STAKEHOLDER MANAGEMENT OF THE IMPACT OF DESIGN CHANGES ON THE TIME, COST AND QUALITY TARGETS OF BUILDING PROJECTS IN SRI LANKA

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ABSTRACT

The activities specific to the construction industry make it distinct from and more complicated compared to other industries. In construction projects, the tendency for changes is higher during the pre contract and post contract stages. Design changes can occur for several reasons, i.e. involvement of stakeholders in the project and they impact on project parameters (time, cost and quality). Since the majority of these impacts would have a negative effect on project parameters and the success of the, this research was done to explore the management of the impact of design changes on project parameters. A literature survey was first carried out followed by a preliminary survey and a questionnaire survey to explore the reasons for design changes and the main impacts of such design changes on time, cost and quality of a project. The analysis reveals that changes in the client's requirements are the main reasons for design changes. Accordingly, it is recommended to have an effective client's brief and a proper project management team for minimizing design changes and for managing their impact on project parameters.

Keywords: *Design Changes; Designing Stages; Time, Cost and Quality*

INTRODUCTION

The construction industry has a high influence on other industries, and the GDP and capital goods of a country (Abeygunawardane, 1993). According to Hemantha (2003), a construction project is a unique product. It is specially designed for the requirements of a client and involves different categories of professionals from the industry. Merritt (1989) has stated that the architect does the overall planning of the building according to the client's needs incorporating the consultant's input in the contract documentation. Erberhard (1970) says that the client would expect more than what he needs and that the architect has to identify these needs exactly. The client's requirements can change throughout a construction process (Hemantha, 2003).

A change in a construction project is a deviation from the original plan resulting from unexpected circumstances (Revay, 2003) which can be either positive or negative (Hanna, 2002). A positive change will save the cost and time of the project and may even improve the quality or the scope of the work. A negative change will deteriorate project outcomes (Hemantha, 2003). According to Ali et al. (2011), a design change is a design error, a design omission, a different site condition or even a scope change. According to Charles (1995), the main reasons for design changes are the changes in the client's requirements, inadequate experience of the architects and structural engineers and conflicts among them and the of the design process by separating out the design phase from the shop drawing review phase and the construction observation phase.

For a construction project to be successful, design changes and their effects on time, cost, and quality of the project have to be identified. This Paper explores the way the stakeholders of building projects in Sri Lanka should manage the impact of design changes on time, cost and quality of the projects. The research aim is achieved by identifying the design changes and their significance at each design stage of a project, problems caused by them, parties responsible for them and their significance on the time, cost and quality of the project and by developing a framework to manage design changes on time, cost, quality parameters.

LITERATURE SYNTHESIS

A construction project relates to the erection of a building or a civil construction or to the process of their erection (Chan et al., 2004). It includes activities that interact with each other at different stages (Ali et al., 2011). Kagathas (2006) has mentioned that a construction process would start with the client's brief provided to the designer stating the requirements and constraints. The initial brief would indicate value for money and describe a pleasing construction product, its purpose and delivery time (O'reilly, 1987). The main activity of the design stage is to complete the project brief and determine the layout, design, methods of construction and estimated costs of the building/ structure so that the necessary approvals from the client and authorities concerned could be obtained (Austen and Neale, 1984).

The Royal Institute of British Architects (RIBA) Plan of Work 2013 (2013) describes the briefing, designing, constructing, maintaining, operating and using building projects and divides them in to eight stages identifying the first five stages as design stages and the other three as construction stages. The design stages are the Strategic Definition, Preparation and Brief, Concept Design, Developed Design and the Technical Design. This RIBA Plan of work 2013 was selected to consider design changes since it clearly defines the design process which includes the developer's brief, outline design and the detailed design.

From among different classifications available for design changes, the classification done by CII (1990) based on the net effect on scope was selected for this research since it classifies the changes in a more competitive manner than the others. It is shown in Figure 1.

