The Influence of Change Orders leading to Disputes in Construction Phase: Contractors' Perspective

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ABSTRACT

Changes and Change Orders are inevitable in almost every type of project. It plays an important role in determination of quality, the overall cost and the completion time of a construction project. Thus, the Change Order process should be managed well. The Change Orders in construction are one of the main causes of conflict between the owner and the contractor. Unless a good management is applied to conflicts, they quickly turn to disputes which require resolution. The dispute resolution process is highly time consuming and costly manner.

The study aims to examine the influence of Change Orders leading to disputes in construction phase of a project from the contractors' perspective. To identify the objective, a questionnaire survey is carried out. To do so, 37 common Change Orders are selected from the literature and the questionnaire survey is carried out with 52 construction companies from the private sector of the North Cyprus construction industry.

From the analysis of the 37 change orders, 4 of them are identified to be the most effective. They are As-built used for design were incorrect, Late issue of design, Change in timing of vendor drawing approval, and Design changes. As it can easily be seen, the all 4 most effective change orders are related with the design. The 4 least effective change orders are identified as Regulatory/Permit change, Code change, Change in access to the work area, and Accident-Change in safety approach. As it can be seen the 3 least effective change orders are related with the regulatory changes.

Often Change Orders can become a polarizing factor between the parties. The owner's objectives are to minimize the impact of Change Orders to the greatest extent possible as a measure of control over a project's budget and schedule. Comparatively, the contractor's interests may involve expanding the scope of work beyond the defined by the contract, in addition to boosting its project revenue. The differing objectives between the parties can result in divergent positions and the inability to attain fair and equitable relations in changes. If the owner and/or the contractor elect to ignore or postpone the negotiation and settlement of Change Orders until the end of a project, the issues that may have been previously solvable have a greater potential of being disputed and becoming claims.

The researches and studies on variations and Change Orders, and their causes and effects are still limited. Further researches and studies should be done in order to have more information and knowledge in hand to fulfil the requirements of the construction industry. The researches should be done in the design, bidding, contract, and construction phase. It has a significant importance for the studies to be done especially in the construction phase which is the case of this study. So that, the researchers will have more data, information and knowledge in hand for further studies and the construction industry will get benefit from them.

Keywords: Change, Change Order, Claim, Conflict, Dispute, Construction, North Cyprus.

ÖZ

Değişiklik ve Değişiklik Emirleri, hemen hemen tüm proje türleri için kaçınılmazdır. Bunlar, bir inşaat projesinin kalitesinde, genel maliyetinde ve tamamlanma süresinde önemli rol oynarlar. Bu yüzden, Değişiklik Emirleri süreci iyi yönetilmelidir. Bir inşaat projesindeki Değişiklik Emirleri, mal sahibi ve yüklenici arasındaki başlıca anlaşmazlıklardan biridir. Eğer bu anlaşmazlıklar iyi yönetilmezse, bunlar süratle tartışmalara yol açar ki çözümlenmesi zor bir hal alır. Bu çözümleme süreci oldukça zaman alıcı ve maliyetli işlemlerdir.

Bu çalışma, yüklenici bakış açısından, bir inşaat projesinin inşaat yapım safhasındaki, mal sahibiyle yüklenici arasında itilaflara yol açabilecek Değişiklik Emirlerinin etkilerini incelemeyi hedeflemektedir. Bu hedef doğrultusunda, bir anket çalışması yürütülmüştür. Bunun için, literatürden 37 genel Değişiklik Emiri seçilmiş ve Kuzey Kıbrıs inşaat endüstrisi özel sektöründen 52 inşaat firmasıyla bir anket çalışması yürütülmüştür.

37 değişiklik emirinin analizi sonucunda, 4 değişiklik emri en etkili olarak öne çıkıtı. Bunlar, Yerinde yapılmışlardan hazırlanan tasarımın yanlış olması, Tasarımın geç çıkması, Tedarikçi çizimlerinin onayındaki zamanlama değişikliği ve Tasarım değişiklikleri'dir. Kolaylıkla görülebileceği üzere, tüm enetkili değişiklik emirleri tasarımla alakalıdır. En etkisiz 4 değişiklik emri ise, Mevzuat/izinler değişikliği, Yönetmelik/standartlar değişikliği, Çalışma alanına girişteki değişiklik ve Kaza-emniyet yaklaşımındaki değişiklik'tir. Burda da görülebileceği gibi en etkisiz 3 değişiklik emri kanun düzenlemeleriyle alakalıdır.

