

Effect on Time Management Due to Variations in Road Construction Projects in Sri Lanka

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ABSTRACT

Variations are reoccurring and inevitable incidents in construction projects. It alludes to any adjustment in project scope at any instance of construction process. There are numerous causes of variation depending upon different parties involved, complexity of project and the type of project. These variations are acknowledged to affect different viewpoints of the projects. The thesis evaluated the effect of time management due to variations in road projects in Sri Lanka to diminish them. In order to achieve the study objectives, a basic survey of literature review was done accompanied with a quantitative survey with industry experts were carried out to gather data on impact of time management due to variations in construction projects. Through the writing study, 50 causes of variation orders were recognized but, they were shortlisted since there were so many similar causes. Out of them design faults were identified as the major cause of variations. When it comes to the impact on time overrun, it was discovered that variations affect on time of a project adversely. Finally, mitigation strategies for variations have been proposed in the study. The recognized results from literature overview were moreover subjected to a test by the 33 specialists in the industry including contractors, consultants, and clients to be more precise. The results were analyzed using SPSS. The study's final recommendation is that to all parties to get involved, to reduce variation orders beginning with the initial design phase, manage variation orders during the construction phase using an efficient change management system, and adopt various technologies to speed up the variation management procedure.

KEYWORDS: *Variations, Time management, Sri Lanka, Road project*

1 INTRODUCTION

The construction industry has a symbolic influence towards globally as well as on economy in a country. According to Silva (2021) Sri Lanka construction development contributes 7.1% to GDP of nation and considered to be one of the major financial development variables of Sri Lanka. Therefore, if a variation in a construction project happens it directly affects towards the country economy. Especially variations on time management effect on both project cost and then on the profit of the project. Variation is simply a change and the variation in construction projects are inevitable. One of the most important aspects of variation is influence on time management. Time management is defined as the time spent on the progress over the projects. As define by per the Westland (2006) time management define as, "Time management is the process of recording and controlling time spent by staff on the project". Time management is vitally important in construction projects because it helps to breakdown, assign tasks and complete projects on time.

When numerous variations in a venture increase, so the risk of misjudge between the included parties may happen. Such a misguided judgment may happen since individual or more of the parties

needs complete information of the variation process, the costs included in executing adjustments, or the lags, clashes, and obstructions of the development course of actions which can unfavorably influence project coordination. Effect of varieties on time administration for development industry are either favorably or antagonistically influenced. Basically, the project cost and profit get influenced by time variety. Company reputation gets harmed, and clients may have a misconstrue towards the company. In the event that the project goes out of scope with the time variety, at that point the control of project may get destitute. So, it is exceptionally much vital to oversee the time appropriately without letting it to be changed.

1.1 Aim of the project

The aim of this study is to assess the impact of variations which affect time management of construction projects related to road sector in Sri Lanka.

1.2 Objectives of the project

- To examine origin agent, types and causes of variations that is prevalent on road development ventures in Sri Lanka.
- To determine the extent of impact of variations on time management.
- To identify preventive measures of variations with support of project management applications.

1.3 Scope of the project

There are various projects which are right now underneath improvement in Sri Lanka. In arrange to attain the communicated goals of the study, the scope would be as well tremendous to handle. In this context, the research will be limited to Road development projects in Sri Lanka.

1.4 Research gap

Various research have been done with reference to the key words of the selected topic worldwide. Most of the previous studies have analyzed the impact of overall project performance due to variations but not sticking to time management. Ranasinghe (2012) carried out research to determine trends of causes for variation orders in road projects in Sri Lanka. The study included causes of variations and ranked them based on number of frequencies of occurrence, percentage variation for each cause using a relatively importance index. Takar (2020) has done a study on impact of variation order in construction projects. The study contributes types of variations, effects on variation on cost, quality, time, and organization. The research was done regarding overall construction projects but not specifying road projects. Chin and Hamid (2015) have done research practice of time management on construction industry. This paper includes details on importance of time management in construction industry. Dolage and Pathmarajah (2015) have researched on topic "Mitigation of Delays Attributable to the Contractors in the Construction Industry of Sri Lanka - Consultants' Perspective" which determine reasons for construction delays in Sri Lanka. Karunasena et al. (2017) have published a journal on challenges in highway construction projects in Sri Lanka where different areas of challenges have addressed regarding expressways. Edirisinghe, Marsh, Borthwick and Cotgrave (2020) have done research on "Significant causes of disputes in construction industry in Sri Lanka." The paper mainly focused on types of disputes arise in a project and selection of the most suitable dispute resolution methods. Yadeta (2014) have assessed impact of variation orders on public building projects in Addis Ababa. There, author describes only public projects and variation orders. It does not address any time management issue on road projects. Depending upon above information it can be clearly seen that most of the papers and articles have published on impact of variations on a project, impact of time management on projects. Variations in Sri Lankan construction projects and other country projects may get different due to constructional law, cultural difference. Also, a less focus have been attempted show how variation and time management interrelate and specially how they make an impact on road construction industry in Sri Lanka. Therefore, this paper would help to fill the vacuum regarding above mentioned matter.