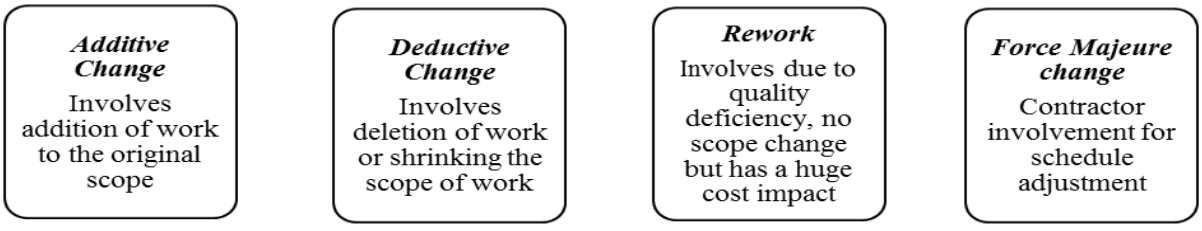

Figure 1: Change classification based on net effect on scope

Source: Construction Industrial Institute (1990)

Changes happen due to additions to or deletions from the work , changes in the materials specified, corrections to the specifications or drawings, acts or omissions of other contractors or trades, departures from the contract schedule, changes in the sequence in which work activities are performed, and changes in the performance resulting from construction conditions (Article Changes, 2010). Design changes made during the pre-contract stage affect the main parameters of a project, i.e time, cost and quality and lead to low productivity, delays and disputes between client and consultant (Al-Dubaisi, 2000). Huovila et al. (1997) have stated that their impact on time is more significant than on cost. Another effect due to design changes is the financial risk (Zainudeen et al., 2008). Kaming et al. (1997), Jackson (2002), Rexi (2004) and Musthak (2005) have identified design changes as the primary and major cause for cost overruns in a construction project. According to Wang et al. (2013), the effect of design changes can basically be categorized in to two types i.e those due to internal / external causes and those that have direct / indirect impact. According to Kaming et al. (1997), Ali et al. (2011) and Kasimu (2012) design changes that lead to a reduction in the quality of work of the consultancy team to ensure on time completion of the project are significant for time over runs.

Stakeholders are those who get involved in a project whose positive or negative contributions affect the results of the project directly or indirectly (Malkat and Byung-GYOO, 2012). They can be either primary or secondary stakeholders. Owners, consultants and contractors are t primary stakeholders who can have a direct effect on the project. Secondary stakeholders such as government, general public and the communities interact with the project in an unpredictable manner (Malkat and Byung-GYOO, 2012). According to Malkat & Byung-GYOO (2012), the most salient stakeholder is the client since he gives his full commitment and contribution from the beginning to the completion of the project and is able to make changes at any time. Ackermann and Eden (2011) however have said that both the client and the consultant are the most significant contributors to design changes .

Huovila et al. (1997) have identified the following for minimizing design changes during a design stage:

- Adopting standards for design information through which false impressions and loss of time in understanding them could be avoided
- Introducing continuous improvement in the design process to avoid repetition of design defects
- Incorporating construction expertise to get solutions for unforeseen conditions that happen at the site

Alarcon and Mardones (1998) have introduced four steps to minimize design changes during a design stage such as supervision, coordination, standardization and control. Al-Dubaisi (2000) has identified a procedure of change control to minimize design changes such as the ability to negotiate changes, justification of changes, encouraging team work, change order for scope, approval in writing and quick approval.

Time, cost and quality are the parameters which get affected due to design changes and cause failure of a construction process. Therefore it is necessary to explore the way stakeholders can manage the impact of design changes on time, cost and quality of building projects in Sri Lanka.

RESEARCH METHODOLOGY

The quantitative approach was adopted for this research study. Firstly, four preliminary semi-structured interviews were carried out with experienced key construction professionals in Sri Lanka to obtain their views about the different types of design changes that take place during the design stages of a construction project, reasons for and the impact of the identified changes and the change control procedure during design stages. The questionnaire prepared based on factors identified from both literature and the preliminary survey was distributed among 35 professionals in the industry who were either consultants or owners of ongoing construction projects located in and around Colombo. With a view to identifying the extents of delay, difference in cost in the initial estimate from that of the Bills

of Quantities and the change of quality due to design changes caused by various reasons, only recently commenced construction projects were considered in the project . The RII technique was adopted to analyze the quantitative data collected. The results of the preliminary interviews and the analysis of the quantitative data are given in the section on analysis.