Değişiklik Emirleri, çoğu kez taraflar arasında kutuplaşmaya yol açabilecek bir etkiye sahiptir. Mal sahibinin amacı, Değişiklik Emirlerinin projenin bütçesi ve iş programı üzerindeki etkiyi mümkün olduğunca çok minimize etmektir. Mukayeseli olarak, yüklenicinin ilgisi, sözleşmede tarif edilen iş kapsamını genişletmek ve buna ek olarak proje gelirini artırmaya yöneliktir. Amaçlardaki farklılıklar, Değişiklikler için, tarafların birbirinden uzak pozisyon almalarına ve iyi ve adil bir ilişki yürütmelerine engel teşkil eder. Eğer mal sahibi ve/veya yüklenici, Değişiklik Emirlerini müzakere etmeyi ve bir karara bağlamayı, projenin bitimine kadar aldırmamayı veya ertelemeyi seçerse, önceden çözümlenebilecek konu sonrasında tartışmalara ve taleplere yol açabilecek daha büyük bir potansiyele ulaşır.

Değişiklik ve Değişiklik Emirleri, onların sebepleri ve etkileri üzerindeki araştırma ve çalışmalar hala sınırlı sayıdadır. Bu konudaki, İnşaat sektöründeki bilgi gereksinimini giderebilmek için daha fazla araştırma ve çalışma yapılması gerekir. Araştırmalar, tasarım, ihale, sözleşme ve inşaat yapım safhalarında yapılması gerekir. Çalışmalar, özellikle bu tezin de konusu olan inşaat yapım safhası da yapılması önem taşır. Böylece, hem araştırmacıların elinde daha ileri araştırmalar için veri ve bilgi olur, hem de inşaat sektörü bundan faydalanır.

Anahtar Kelimeler: Değişiklik, Değişiklik Emirleri, iddia, uyuşmazlık, ihtilaf, inşaat, Kuzey Kıbrıs.

TO MY FAMILY

FOR THEIR VALUABLE SUPPORT

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LIST OF ABBREVIATIONS

C	Change Order
CA	Chamber of Architects
CCE	Chamber of Civil Engineers
CTBA	Cyprus Turkish Building Contractors Association
DART	Dispute avoidance and resolution techniques
DRL	Dispute resolution ladder
RII	Relative Importance Index
SD.	Standard Deviation
SPSS	Statistical Package for Social Sciences

Chapter 1

INTRODUCTION

1.1 General Introduction

The construction business is a complicated and challenging atmosphere where the participants with altered visions, aptitudes, experience and education levels of the construction procedure work together. In this complicated atmosphere, participants from different professions, everyone has its own aims and everyone hopes to get the maximum of its own profits [1, 2].

A change is any kind of alteration from a settled upon, properly identified scope or work schedule. A change order is an approved document which helps to update the settled contractual settlement and gets to be part of the documentation of a project [3-5]. In all kinds of construction projects, Changes are shared experiences [3-6]. Among the leading causes of conflicts, changes have significant importance.

In the construction industry, as each party of a project, alters in perceptions, conflicts are not avoidable. Good management should be applied on conflicts; otherwise, they are for sure lead to disputes. One of the leading reasons that frustrate the construction project completion successfully is disputes. Therefore, it is essential to avoid the reasons of disputes so as to finish the project successfully, in the required base of schedule, financial plan and quality [1, 2].

There are confusion among construction professionals about the differences between conflict and dispute, and these terms have been used interchangeably especially in the construction industry [1, 2]. However, conflict and dispute are two distinct notions [7]. Conflict occurs whenever the interests of the parties are not compatible. Management can be applied to Conflicts, probably to be aware of the conflicts leading to disputes. Then again, one of the leading reasons that frustrate the construction project completion successfully is disputes. Disputes are accompanying with discrete justiciable matters and need resolution like mediation, negotiation, and arbitration, etc. [1, 2, 7].

This thesis aims to analyse the influence of change orders leading to disputes in the construction industry, in construction phase from the contractor perspective. So as to reach this goal, a literature review was carrier out to define the common construction change orders which may lead to disputes. The questionnaire survey was undertaken to rank the change orders by questioning 52 construction companies in the North Cyprus.

Finally, Statistical Package for Social Science (SPSS) was used to analyse the influence of change orders to determine the main causes of conflicts which may lead to construction disputes in the construction phase from the contractor perspective.

