs by accommodating his creative and practical ideas (Arain *et al.*, 2004). Lack of contractor's involvement in design may eventually cause variations. Practical ideas which are not accommodated during the design phase will eventually affect the project adversely.

**Differing site conditions:** Differing site condition can be an important cause of delays in large building projects (Assaf *et al.*, 1995). The contractor may face different soil conditions than those indicated in the tender documents. Eventually this may affect his cost estimates and schedule adversely.

**Unavailability of skills (shortage of skilled work force):** Skilled work force is one of the major resources required for complex technological projects (Arain *et al.*, 2004) Shortage of skilled is more likely to occur in complex technological projects. This lack can be a cause for variations that may delay the project completion.

**Contractor's financial difficulties:** Construction is a labour intensive industry. Whether the contractor has been paid or not, the wages of the worker must still be paid (Thomas and Napolitan, 1995). Contractor's financial difficulties may cause major variations during a project, affecting its quality and progress.

**Contractor's desired profitability:** Contractor's desired profitability can be a potential cause of variations in construction projects. O'Brien (1998) stated that this is because variations are considered a common source of additional works for the contractor.

The existing literature reveals that defective workmanship, unfamiliarity with local conditions, lack of a specialized construction manager, fast track construction, poor procurement process, lack of communication, contractor's lack of judgment and experience and complex design and technology could also be identified as causes of variations due to contractor.

Thus, the research discussed the aspects in relation to variations in construction projects, variation procedure, evaluation of variations, variations in lump sum contracts, potential variations and their causes. The next section tends to furnish the methodology adapted to this study.

### **3. METHODOLOGY**

The current research adapted a mixed approach which consists of both qualitative and quantitative approaches in different stages. Researchers urge to use both quantitative and qualitative approaches in order to triangulate results which guide to integrate both approaches by the investigator (Yin, 1997). The data collection was done in two different stages. The first stage of the data collection was done using semi structured face to face interviews. The interviews were conducted among the experienced professionals who involved in handling variations in lumps sum contracts. An interview is an in-depth discussion in between two or more people (Saunders and Lewis, 2003). In semi-structured interviews, the researcher could ask questions which even slightly differs from one to another interview without deviating from the objective of the research. Thus, semi-structured interviews have the flexibility to allow the researcher to do such modifications. The semi structured interviews were conducted in order to explore the current practices of variations in lump sum projects in Sri Lanka. The results through interviews were analysed using content analysis. Content analysis facilitates the researcher to extract the important facts from the interview transcripts under different themes.

In the second stage of the data collection evolved questionnaire survey. Questionnaires were issued to experienced professionals who are involving in variations of construction projects particularly lump sum contracts. The questionnaire survey was conducted in order to identify and rank the most common causes of variations in lump sum projects. Further, the survey facilitated the researcher to rank the practice mechanisms used to minimize those variations. Relative importance index (RII) formula was used to rank the causes of variations which have obtained from the literature survey and questionnaire survey. Using RII formula, the researcher could achieve the objectives; rank the effects of variations in lump sum project and the ways of minimising variations.

$$RII = \frac{\sum (W_n)}{N \times A} \quad (\text{Eq:01})$$

Where, W-Rating of each Factor given by respondent, n-Frequency of Responses, N-Total number of responses, A-Highest Weight. Thus, the research identified the most significant causes of variations in lump sum projects. Hence, the methodology was set in order to achieve the aim and objectives of the study.

### **4. RESEARCH FINDINGS AND ANALYSIS**

#### **4.1. VARIATIONS IN SRI LANKAN CONSTRUCTION INDUSTRY: THE POSITIVE AND NEGATIVE ASPECTS**

##### **4.1.1. PROFILE OF THE INTERVIEWEES**

The interviews were conducted to collect data from experienced professionals who are currently working in the construction companies in Sri Lanka and involved in lump sum projects. Interviewees were selected deputed both consultants' and contractors' fields including project managers and quantity surveyors as shown in Table 1.