RESEARCH FINDINGS

Preliminary Survey

Since there are different types of design changes and there is variation among their applications during the design stages defined in the RIBA Plan of Work 2013, it was necessary to ascertain their suitability for Sri Lanka. Thus a preliminary survey was carried out to validate literature findings. Its outcome as shown in Table 1 tallied with literature and the preliminary survey findings. In the concept design and the developed design stage there can be additive, deductive and rework design changes. In the technical stage, force majeure change can also occur.

Table 1: Comparison of reasons for design changes identified from the literature and the preliminary survey

	Literature	Preliminary Survey
Reasons for design changes	Changes of client's requirements	Changes of client's requirements
	Lack of coordination among the members of the design team	Lack of coordination among the members of the design team
	Lack of communication	Lack of communication
	Inadequate experience of the consultancy team	Inadequate experience of the consultancy team/client
	Unexpected site conditions	Unexpected site conditions
	Changes to drawings	Improvements made to the design by the Architect
	Changes to specifications	Financial difficulties of the client
		Practical difficulties of the design
		Rules and regulations of the authorities
		Geographical changes
		Economical changes

Through the preliminary survey, reasons for various design changes were investigated and Table 1 shows the comparison of the reasons identified from the literature and the preliminary survey. According to experts, client's requirement changes lead to changes to drawings and specifications. Strategies for managing design changes during designing were also investigated through the preliminary survey and Table 2 presents the comparison between the findings of the literature and the preliminary survey.

Table 2: Comparison of strategies that manage design changes during design stages identified from the literature and the preliminary survey

	Literature	Preliminary Survey
Strategies to manage design changes	Good supervision	Using a project management service at the conceptual design stage
	Coordination	Coordination
	Standardization	Good negotiations
	Team effort	Utilizing contractors' knowhow for the design
	Good negotiation	Justification of changes
	Utilizing contractors' knowhow for the design	Team Work
	Justification of changes	
	Team Work	

Questionnaire Survey

The questionnaire was based on four types of design changes (Additive change, Deductive change, Rework change, Force Majeure change) which can occur during the three design stages identified in the RIBA Plan of Work 2013, eleven types of reasons that cause design changes and the main impacts of a design change on time, cost and quality of a project. The main objectives were to identify the significance of design changes , the party responsible for each change and their significance on the time, cost and quality of a project.

The questionnaires were distributed among 35 professionals in the industry who were either consultants or owners of ongoing construction projects in and around Colombo. Thirty one of them responded. Figure 2 shows the response rate and Tables 3 and 4 give the details of the respondents.

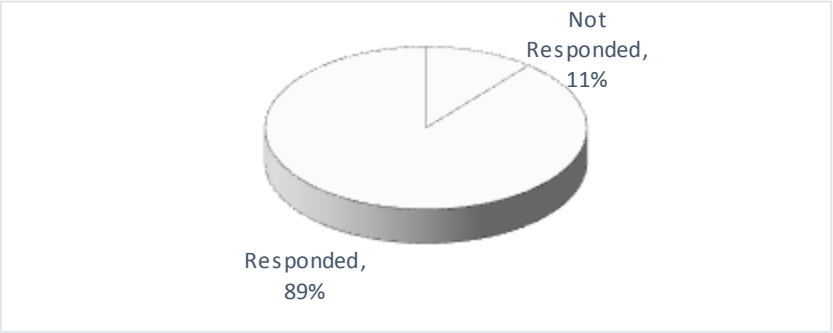

Figure 2: Rate of Response

Table 3: Respondents' Professions

Profession	Number	Number Responded	Response Rate (%)
Architect	10	10	100%
Engineer	10	7	70%
Quantity Surveyor	12	11	92%
Client	3	3	100%
Total	**35**	**31**	**89%**

The response rate of 89% is a good response rate for the research as per Taylor (2010).