1.2 Research Questions and Objectives

This research is carried out to provide reasonable answers to the questions:

- What are the common change orders which may cause conflict between the client and the contractor?

- What are the influences of those change orders leading to disputes in construction phase, from the contractor perspective?

The objective of this research is to identify the change orders that may cause conflicts between the client and the contractor leading to disputes in construction phase.

1.3 Significance of the Research

There is limited amount of researches to determine the influence of change orders leading to disputes in the construction phase.

It is significant to identify the causes of changes, the effect of changes, and to construct an effective change management in the construction process for the construction companies [8].

In construction phase, change orders have negative effect on completion time, budget and quality [1, 2]. So, this will obviously raise cause of conflict between contractors and clients.

In this research, the determination of the influence of the change orders are aimed to give the construction industry an insight to manage change orders before turn to conflict. And an insight of conflict management, not to turn conflicts to disputes. Because, especially in construction phase the disputes are highly straggling duty, as the disputes requires resolution and it is highly time consuming and costly manner as it may requires litigation to be resolved [7].

1.4 Research Limitations

- The research examines the North Cyprus construction industry and is standing on the variations and change orders and their causes, effects and how to manage them not to turn to conflict and further to disputes. To do this 37 common change orders are obtained by literature review.
- In this research a questionnaire survey is carried out and is held by questioning 52 construction companies in the private sector in North Cyprus. The construction companies are of contracting class 1&2 of the registered construction companies of The Cyprus Turkish Building Contractors Association (CTBCA).
- The structure of this research is formed by examining the influence of change orders leading to disputes in construction phase from the contractors' perspective.

1.5 Research Structure

Chapter 2 identifies the Changes and the Change Orders in Construction. It also determines the causes, categorization of the causes of the Changes. Further, effects of Changes are mentioned. Finally, Change Order procedures and managerial recommendations are made.

Chapter 3 defines the differing notions of conflicts and disputes. Also the chapter identifies the common causes of Conflicts, and discusses the Conflict management and Dispute resolutions in construction.

Chapter 4 identifies the research methodologies in this study; that is to say, sampling, questionnaire survey, and data collection of the research.

Chapter 5 presents the analysis of the data gathered by the help of questionnaire survey and the results of the analysis.

Chapter 6 discusses the results of the analysis, presents theoretical contributions and managerial implications.

In **Chapter 7** conclusions of the findings of the study are presented. Recommendations to the Construction industry and suggestions for further studies are made.

Chapter 2

CHANGE ORDERS IN CONSTRUCTION

2.1 Introduction

As the Changes are one of the main problems in all kind of construction projects, it has a crucial importance to study and to make researches on that subject.

To do this, the different definitions of the changes and Change Orders from the various researchers are given. In this chapter, the common causes and categorization of the causes of Changes and Change Orders in construction are also identified. Then, because of the significance of the Changes in construction, the effect of Changes are mentioned.

Finally, As Changes are one of the main causes of conflicts, Change Order procedures and managerial recommendations are made in order not to cause conflicts and further to disputes.

2.2 Definitions of Change and Change Order

A change is any kind of alteration from a settled upon, properly identified scope or work schedule. A change order is an approved document which helps to update the settled contractual settlement and gets to be part of the documentation of a projects [3-5]. In all kinds of construction projects, Changes are shared experiences [3-6].

Decisions are made every day in construction processes based on incomplete information, assumptions and the personal experience of the construction professionals that might lead to change and/or rework. Both change and rework are done in the form of either ‘adding’, ‘deleting’ or ‘replacement [8].

A Change Order is a document that contractually alters an original agreement between the signed parties. Relative to construction, a Change Order is the result of an owner approved revision to terms and conditions (e.g., scope of work, timeframe for performance, price etc.) that are defined in a contract of a project [9].

2.3 The Causes & Categorization of the Causes of Changes and Change Orders

The reasons of changes and change orders are researched by literature review. It is seen that these reasons may be categorized considering the participants of a project. Hence the reasons are categorized into three considering the contracting participants: owner-related changes, consultant-related changes, and contractor-related changes. Further, to define changes considering the non-party related reasons, one more category is formed and identified as “other changes” [5]. Furthermore, this study forms one more category and makes it five, identified as the regulations-related changes.