2 LITERATURE OVERVIEW

2.1 Introduction of variations

The time administration of a development project from initiation to completion holds an extraordinary significance because it straightforwardly influences the project cost and quality. Cost, quality, and time are the key components in a venture, and they are depended upon each other. However, due to many reasons a project can be varied from initial plan. Ndiokubwayo (2008) says “Variation orders can potentially occur on all construction projects. They occur due to several reasons that include finance, changes in the minds of parties involved into the contract, weather conditions and feasibility of construction, statutory changes, product improvement, and discrepancies between contract documents.” Yadeta (2014) determines “Variation is inevitable in construction projects due to the complex nature of the construction industry.” Edirisinghe et al, (2020) proposed their review regarding reasons for disputes in Sri Lankan construction industry where they identified major factor of cause were variations. Further, they stated that the key to the variations was budget. When variations affect to the project cost there is a high risk of arising a dispute. Halwatura et al, (2013) express their point of view as most of the road improvement ventures in Sri Lanka have gone through a colossal amount of variety orders. The client had to spend more than initial budget to get over with in most cases. In some cases, wrangle about and inconsequential delays happen due to varieties. Sun and Meng (2009) alluded to a variation in development projects as changes to design, development process, and adjustments to the project program in preexisting conditions, assumptions, or necessities.

2.2 Origin agents, types and causes of variations

Ndiokubwayo (2008) distinguished 2 sorts of variations to be specific, beneficial variations and detrimental varieties where beneficial variations are that lead to esteem enhancement whereas detrimental varieties are driven to deterioration. Four origin specialists were recognized thru the consider i.e., Contractor related, client related, consultant related and unspecified. Moreover, he states that occasion of variation unfavorably impacts the execution of development ventures by, being responsible to cost and time attacks. The occurrence of varieties can impact for the most part of quality of works. Yadeta(2014) sorted out list of causes of variations according to the frequency of occurrence. The study of Halwatura and Ranasinghe, (2013) recognized that misguided estimation is the dominant cause of variety orders inside the street improvement trade in Sri Lanka. For case, the specialists fail to carry out palatable examinations at the beginning during the site investigation and design organize. Subsequently, many location conditions rise within the development organize. Further, clients fail to provide competent proficient staff to carry out examinations and estimates. Hence, a number of inconsequential varieties happen during the construction phase. Apart from primary cause, most often, the opinion of the client isn't considered and not recorded. Contractors and specialists are hesitant to point out client's insufficiencies, considering their stability within the development industry. Underneath variables causing variety, there are three categories these are owner related components, contractor related factors, and specialist related factors. (Chalchissa, 2021).

2.3 Impact of variations on time management

Ndiokubwayo (2008) has ranked adverse impacts of variations on project performance and which the time overrun has occupied rank number 2. The study of Yadeta(2008) has stated that delay in completion of works is major impact of variation. Delaying of completion may result in cost overrun and in productivity. This proved that variations affect the venture unfavorably, drive to being delayed within the project finalization. Osman, Omran and Foo (2009) have found from their research completion schedule delay bears 4th prominent impact of variations. The results gotten can be considered exceptionally significant to the construction industry as at whatever the point there are variations or extra works all along the construction phase, it ordinarily brings around additional work or demolition or adjustments to be accomplished by the contractor which interferes more cash for the contractor: in turn it will result in project cost increment and may also influence the complete project's time plan. Pathirana and Halwatura, (2010) realized that Sri Lankan Road construction projects usually go through an average of 70% time overrun compared to the authentic (planned) project duration. The study investigated financial problems, insufficient site management, contract modifications, worse

weather conditions, incomplete documents, shortage of site labor and material make projects delayed. Hanna et al. (2002) mentioned that variation orders increase efficiency losses and efficiency is characterized by the sum of yield. The adversity of efficiency in this way involves a catastrophe of time and related delays. Priyantha et al. (2011) moreover, realized that due to the extra works, changes to arrangements and levels/dimensions variations result with the need of additional time to complete the works.