Table 4: Respondents' Experience

Years of Experience	Frequency	Percentage	Cumulative Percentage
1-5	1	3%	3%
5-10	10	32%	35%
10-15	13	42%	77%
15-20	4	13%	90%
20-25	3	10%	100%
Total	**31**	**100%**	**100%**

According to Table 4, 97% of the respondents have more than 5 years of relevant experience in their carriers.

Findings of the Questionnaire Survey

According to Table 5, the concept design stage has a higher significance for additive changes than deductive and rework changes. Rework change has a higher significance at the developed design stage.

Table 5: Importance Index of the Significance of Design Changes

Design Stages	Type of Design Change	Relative Importance Index (RII)	Rank
Concept Design	Additive change	64.52%	1
	Deductive change	53.55%	2
	Rework change	50.32%	3
Developed design	Rework change	68.39%	1
	Additive change	63.87%	2
	Deductive change	60.65%	3
Technical Design	Additive change	77.42%	1
	Rework change	69.03%	2
	Force Majeure change	69.03%	3
	Deductive change	63.87%	4

Reasons for different types of design changes at each stage

<u>Reasons for Additive Changes</u>

Figure 3 presents the most significant and common reasons for additive changes during stages related to concept design, developed design and technical design. , i.e client's requirement changes, improvements to the design made by the Architect, financial difficulties of the client and lack of coordination among the members of the design team.

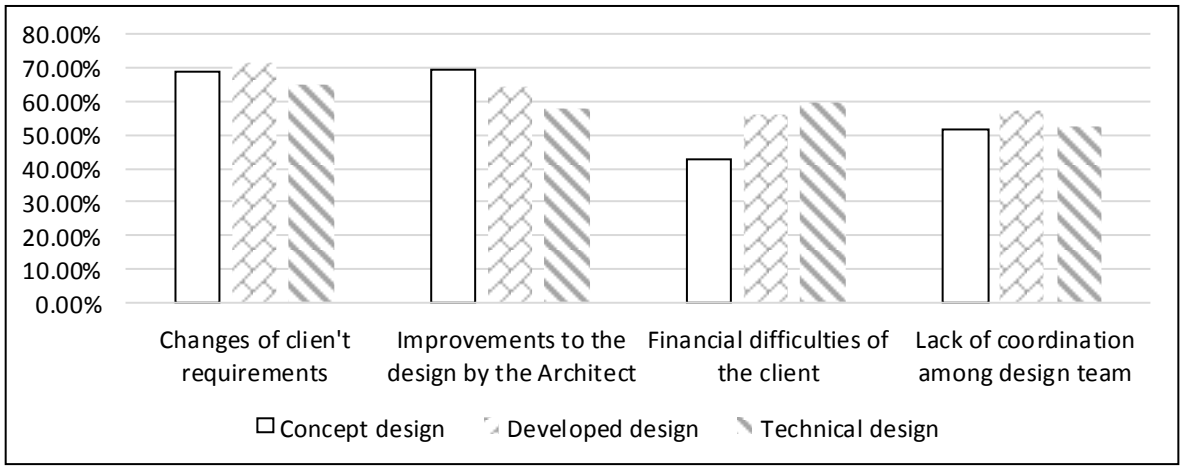

Figure 3: Importance Index of main reasons for Additive Change at each of the design stages

<u>Reasons for Deductive Changes</u>

Figure 4 shows the most significant and common reasons for deductive changes during concept design, developed design and technical design stages with client's requirement changes being most significant for deductive changes in all three stages. The financial difficulties of the client and lack of coordination and communication among the members of the design team will also be main and common reasons for deductive changes.