2.3.1 Consultant-Related Changes

Consultant-related changes mostly arise from the design phase of a construction project and they are mostly related with the designs. Consultant related changes may be requested during the construction phase of a construction project mostly causing from the deficiencies in the design phase. Consultants may want changes causing from:

- Variations in specification made by the consultant: Changes in specification are frequent in construction projects with inadequate project objectives [4].
- Inadequacy in details of drawings for construction works: To convey a complete concept of the project design, the working drawings must be clear and concise [10]. Insufficient working drawing details can result in misinterpretation of the actual requirements for the project [11].
- Technology variations: Technologic changes may arise variations on a project. Project planning should be flexible for accommodating new beneficial variations [12].
- Ambiguousness of design details: A clearer design tends to be comprehended more readily [4].
- Complex designing: Complex designs require unique skills and construction methods [11]. Complexity affects the flow of construction activities, whereas simpler and linear construction works are relatively easy to handle [3].
- Conflicts among contractual documents: Conflict between contract documents can result in misinterpretation of the actual requirement of a project [13].
- Consultant's lack of needed information: A lack of data can result in misinterpretation of the actual requirements of a project [14].
- Poor coordination: A lack of coordination between parties may cause major variations with adverse impact on the project [11].
- Errors and omissions in design: Errors and omissions in design are a significant cause of project delays [11].
- Lack of knowledge about available equipment and materials: Knowledge of available materials and equipment is an important factor for developing a comprehensive design [10].

- Value engineering: Value engineering should ideally be carried out during the design phase [15].
- Variation in design made by the consultant: A change in design for improvement by the consultant is a norm in contemporary professional practice [11]. Changes in design are frequent in projects where construction starts before the design is finalized [3].
- Inadequacy in design: Inadequate design can be a frequent cause of variations in construction projects [3,16].

2.3.2 Owner-Related Changes

Owner-related changes are mostly caused due to the owner's obstinate and hesitant nature. As well as the owner's lack of knowledge about the construction industry and the processes carried out in the construction phase of a construction project are the general factors affecting the changes related with the owner. Owner related changes can occur causing from:

- Variation in specifications made by the owner: Changes in specification are frequent in construction projects with inadequate project objectives [4].
- Replacing the procedures or materials: The replacement of materials or procedures may lead to variations during the construction phase [5]. The substitution of procedures includes variations in application methods [17].
- Variation of scope: Change of plan or scope of the project is one of the most significant causes of variation in construction projects [18], and is usually the result of insufficient planning at the project definition stage, or because of lack of involvement of the owner in the design phase [11].
- Impediment to a prompt decision-making process: Prompt decision making is an important factor for project success [19,20]. Failure to efficiently address

decisions may result in delay, causing the need for the change order due to cost increments [5].

- Owner's difficulties in finance: The owner's financial problems can affect project progress and quality [4,21].
- Owner's persistent nature: A building project is the result of the combined efforts of the professionals involved, who have to work at the various interfaces of a project [11,22]. If the owner is obstinate then this could cause major variations at the later stages of a project [5].
- Inadequacy in project aims: Inadequate project objectives can cause variation in construction projects [23].

2.3.3 Contractor-Related Changes

Contractor-related changes occur in the construction phase of a construction project. The changes occur during the construction processes due to various reasons. Contractor related variations arise as a result of:

- Poor strategic planning: Proper strategic planning is an important factor for successful completion of a building project [21].
- Poor procurement process: Procurement delays have various adverse effects on other processes in the construction cycle [3].
- Different site conditions: There may be unforeseen problems at substructure construction that could not be picked up on a site investigation [5].
- Absence of equipment: Unavailability of equipment is a procurement problem that can affect the project completion [4].
- Complexity in design and technology: Complex design and technology require detailed interpretations by the designer to make it comprehensible for the contractor [14].

- Fast-track construction: Fast-track construction requires an organized system to concurrently carry out independent project activities [3].
- Desired profitability: Variations are considered a common source of additional work for the contractor [4].
- Lack of participation in design: Involvement of the contractor in the design may assist in developing better designs by accommodating his creative and practical ideas [11].
- Long-lead procurement: Procurement delays have various adverse effects on other processes in the construction cycle [3].
- Inexperience with local conditions: Familiarity with local conditions is an important factor for the successful completion of a construction project [21].
- Contractor financial problems: Whether the contractor has been paid or not, the wages of the worker must still be paid [24]. The contractor shouldn't have financial difficulties otherwise changes occur.
- Poor communication: A lack of coordination and communication between parties may cause major variations that could eventually impact the project adversely [11].
- Poor workmanship: Defective workmanship may lead to demolition and rework in construction projects [3,4].
- Absence of skills: Skilled manpower is one of the major resources required for technological projects [11].