Table 1: Interview Participants' Profile

Project Participants	Experience in Construction Industry (Years)	Number
Consultant	>15	3 (A, B, C)
Contractor	>15	3 (D, E, F)
Total		6

#### 4.1.2. FINDINGS OF INTERVIEWS

According to the responses of the research participants, the existence of both negative and positive impacts of variations in construction projects were clearly identified in both contractor's and consultant's sides. Out of above six, three respondents (Interviewee D, E and F) from contractor's side clearly stated that they prefer variations to occur within projects and it could cause several advantages for the contractors. An interviewee D agreed that *"Generally, most of the contractors look forward for variations within the project in order to earn an extra profit. However, very rarely there can be some fair contractors who try to proceed the project without any deviation to the original scope of works and the schedule."* By this statement, the contractors' adherence with variations was clearly identified. On a different note, an interviewee E stated that *"we have to deal with variations without considering the negative impacts as variations are inevitable to proceed the project and it would be a practical reality in the construction industry. Therefore, it is impossible to get rid of variations."* This statement proves the vitality of enhancing knowledge in dealing with variations in construction projects to achieve successful projects. Moreover, Interviewee F also mentioned that variations are important to get project done in a desired level. This seems the variations are inevitable in construction projects.

Majority of participants in consultant sector mentioned that the contractors accept variations in order to get higher profits through variations. Interviewee A stated that *"Generally contractors ask additional payments for any work which is not included in the BOQ. However, in such cases most probably that relevant item can be already included in specifications or drawings. The common scenario here is that the contractors tend to miss items and ask for variations fraudulently whenever possible. So we should pay our special attention when dealing with variations and issuing instructions otherwise it will be a double payment to the contractor"*. In consultants' point of view, the contractors earn additional profit using variations.

Most of the respondents from contracting sector stressed that the consultants show lack of tendency to accept variation requests from contractors. An interviewee D added that *"The consultants often try to refuse variation requests by including the varied work under BOQ items by giving many reasons. Ultimately the contractor is the person who is going to suffer due to loss of payments"*. In contractor's point of view, one of the most significant positive impacts of the variations is increasing the profit margin of the contractor. An interviewee C stated that *"The variations are beneficial to the contractor since it carries additional payments to him and accordingly the profit margin goes up"*. Moreover, the respondent C expressed that *"The contractor's higher earning of money from the project may reduce the risk involved in the project. So that the contractors tend to go for variations with these dual purposes of earning profits and reducing the risk related to performance of the project."* Thus, the research found that the contractors accept variations in construction projects while considering the benefits: extra income, risk reduction and increase in profit margin.

The consultant representative (B) opined that *"In some instances, the variations assist in mitigation of tendering errors and there fails to find another way to cover up the tendering errors than variations"*. Accordingly, variations give space to recover the mistakes in the tender/contract document and this lead to successful projects.

The chances of arising conflicts and possibility for disputes between parties were identified as significant negative impacts of variations in construction industry. Interviewee C stated that *"Variations may cause large number of disputes between parties to the contract and this would affect the project progress at last."*

Therefore, those disputes need to be managed in a proper way otherwise it will affect to the project as a whole and the contractor's reputation in the industry". On a different note, an interviewee A stated that "the variations could decrease the profit margin when it is not managed properly with increased number of variations. This revealed that allowing high number of variations could not be always beneficial to contractors.

In accordance with the above facts, it can be concluded that there are both positive and negative effects of variations. The same effect can negatively and positively impact on two parties: contractors and consultants. Thus, the research found the positive and negative impacts due to variations in construction projects. The next section explains the analysis of questionnaire survey.

## 4.2. QUESTIONNAIRE SURVEY ANALYSIS

The questionnaire survey was conducted among the professionals who are currently working in the industry and especially it was based on lump sum projects. The questionnaires were issued to a total of thirty five professionals. Out of thirty five, thirty questionnaires were properly completed and returned. Duly completed questionnaires were from industry professionals and include cost consultants (47%), consultant engineering (13%) and contractors (40%) who deputed the various organisations in construction industry. The research concerns that the questionnaire survey evolves both the contractor and consultant representatives. The questionnaires were issued to the professionals: engineers and quantity surveyors who have experience of more than ten years. This affirms the quality and the reliability of the research.