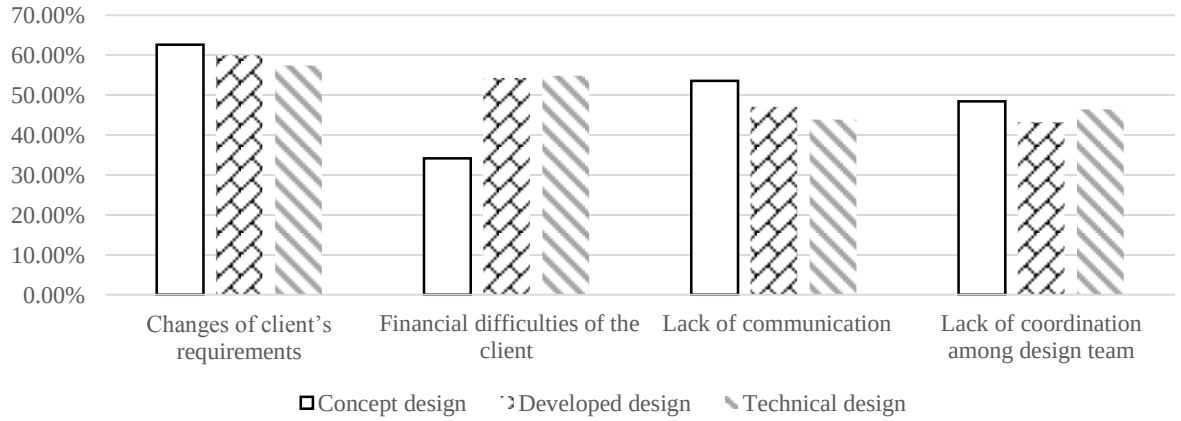

Figure 4: Importance Index of main reasons for deductive change at each designing stage

Reasons for Rework Changes

Figure 5 presents the most significant and common reasons for rework changes during concept design, developed design and technical design stages, i.e changes of client's requirements, improvements to the design made by the Architect, financial difficulties of the client and practical difficulties of the design. Lack of experience of the consultancy team/client, economic changes and unexpected site conditions could also lead to rework changes.

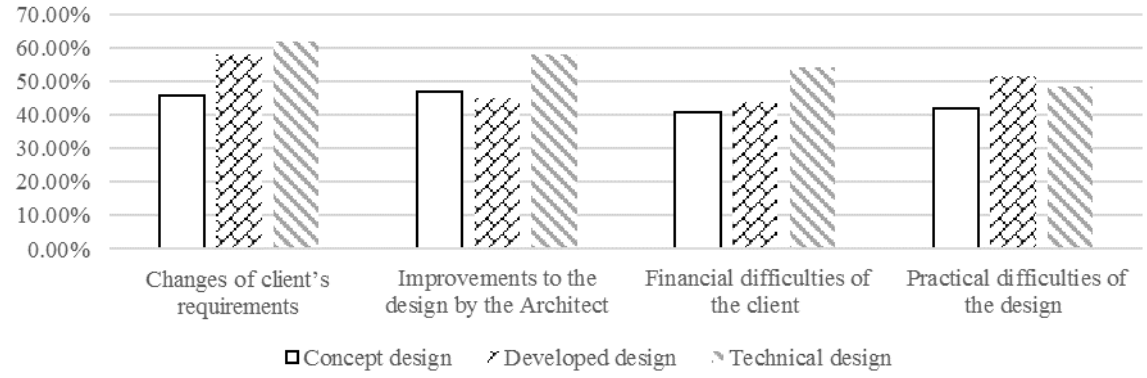

Figure 5: Importance Index of main reasons for the rework change at each designing stage

Reasons for Force Majeure Changes

The significant and common reasons for the force majeure changes at the technical design stage of a construction project are the lack of coordination and communication among the members of the design team, unexpected site conditions, lack of, geographical changes, economic changes and client's requirement changes. Force majeure changes can happen due to unforeseen reasons such as unexpected site conditions, geographical changes, and economic changes .

Impact of each type of design change on time, cost and quality targets

According to Figure 6, rework change has a higher impact on the time parameter compared to other design changes. The impact of additive, deductive and force majeure changes on time are comparatively similar. Deductive change has a higher impact on cost than the other three types of change with additive changes having a higher impact on the quality than the other three changes .