2.4 Recommended measures to minimize variation orders

According to Yadeta (2014) there are some ways of mitigation or minimizing of variations. The main strategy was to complete designs and contract documents at the tendering phase. Also, works should be executed along with an experienced and dedicated supervisor. Improving interaction within included parties was another strategy proposed. Diverse parties included in a project to perform work so, a fine communication between the parties is vital. This should be done since interaction can increment project performance during the processes of a project. Yadeta (2017), recommended strategies to minimize variations and ranked them according to the efficiency. Accordingly, it was recommended to carry on a detail site investigation before tendering process which was highest ranked. So that, automatically other strategies can be accomplished. Incomplete design and drawings will head to additional works where a variation can be arisen. By appointing well experienced supervisors, it can be known about risks the project will face beforehand. As per Halwatura and Ranasinghe, (2013) the examination should be done appropriately by qualified and experienced skillful staff at the beginning stage (within the pretender period) and sufficient planning in development is required by all included parties before work begins at the site. The estimation work should be formulated. Further, consultants should guarantee that the designs and specifications drop within the initial financial limits. Further, all parties ought to estimate unanticipated situations. Specialist coordination is required at the planning stage, and utilization of an experienced specialist to create a proper plan and drawings.

2.5 Initial results obtained from the literature overview

Following Table 1 shows the causes of variation orders which acquired from literature survey. From literature survey it was found that variations can be happen under 4 main categories. They are, • Owner related variation causes • Contractor related variation causes • Consultant related variation causes • Unspecified variation causes. Based upon above main 4 categories following listed are the most common causes.

Ruben Ndiokubwayo [1], Andualem Endris Yadeta [2], R.U. Halwatura and N.P.N.P. Ranasinghe [3], Haimanot Chalchissa [4].

Table 1. Causes of variation orders

Causes of Variation Orders	Source [1]	Source[2]	Source[3]	Source[4]
Difficulty in rapid decision-making process	√	√		√
Change in design by the parties		√	√	√
Insufficient drawing details	√	√		
Change in specifications	√	√		√
Destitute in procurement process	√	√		√
Scarcity of communication	√	√		√
Unforeseen problems	√	√	√	√
Design faults	√	√	√	√
Contractor's desire on high profit		√		√
Absence of parties' involvement in design	√	√		
Change of plans or scope (including timeplans)	√	√	√	√
Lack of strategic planning	√	√	√	

Contractor's lack of required testimonies and professionalism		√		√
Consultant's lack of judgment and professionalism	√	√		
Consultant's lack of required testimonies	√	√		
Poor coordination within involved parties	√	√		√
Varying site conditions		√	√	
Unawareness with local conditions		√	√	
Void of skills (including labors)		√	√	√
Transition in budgetary conditions	√	√	√	√
Technological variations	√	√	√	√
Climate conditions	√	√	√	

3 MATERIALS AND METHODOLOGY

The initial information for this study was gathered from a literature overview. Advance, a set of questions were distributed among experts within the road development ventures in Sri Lanka. The writing survey was done by reviewing the online sources, and construction administration and designing journals. The quantitative analysis is supposed to be done in online form. To achieve the research's goals, the questions were divided into five parts: General information (company and respondent profiles) make up section 1. The prevalence of variants in road construction projects is covered in section 2. Causes of variation orders are covered in part 3. Implications of variation on time management are discussed in section 4. Lastly, strategies to minimize variations are discussed in section 5.

4 RESULTS

This study examined how variations in road construction projects in Sri Lanka impact on time management. The outcome of the analysis is presented in this chapter. The Statistical Package for Social Sciences was used to examine the data collected. Science (SPSS).

4.1 Respondents' profile

All parties who serve as clients, consultants, and contractors were provided with 14 questions. Thirty-three responses were responded which was sufficient for data analysis and discussion of the study. The professionals from various parties involved in Sri Lanka's Road construction industry who were working on projects were the target respondents of the survey. According to Table 2 below, among the responders, 23 (69.7%) were contractors, 7 (21.2%) were consultants, and the other 3 (9.1%) were clients or owners' representatives.