2.3.4 Regulations-Related Changes

Regulations-Related Changes are related with the regulations of the laws of the country where the construction project is. Regulations are made by the authorities, and the parties including the owners, consultants, contractors as well as the

construction professionals should obey. Regulations-Related Changes arise as a result of:

- Regulatory/permit issues: Regulatory/Permit issues are the regulations made by the governmental authorities. The issues are about permits given and approved by the authorities such as municipality.
- Codes considerations: Codes are usually identified by the researches and they are made binding regulations by the Governmental authorities.
- Health and safety: Safety is an important factor for the successful completion of a building project [21].
- Work rules: Work rules define the regulations about the working rules such as working hours, working conditions etc.

2.3.5 Other Changes

Causes of changes that neither directly based on the regulations nor directly based on the parties involved in a construction project. Other changes may include:

- Unexpected difficulties: Unforeseen conditions are usually faced by professionals in the construction industry [4,21].
- Sociocultural features: Lack of coordination is often between professionals with different sociocultural backgrounds [4,].
- Weather conditions: Adverse weather conditions can affect outside activities in construction projects [3,4].
- Variation in economic circumstances: Economic conditions are one of the influential factors that may affect a construction project [3].

The detailed causes and the categorization of the causes of changes are given in the Table 1 below:

Table 1: Causes and categorization of changes (adapted from [5])

Category of Changes	Causes of Change	References
Owner-related Changes	Change of plans or scope	[18]
	Insufficient planning at the project definition stage, or lack of involvement of the owner in the design phase	[11]
	Owners' financial problems	[4,21]
	Inadequate project objectives	[23]
	Replacement of materials/procedures	[17]
	Impediment of prompt decision-making process	[19,20]
	Obstinate nature of owner	[11,22]
	Change in specifications by owner	[4]
Consultant-related Changes	Change in design	[3,11]
	Errors and omissions	[11]
	Conflicts among contract documents	[13]
	Technology change	[12]
	Value engineering	[15]
	Poor coordination	[11]
	Design complexity	[3,11]
	Poor working drawing details	[10,11]
	Poor knowledge of available materials	[10]
	Lack of required data	[14]
	Ambiguous design details	[4]
	Poor design	[3,16]
	Change in specifications	[4]
Contractor-related	Lack of involvement in design	[11]
	Unavailability of equipment	[4]
	Skills shortage	[11]
	Financial problems	[24]
	Desired profitability	[4]
	Differing site conditions; poor workmanship	[3,4]
	Fast-track construction	[3]
	Poor procurement process	[3]
	Lack of communication	[11]
	Lack of experience	[5]
	Long-lead procurement	[3]
	Complex design and technology	[14]
	Lack of strategic planning	[21]
Regulations-related	Regulations and Permits issues	
	Codes considerations	
	Safety considerations	[21]
	Work rules	
Other Changes	Weather conditions	[3,4]
	Change in economic conditions	[3]
	Sociocultural factors	[4]
	Unforeseen problems	[4,21]

2.4 Effects of Changes and Change Orders

By the literature review outcomes, effects of changes and change orders may be classified to 5 groups; these effect groups are quality-based, organisation-based, cost-based, time-based, and other effects [5].

2.4.1 Quality-based effects

Throughout a construction project, quality may be affected by changes. Changes, if frequently occurs, the work quality may be affected negatively [3]. Completion time of a project can be affected by changes and the quality may be affected negatively due to acceleration in construction process.

2.4.2 Organisation-based effects

Professional relations could eventually be affected by changes on any construction project, resulting of disputes and furthermore delay. Company's overall reputation can be affected severely by claims and disputes, and additionally can lead to professional disputes probable to happen. The safety conditions can be affected by changes in a construction project [4]. Extra health and safety approaches and precautions may be needed due to changes. Poor safety conditions and further rise in accident rates can be caused due to acceleration of the work. Additionally, late accomplishment of a construction causes disappointment in reaching quality needs, and a company's overall reputation may be tarnished due to rising accident rates, worsening professionals' relations and leading to disputes among the engaged professionals in a construction project.