### 4.2.1. FREQUENCY OF VARIATIONS IN LUMP SUM PROJECTS

The respondents were asked to indicate their opinion on existence of variations in lump sum projects. The responses of the research participants on closed ended questions were collected basically using the ordinal scale of 1-5. Also, in some instances, respondents were asked to state their own views by means of a percentage value in order to derive a mean-average response. The following Figure 1 shows the frequency of variations in lump sum projects in Sri Lanka.

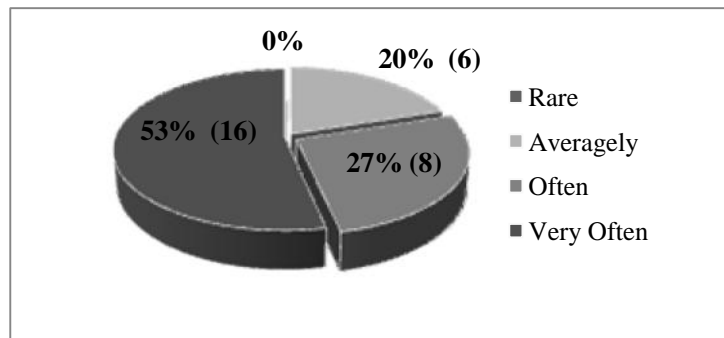


Figure 1: Frequency of Variations

According to Figure 1, most of the participants (53%) indicated that variation occur very often in lump sum projects. It is identified that variations occur often and averagely by 27% and 20% participants respectively. None of the respondent revealed that variation happens rarely. This confirms that variations are reality and inevitable in construction industry. Further this in line with the interview findings.

### 4.2.2. MAGNITUDE OF VARIATIONS IN DIFFERENT PROJECT PHASES

The magnitude of variation occurrence in different stages of the project would not be the same. Thus, the research participants were asked to indicate the magnitude of variations in different stages of project: design, construction and the end. The research finding was illustrated in Figure 2.



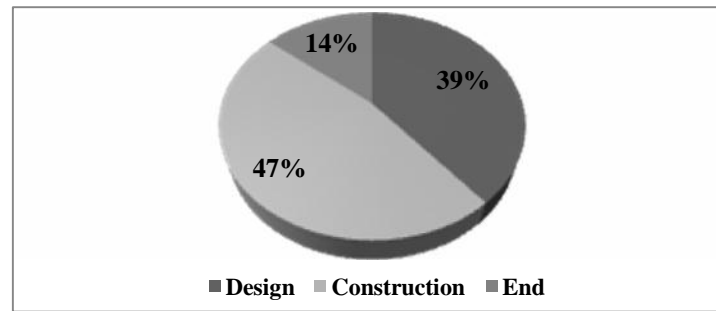


Figure 2: Magnitude of Variation in Different Project Phases

According to Figure 2, 47% of the participants indicated that most of the variations are occurred during the construction process. The client tends to change his requirements time to time during the construction stage then and there when he visits site. Moreover, the new work items occur while construction. Therefore, there is a high tendency for variations. The occurrence of variations during design was accounted by 39% of the research participants. At the end of the project, the chance of occurring variations was indicated as less and 14% of the participants indicated so.

#### 4.2.3. EFFECTS OF VARIATIONS IN LUMP SUM CONTRACTS

A variation needs to be carefully assessed in terms of its direct impact on the cost of the project, quality, schedule and the work progress. Even a small scope change can be accountable into a significant amount of increase in cost of project. Thus, the variations should be highlighted in each and every phase of construction due to the significance of the impact of changes and its effect on the success of the project.

The research participants were asked to indicate the effects of variations in lump sum projects using the ordinal scale of 1-5. A total number of 23 effects were included in the questionnaire. The findings through questionnaires were ranked using RII. Table 2 shows the significant effects with the respective RII value.