Table 2. Type of the organization

Type of the organization				
		Frequency	Percent	Cumulative Percent
Valid	Consultant	7	21.2	21.2
	Contractor	23	69.7	90.9
	Owner/ Client	3	9.1	100.0

According to Figure 1, the majority of respondents (69.7%) worked as contract administrators, followed by 27.3% of site engineers, 6.1% of project managers, 21.2% of quantity surveyors, and rest were consisted of technical officers, structural and planning engineers, site surveyors and safety officers.

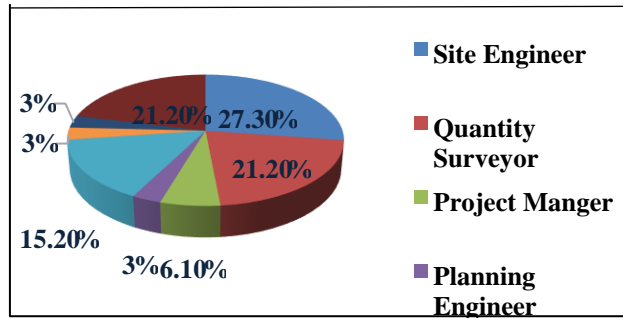


Figure 1. Current position of the organization of respondents'

The majority of responders had 0 to 5 years of experience, according to their years of experience. 57.6% of respondents have less than five years' experience, 21.2% have six to ten years' experience, 12.1% have eleven to fifteen years' experience, and 9.1% have more than fifteen years' experience.

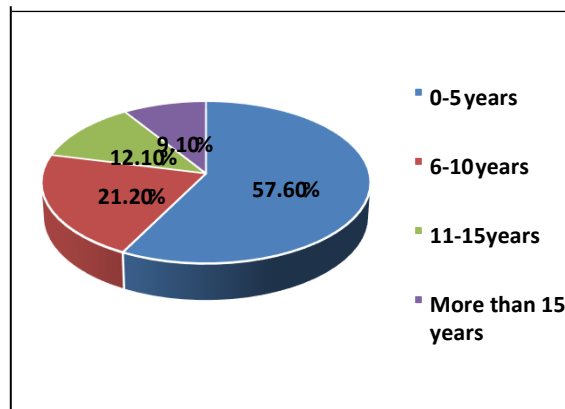


Figure 2: Professional experience in road construction projects

4.2 Factors causing variations

Under factors causing variations there were 5 categories upon their nature. These categories were further sub categorized for precise data collection.

- Variations which occur due to site conditions
- Variations which occur due to involved parties
- Variations which occur due to technical factors
- Variations which occur due to procurement process
- Variations occur due to local conditions

A mean score of 0 indicates that respondents strongly disagree with the measuring variable used in this study, a number between 1 and 2 indicates that respondents are disagreeing, and a score between 2 and 3 indicates that respondents were neutral.. Respondents who gave the statement a mean score of 3.00–4.00 indicated agreeing and a mean score of 4.00– 5.00 strongly agreed with it.

Under variations which occur due to site conditions three factors were subjected into consideration. In item 1- Right of Way (ROW) which means difficulties faced in land acquisition process was ranked 2nd with the mean score was 3.6970. It means majority of the respondents were agreed upon the statement. In item 2- Delay in obtaining permits from local authorities and insufficient coordination between the parties of relevant authorities; usually from electricity board, telecommunication and water authorities ranked in 1st with a mean of 3.8485. As in last, varying site condition ranked in 3rd. Based upon above statements it can be seen site conditions impact on a considerable range on variations.

Table 3. Variations which occur due to site conditions

Variations which occur due to site conditions						
	N	Minimum	Maximum	Mean	Std. Deviation	Rank
Right-of-way	33	1.00	5.00	3.6970	1.01504	2
Delay in Obtaining Permits from Local Authorities	33	2.00	5.00	3.8485	1.00378	1
Varying Site Conditions	33	1.00	5.00	3.3030	1.04537	3

According to the table 4 inefficient co-ordination within parties score a mean of 3.5758 which is most likely to be agreed on the statement. The disputes arise between the parties may directly affect on project variation when they are not coordinated properly by involved parties. In the 2nd score delays in engineers' decision making has taken place. Most respondents have agreed that prompt decision making process could be a cause. As in 3rd rank inadequate detailing provided by consultants specially about the site conditions, the population of the relevant area, and other engineering details. The item number 4 shows that contractor's lack of required testimonies and professionalism is not really affected on a variation.