2.4.3 Cost-based effects

From changes in construction projects demolition and rework happen frequently [16, 21]. Late payment may happen [16], resulting in overall cost increase as a result of interest rates. Changes need paperwork, reviews, and processing procedures before

their implementation [4], causing an increase in overhead expenditures. Extra payments for the construction company may be a probable effect of changes on a construction project.

2.4.4 Time-based effects

Changes which are imposed when construction is on the go or even finalized generally result in reworks and late project completion [16]. The project progress may be affected by the changes throughout the project, that payment to subcontractors can be affected consecutively, generally since the main contractor cannot pay subcontractors till the owner pays themselves. Completion schedule delay occurs frequently due to changes in construction projects [26]. As a result of changes needing new materials and equipment, logistics delays can happen [3].

2.4.5 Other effects

The progress may be affected by the changes without resulting delay. Negative time-based effects of changes may be compensated by the aid of floats on construction processes and accelerating work progress.

The effects and sub-effects of changes are grouped in the table 2 below:

Table 2: Effects and Sub-effects of Changes (adapted from [5])

Effects of Changes	**Sub-effects of Changes**	**Referances**
Cost-related	Increase in overhead expenses	[4]
	Additional payment for contractor	[4]
	Rework and demolition	[16,21]
Quality-related	Quality degradation	[3,25]
Time-related	Delay in payment	[16]
	Procurement delay	[4]
	Rework and demolition	[16,21]
	Logistic delay	[3]
	Completion schedule delay	[26]
Organization and its reputation-related	Tarnish firm's reputation	[3]
	Poor safety conditions	[4]
	Poor professional relations	[3]
	Dispute among professionals	[3]
Other effects	Progress affected without delay	[25]

There isn't any clear difference among the main effects of changes. Sub-effects may be categorized under multiple main effects.

2.5 Change Order Procedures and Managerial Recommendations

Changes often have a major influence on the success of projects. The procedures that are defined for change management in the general conditions sections of most construction contracts address the steps to take following the initiation of a change order. However, these guidelines do not normally identify the needs for managing the change and its influences. Items that should be considered as part of a project's Change Order procedure include the following [9]. One, for the phase of Design and Pre-construction, which is not the case of this study. The second, for the construction phase of a project.

2.5.1 Change Order Procedure for the construction phase [9]

- Evaluate the bid proposal of contractor to make sure that the documents are complete and that the cost and schedule reasonably represent the scope objectives and timelines required for the project.
- Review the contractor's construction methods, procedures, and resources to confirm the contractor's flexibility and capabilities to handle the quantities, types, and magnitudes of Change Orders that are expected for the project.
- Form a comprehensive system for finance and schedule baseline control.
- Process, approve, and execute Change Orders in a timely manner to be aware of claims and disputes that the progress and project completion may be affected.
- Do not go on with the work for Change Orders without authorization and be aware of verbal authorization.
- To be aware of confusion and misinterpretations of the work scope and needing that are defined for Change Orders, work to make sure that the packages for each change are complete. Actively continue with the participants involved and solicit any requests or questions for clarification.
- The determined conditions to be the general cause or the reoccurring factor for Change Orders on a project must be corrected.
- Detailed information from the changes must be gathered and documented so that the data may be needed to provide a historical reference on a continuing and future projects.

2.5.2 Change Order Management

An important aspect of project management is the management of change in construction, as changes create a major cause of delay and disruption, and it is

usually accepted by both construction constructors and owners that change effects are hard to quantify and often lead to disputes [27].

During a construction project changes are inevitable but many projects are also plagued by severe construction disputes caused by such changes. These disputes can become time consuming and costly problems which may need litigation to resolve [28].

A project should be managed well at every stage of a project in order not to face litigation to be resolved. Here are two good examples of a Change Order managerial procedure for a construction modified from [9] Change Order Procedure Flow Chart; figure 1 presents the change order procedure from the Contractor side and the figure 2 presents the change order procedure from the Owner side.