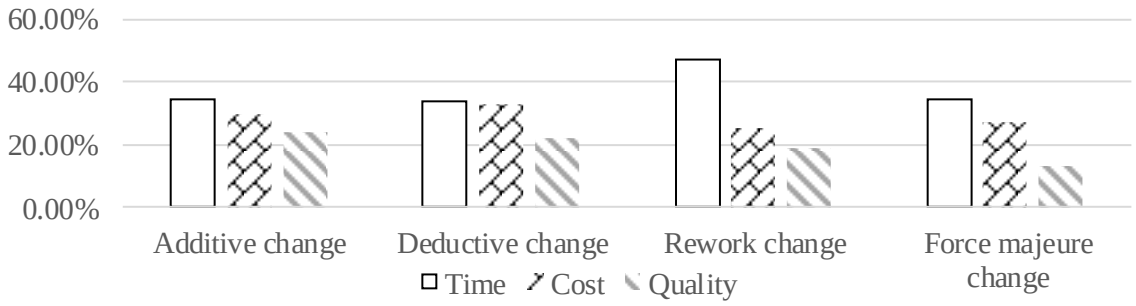

Figure 6: Impact of each type of design changes towards time, cost and quality of a project

Stakeholder's effect on design changes

<u>Party responsible for Design Changes during Concept Design</u>

According to Figure 7, the Architect is the person most responsible for design changes during concept design, followed by the client, engineer and quantity surveyor in that order.

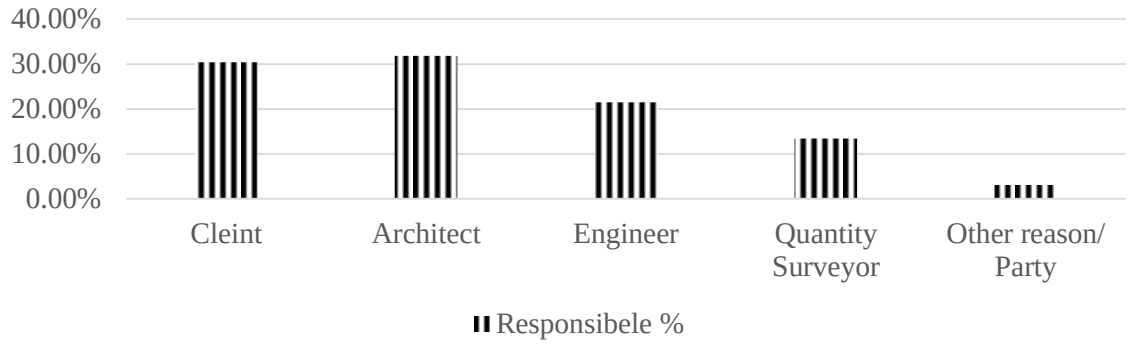

Figure 7: Party responsible for the design changes during concept design

<u>Party responsible for design changes in the Developed Design</u>

The client is the party most responsible for design changes in the developed design followed by the architect, engineer, and quantity surveyor in the given order (Figure 8).

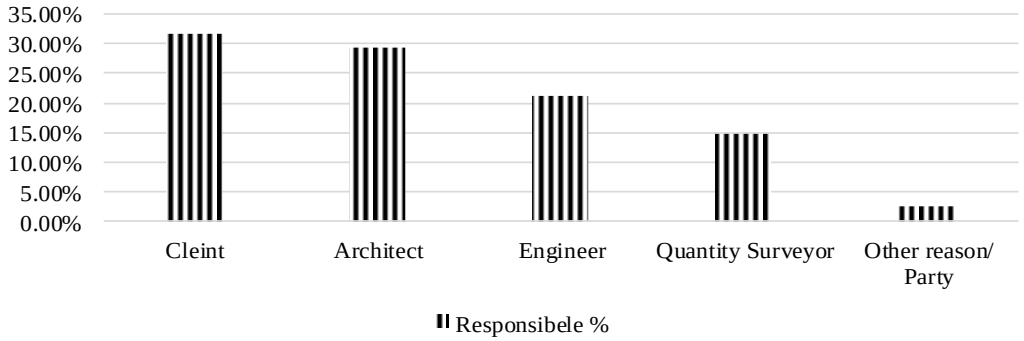

Figure 8: Party responsible for the Design Changes of a Developed Design

Party responsible for design changes in the Technical Design

According to Figure 9, the architect is the party most responsible for the design changes of the technical design followed by the client, engineer and quantity surveyor in that order.