Table 4: Factors which influence involved parties to get into a variation.

Variations which occur due to involved parties						
	N	Minimum	Maximum	Mean	Std. Deviation	Rank
Lack of Communication	33	2.00	5.00	3.151 5	.83371	4
Delays in Engineers decision making process	33	3.00	5.00	3.363 6	.60302	2
Poor coordination within involved parties	33	2.00	5.00	3.575 8	.86712	1
Contractor's lack of required testimonies and professionalism	33	1.00	4.00	2.697 0	.98377	5
Inadequate detailing provided by the consultants	33	2.00	5.00	3.303 0	.76994	3

Table 5 represents variations which occur due to technical factors. Rank no1- Required equipment and tools not been available scores a mean of 3.5455 which means most respondents have agreed that the lack of availability of tools and equipment can cause a variation. Furthermore, the inefficiency of these equipment also may cause to arise a variation. The mean score 3.5152 implies that most of the respondents have agreed that lack of skills including staff also a major cause of variation. The workmanship may not be available as per specifications. Other than that lack of technically competent and experienced staff has also impacted on variations.

Table 5: Variations which occur due to technical factors

Variations which occur due to technical factors						
	N	Minimum	Maximum	Mean	Std. Deviation	Rank
Scarcity of skills including labor	33	2.00	5.00	3.5152	.93946	2

The required equipment and tools not being available	33	2.00	5.00	3.5455	.75378	1
Health and safety considerations	33	1.00	5.00	3.4242	.93643	3
Lack of technical competent staff	33	1.00	5.00	3.1212	1.05349	4

According to the table 6 it can be observed that procurement process causes a considerable impact when comparing to other variation causing factors, as they clearly show a higher mean value. The design faults have scored a mean of 4.0303 which means most of the respondents have strongly agreed that design faults cause variations. The rank 2nd and 4th describe causes which are more over similar to 1st rank while in 3rd place respondents have agreed that alteration of plans including time plans most probably time extensions, cause variations. Other than that poor estimation and transition in budgetary conditions have also been impacted on variations. Value engineering (mechanism of saving cost for mutual benefit) the mean score of 3.4848 implying the most respondents have agreed that the mechanism of saving cost for mutual benefit is one of the reasons for variations.

Table 6: Variations which occur due to procurement process

Variations which occur due to procurement process						
	N	Minimum	Maximum	Mean	Std. Deviation	Rank
Change of plans including time plans	33	1.00	5.00	3.7879	1.08275	3
Insufficient project objectives	33	1.00	5.00	3.0909	.97991	10
Design faults	33	3.00	5.00	4.0303	.80951	1
Change in design by the parties	33	2.00	5.00	3.9091	.84275	2
Change in specifications	33	2.00	5.00	3.7273	.76128	4
Value engineering	33	2.00	5.00	3.4848	.83371	7
Additional preliminaries due to time extension	33	2.00	5.00	3.5758	.96922	5
Poor estimation	33	2.00	5.00	3.4848	1.06423	7
Transition in budgetary conditions	33	1.00	5.00	3.5152	1.03444	6
Changes in project duration	33	1.00	5.00	3.3030	.95147	9

In table 7 represents the other considerable factors causing variation orders. In the 1st rank the changes due to price inflation and fluctuations in foreign exchange rates have impacted considerably on variation. The climatic conditions mostly during the rainy seasons work cannot be carried out in open areas. Change in government regulations and unawareness also a main reason behind variations. Moreover, the ban imposed by the government currently (2023) on importing of construction materials and equipment has adversely impacted on the industry.