Table 2: Significant Effects of Variations in Lump Sum Projects

Effects of Variations in Lump Sum Projects	RII	Rank
Delay in project completion	0.800	1
Increase in project cost	0.760	2
Rework and demolition	0.760	2
Quality standards enhanced	0.760	2
Delay in payments	0.733	5
Wastage of resources and non-value adding activities	0.706	6
Increase in overhead expenses	0.693	7
Additional payments for contractor	0.680	8
Logistic delays	0.680	8
Productivity degradation	0.653	10

As illustrated in Figure 2, delay in project completion was identified as the most significant impact of variations in construction projects. Generally it is accepted that the maximum project performance could be achieved if the work progress flows smoothly within the time frame. However, the practical reality is, it is almost difficult to continue the work proceedings exactly within the initially scheduled time frame due to variations which may arise due to unavoidable obstacles and uncertainties. The negative influence of variations on the efficiency of construction activities has to be clearly identified and well managed as much as possible in order to avoid unnecessary delays.

Increase in project cost, Rework and demolition, Enhancement of quality standards were observed as second most significant effect of variations. The effects, increase in project cost and Rework and demolition are inter-related as the rework and demolition evolve additional cost. Each and every additional work involve additional cost simply because it needs extra material, labour force, supervision and some instances specialized knowledge. Rework and demolitions are often occurred when the ongoing

process is not according to the requirement at the initial stages. Enhancement of quality standards is identified as a positive impact of variations. The variations take place in order to achieve the final output in a desired level. Thus the quality of project increases.

Delayed payments occurred frequently due to variations which may slow down the project progress and leading with project delays. Eventually payment delays to main contractor may affect the payments to the sub-contractors. Wastage of resources is considered as a significant impact of variations. This causes due to demolitions of the already constructed structures, change of the materials, plant and equipment which were already hired or purchased. According to the results of questionnaire survey, additional payments to the contractor can be a potential positive effect of variations in lump sum contracts. The client, as the person who invests and finances for the project should always bear up the cost involved in variations. Thus, the research ranked the effects variations in lump sum projects. The next section explains the ways of minimizing variations in lump sum projects.

#### 4.2.4. WAYS OF MINIMIZING VARIATIONS IN LUMP SUM PROJECTS

The views of respondents regarding ways of minimizing variations in lump sum projects were collected basically under three major categories: design stage, construction stage and at the end of the project. The research participants were asked to indicate their opinion on the degree of contribution of each and every strategy to minimize variations. Table 3 furnishes the research outcome on the ways of minimizing variations with the respective frequencies.

Table 3: Ways of Minimizing Variations in Lump Sum Projects

Ways of Minimizing Variations in Lump Sum Projects	During Design	During Construction	At the End of the Project	Total
Review of contract documents	62	32	6	100%
Freezing design	75	21	4	100%
Value engineering at conceptual phase	56	40	4	100%
Involvement of professionals at initial stages of project	63	32	5	100%
Owner's involvement at planning and design phases	66	32	2	100%
Thorough detailing of design	57	36	7	100%
Clear and thorough project brief	71	27	2	100%
Reducing contingency sum	65	35	0	100%
Clarity of variation order procedures	5	86	9	100%
Written approvals	19	73	8	100%
Variation order scope	25	72	3	100%
Variation logic and justification	26	69	5	100%
Project manager from an independent firm to manage the project	24	67	9	100%
Restricted pre-qualification system for awarding projects	14	78	8	100%
Owner's involvement during construction phase	5	90	5	100%
Avoid the use of open tendering	10	85	5	100%
Use of project scheduling techniques	25	67	8	100%
Comprehensive documentation of variations	14	77	9	100%
Prompt approval procedures	25	62	13	100%
Valuation of indirect effects	27	65	8	100%
Team effort by owner, consultant and contractor to control variation	32	61	7	100%
Utilize work breakdown structure	16	82	2	100%
Continuous coordination and direct communication	34	55	11	100%
Control the potential for variation orders to arise through contractual clauses	17	80	3	100%
Comprehensive site investigation	70	28	2	100%
Use of collected and organized project data compiled by owner, consultant and contractor	64	32	4	100%

The above Table 3 listed the available strategies and the usage level during the stages: design, construction and end of project. The Table shows that strategies under design stage and construction stage

were predominantly promoted to minimize variations respectively with different magnitudes. Review of contract document is identified as 62%, 32%, 6% in the stages design, construction and end of the project respectively. Freezing design to minimize variations in lump sum contract is indicated with a mean percentage contribution of 75%. Variations in design can adversely affect to a project depending on the timing of occurring changes. Therefore, freezing the design would be a highly important controlling method during design stage. Respondents mentioned that after proper completion of the drawings, many clients tend to freeze the design and obstruct the chances of occurring changes to minimize variations.