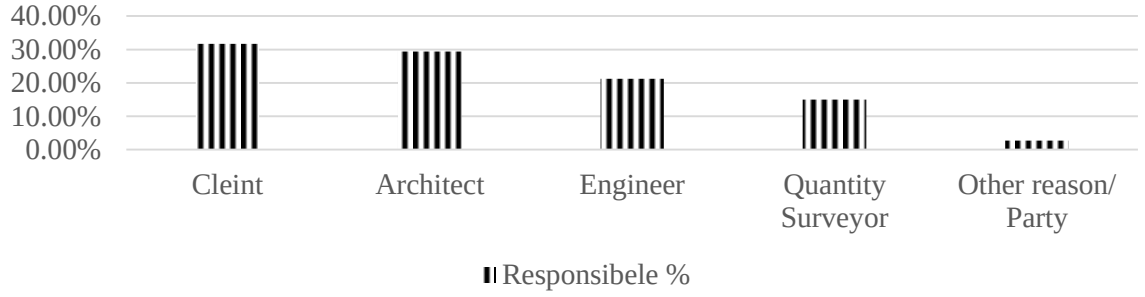

Figure 9: Party responsible for the design changes of the technical design

The party responsible for the overall changes in the design stage is the client (Figure 10). The architect, engineer, quantity surveyor and other parties have less responsibilities.

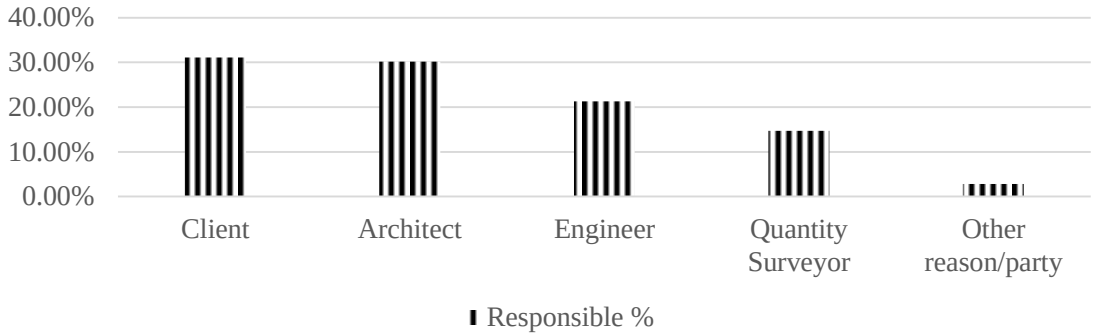

Figure 10: Party responsible for changes at all of the design stages

CONCLUSIONS

In construction projects there is always a tendency for design changes during both design and construction stages. According to the analysis done, at any design stage, three types of changes, i.e additive change, deductive change and rework changes can happen for various reasons. Project owners are mostly responsible for initiating changes during design stages due to financial constraints or due to specification changes. The architect is also often responsible for changes during design stages. Some of the main reasons for changes done by the design team comprising the architect, engineer and the quantity surveyor are the modifications to the design, and the lack of coordination among the members of the design team. Due to these ultimately the major parameters of a construction project, namely those related to its duration, cost and quality would be affected even at the initial stage. In addition, time over runs can occur significantly leading to drastic cost overruns. These will ultimately have a negative effect on the quality of the project. It is recommended that the client be advised effectively during the design stage to finalize his design as much as possible. It is also recommended that there should be a clear client's brief, an effective mechanism for communication among the members of the design team as well as with the client, adequate financial planning and strategic decision making by the client and a proper procedure for the team to manage the impact of design changes on project parameters; time, cost and quality.

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