Table 7: Variations which occur due to socio, economic, and local conditions

Variations which occur due to socio, economic, and local conditions						
	N	Minimum	Maximum	Mean	Std. Deviation	Rank
Climatic conditions	33	1.00	5.00	3.848 5	1.00378	3
Sociocultural factors	33	1.00	5.00	3.121 2	.92728	7
Changes in government regulations	33	2.00	5.00	3.848 5	.79535	3
Unawareness with local conditions	33	1.00	5.00	3.181 8	.84611	6
Unforeseen problems	33	2.00	5.00	3.666 7	.88976	5
Changes in price due to inflation	33	1.00	5.00	3.939 4	.99810	1
Foreign exchange rate fluctuations	33	1.00	5.00	3.939 4	.96629	1

4.3 Effect of time on overall project performance due to variations

Time administration is a most important key component in road construction project. According to the findings it can be observed that that time has been negatively impacted by variations. Regarding the 1st item variation plays a major role when delaying of projects. The majority have agreed that occurrence of variations is inversely proportional to efficient time management. It means when variations increase it will allow a project to be inefficient in terms of time management. Most of the respondents have neutralized their opinions but still majority has extended that they disagree with the statement. So, it represents that when a variation is handled carefully so as the time plan will also be according to the provided schedule. But when comparing with the previous statement a little contrast can be seen between these. The time is directly proportional to the cost of the project. Majority of the respondents have agreed on the statement. Usually when the time is incurring the overhead costs, labor wages get increased eventually.

Table 8: Effect of time on overall project performance due to variations

Effect of time on overall project performance due to variations						
	N	Minimum	Maximum	Mean	Std. Deviation	Rank
Excessive variation orders result in incurring unnecessary time	33	1.00	5.00	3.1515	.87039	4
Reducing time duration of construction projects will results reduction on project cost	33	1.00	5.00	3.3030	.88335	2
No matter how carefully a variation order is administrated initial time plan will be altered	33	1.00	5.00	3.0000	1.00000	5
The reduction of variability in construction operations can contribute to efficient time management	33	2.00	5.00	3.5758	.79177	1
The occurrence of variation orders is the major factor of delay in delivery in construction projects	33	1.00	5.00	3.2424	1.03169	3

4.4 Mitigation strategies to minimize variations

To overcome these issues some mitigation strategies have been proposed in the paper. The procurement process which means, precise designs and documents should be present. Also, before initiating the project scope, objectives should be clearly understood by the parties.

Coordination among parties, proper communication also plays a major role. Other than these even though parties get early warnings on variations it could be/ not be identify the issue in advance. This might happen due to unawareness with local conditions. Using modern technologies like BIM, lean principles also that might be because of the lack of knowledge about it between parties.

5 DISCUSSION

Based on the results which gained from both case study and the literature survey the eight most important factors causing variation orders can be discussed as follow.

1) Design faults

According to the findings, design issues brought on by errors and omissions result in delays, and the waste of public expenditures because they necessitate redesigning during the implementation stage. If it isn't fixed during the design phase, it may cause delays and productivity losses and, it might show up during the construction phase.

2) Unforeseen problems

The second most significant reason for order variation in road construction projects was discovered to be unforeseen site characteristics/unexpected ground conditions and terrain as a result of ineffective site inspections. The findings proved that while conducting proper site or subsurface studies, the responsible party, probably the consultant, do not learn much about the site conditions during the design stages. As a result, contractors frequently run upon unexpected subterranean or concealed circumstances throughout some projects, which can lead to variations and have a significant impact on the amount of time and budget needed to complete their work.

3) Change of plans including time plans

One of the primary reasons for construction project variation is changes to the planning including time plan. This is the result of poor project definition planning or a lack of owner participation in the design process. Through this study it was discovered that one of the factors that has a significant impact on project implementation is the client's additional scope of work.

4) Transition in budgetary conditions

The owner's financial issues have an impact on the project's overall development and quality. As a result, work plans and specifications are modified. Due of the dependency of laborers and subcontractors on the contractor, construction projects may be significantly altered by the contractor's financial issues. Such challenges during a project will lead to variation orders, which may also have an impact on the project's quality and progress.

5) Technological variations

The construction process evolves as a result of technological improvements, including construction methods may alter to meet quality and safety standards.

6) Changes in specifications

Due to insufficient project objectives, changes in specification are a typical occurrence in construction projects. If the client's requirements change, the construction phase will also change.

7) Climatic changes

Poor weather conditions might affect project construction, which could result in adjustments, delays, and higher expenses.

8) Delay in obtaining permits from local authorities or insufficient coordination between various departments in utility shifting and placing.

Finding the effects of variation order on time management was the study's second goal. To do this, the study organized the impacts from the literature, sought for professional input, and then set out to identify the effects of variation ordering based on respondent responses.