Clear and thorough project brief, Comprehensive site investigation, Owner's involvement at planning and design stage and Reducing contingency sum were indicated with a mean percentage contribution of 71%, 70%, 66%, and 65% respectively to minimize variations during design stage. According to the respondents' views, Clear and thorough project brief is considered as a significant control for variations in lump sum projects as it helps in clarifying the project objectives to the participants and eventually it may cause for reduction of both design errors and non-compliance with the requirements of the owner. Comprehensive site investigation is needed to build up unambiguous and broad understanding about the actual conditions of the site and practical obstructions before implementing the works in order to minimize variations. Similarly, owner's involvement at planning and design stage is needed in clarifying project objectives and identifying noncompliance and conflicts with their requirement at the initial stage of the project. Therefore, it would assist in eliminating variations during the construction stage where the occurrence of variations can be severe.

The provision of a large contingency sum for the project may heavily affect the participants' work handling approaches because of the designer's lack of tendency to develop a comprehensive design and consequently it may result to carry out rectifications in design as variation orders during the later stages of the project. Therefore, by reducing the contingency sum the professionals would perform and complete their tasks up to their maximum level. In addition, contract documents are the main source of providing information for any project. Therefore, it is advisable to have comprehensive, balanced and well-written variation clauses to eliminate conflicts between parties and minimize variations. As presented in Table 3, the mean percentage contribution for Review of contract documents is 62% in design stage.

Throughout the questionnaire survey, the contribution of controls for variations during construction stage was indicated with relatively higher mean percentage values. Owner's involvement in construction phase was taken place with 90% mean percentage contribution. The owners would assist in identifying noncompliance with requirements and eventually may aware of the current ongoing activities with prompt decision making. Clarity of variation order procedures was indicated with a mean percentage contribution of 86%, as an effective way of minimizing variations in lump sum projects and would help in reducing processing time and mishandling issues of variations in the project. The research identified that the mean contribution value is comparably less during the end of projects as it was found already that fewer variations arise during end of project. Thus, the research revealed the ways of minimizing variations and the respective mean values in the stages of project separately.

## **5. CONCLUSIONS AND RECOMMENDATIONS**

A variation is any deviation from an agreed well-defined scope and schedule. Client is aware about variations to some extent and not always fully. There could be unnecessary costs that accrue due to variation orders. The research found that the variations cause negative and positive impact to the parties to the contract: client, consultant and contractor. The interviewees revealed that the contractor tends to get advantages through variations. The positive impacts to contractors are extra income, risk reduction and increase in profit margin. The research participants further found that the variations give space to correct the mistakes of contract document and lead to fulfill the client's requirements completely. In contrary, the variations could cause disputes within project parties.

The research participants ranked the effects of variations. The most significant effect of variation is identified as delay in completion with RII value of 0.80. Increase in project cost, Rework and demolition and Enhance quality standards are identified as second significant effects with a RII value of 0.76. The research further found that most of the time client's satisfaction becomes much higher with the occurrence of variations since the major role of a variation is to perform the project according to the

desired output to be achieved at the end of the project. Disputes between parties also may significantly involve with variations in a project.

According to the research findings, client's requirements need to be clearly identified by the design team prior to the implementation of the project. Hence, the proper relationship and understanding between client and the design team is vital to perform the project without unnecessary deviations. The contract should be awarded to the most suitable and potential contractor selected through the tendering process. This could also minimize unnecessary variations. Moreover, the good communication and cooperation between parties also will be helpful to build up a proper relationship among them and similarly it may reduce the disagreements and conflicts which can be seen as root causes of variations. The research recommended that the construction industry could minimize variations by adopting the strategies during the respective stages of construction projects.

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