The results demonstrate that the most significant effect of variation orders on time of road projects is time extension (time overrun). Small variations may not affect overall project completion, but they will slow down development, according to Arain and Pheng (2006b). However, frequent minor and

substantial variations have a negative impact on the project and create delays in its completion. Even while contractors typically use the free floats in the construction schedules to account for the implementation time for variations, there are occasions when they become continuous and of a degree that prevents them from fitting within the floats. Every project assigns a contingency payment to account for potential project variations while retaining the total project cost because it is predicted that some project variations may cause the project cost to increase. However, frequent and significant deviations cause the contingency sum to cost more than expected.

Another most common issues in the construction sector which occurs due to variations is the delivery of construction projects being late. All individuals and organizations participating in the project are impacted by delays. This is certainly relevant for the owner's company because postponing the project's commencement would make it more difficult to generate the anticipated project revenue and will increase financial expenses. The obligations assumed based on the delivery date specified in the contract may also put the owner in a difficult situation. On the other hand, extending the project's execution period typically forces contractors to deal with cost overruns caused mostly by the following factors: additional management personnel costs, material cost inflation, finance cost growth, contract penalties, etc.

According to the results obtained from both literature overview and case study the main strategy proposed was to conduct site investigations and preparing of precise design documents during procurement processes.

Conducting site investigations prior to initiation of the project will minimize the risk of variations which occur due to contrasting geographical features and other circumstances. Being more aware during the procurement processes is an important task because variation in design may lead to rework which incur cost and time also. Defining project goals and scope of the work plays an important role when it comes to minimization of variations. Each individual should have an idea about the project so that he/she can contribute as required. Since various parties are including proper communication should be at its maximum potential. Because if a party propose an opinion and if it does not go through with other parties properly not only variations even misunderstandings and contradictions may occur. Moreover, working with experienced staff (both technical and labor) will lead to resolve negative effects of variations as in getting specialized labor for machinery and equipment handling and specially knowing their potential.

Apart from that using modern construction methods, integrated procurement methods (i.e., lean principles, BIM technology) would minimize variations in the industry.

6 CONCLUSION

The first objective of the study was to find prevalence, causes and origin agents of variations in Sri Lankan Road construction industry. The most common cause was disputes arise in designing stage. The same opinion was headed by authors in literature survey too. Therefore, based on the data obtained from both studies' variation seems to be a major problem in Sri Lankan Road Construction projects and the main effect of it on works are omission of works. The client has a higher responsibility when compared to other parties throughout the project.

The second objective of the study is to find out how much impact does the variation affect on time of a project. As in both studies variation results negatively in overall project performance.

Even if it's a minor or major variation incurring of excessive time could not be neglected. Since project cost, time and quality are interconnected if time is altered definitely the project cost and quality will be altered. Apart from that if a project experiences a time overrun the reputation of the organization will get damaged so as disputes and conflicts may arise between involved parties. For efficient time management project management tools could be used.

According to the third objective of the study there were various strategies proposed to minimize variation orders in the industry. Conducting site investigations at an initial stage of a project is most important. The whole process should be involved by well experienced and technically qualified staff. Defining project objectives and scope in a clear manner at an earlier stage so that everyone knows their duty prior. Precise procurement processes including design documents, proper estimations play a major role when minimizing variations. Better coordination with involved parties in every stage of the construction also play a vital role. Ensuring that designs and specifications are on point before

commencing major stages of the process is important. Since road construction directly deals with the public and other stakeholders, management of them should be done carefully and in a polite manner.

According to the study's findings, variation orders are one of the biggest issues with Sri Lankan Road construction projects and have a big impact on their success. The first issue that needs to be addressed in order to minimize variation orders and their impacts is effective management of construction modification, which calls for both engineering and project management expertise. The design stage through the construction phase is all considered possible causes of variable order in this study. The researcher advises that thorough planning should be done at the beginning of the project by all stakeholders involved.

7 ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my advisor Mr. Hemantha Bandara for the continuous support of my research, for his motivation, patience, and immense knowledge.

Beside my advisor, I must thank Dr. Upaka Rathnayake, Prof. Saman Thilakasiri, Dr. Ayantha Gomes for giving us this valuable opportunity to come up with a thesis. I would also like to thank all the experts who were involved in this thesis and in the survey for this research, without their participation the survey could not have been successfully conducted.

Finally, I must express my very profound gratitude to my parents and to all my friends for providing me with unfailing support and constant encouragement during my years of study and through the process of researching and writing this thesis.

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