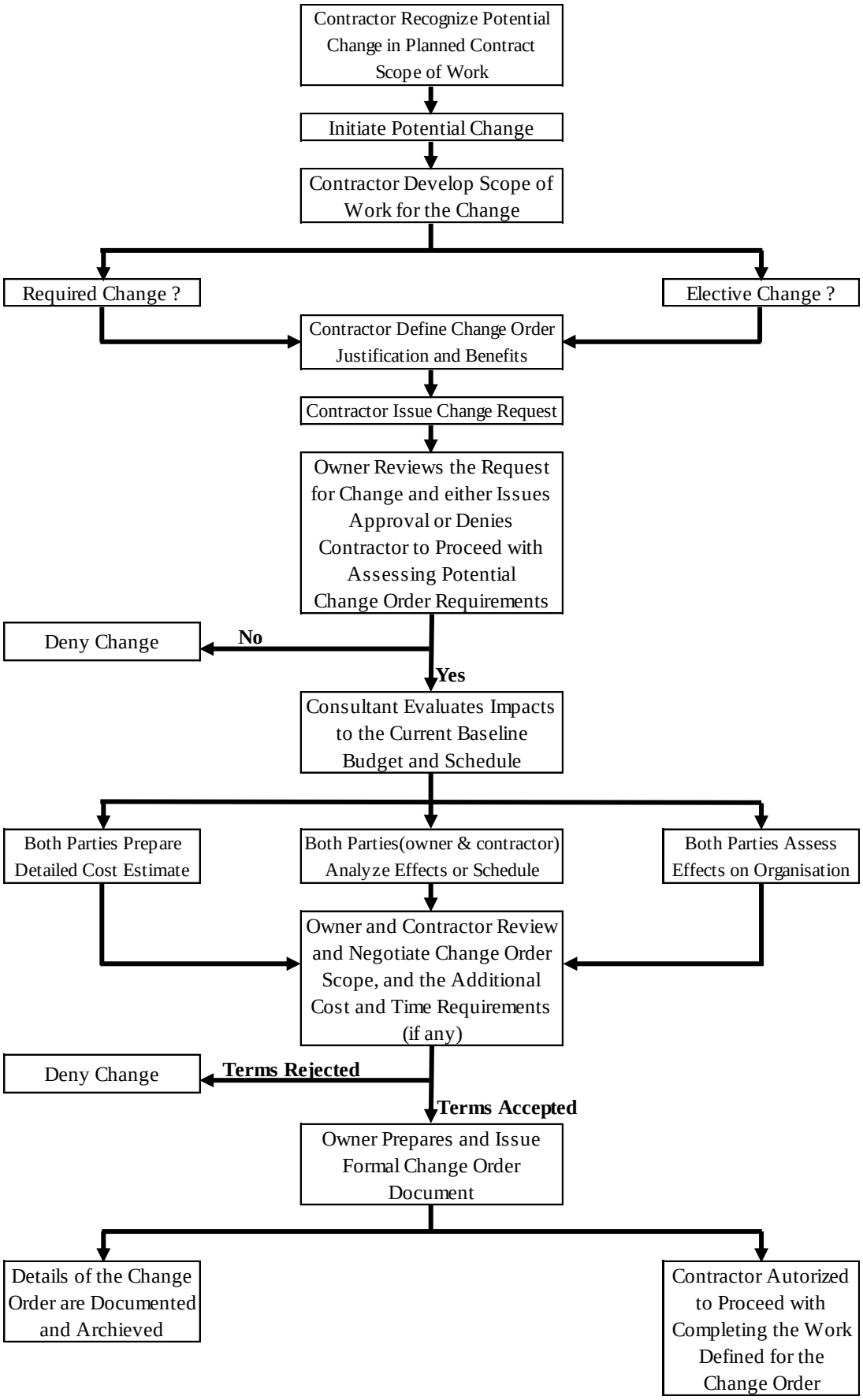

Figure 1: Example of a Contructor required Construction Change Order Procedure (Adapted from [9])

For the figure 1 which presents the change order procedure from the contractor side is as follows: In the first step contractor recognize potential change in planned contract scope of work and initiate potential change. Then the contractor develops scope of work for the change. Considering the scope of work for the change, the contractor decides either if the change is required or decides the elective change. Then the contractor defines change order justification and benefits and issues change request. Owner reviews the request for change and either issues approval or denies contractor to proceed with the assessing potential change order requirements. If the owner does not issue approval change denied. If the owner issues approval, consultant evaluates impacts to the current baseline budget and schedule. Then both parties (owner and contractor) prepare detailed cost estimate, analyse effects or schedule and assess effects on organization. Then owner and the contractor review and negotiate change order scope, and the additional cost and time requirements (if any). The owner either reject terms to deny change or accept terms and prepares and issue formal change order document to authorize the contractor to proceed with completing the work defined for the change order. Finally details of the change order are documented and archived.

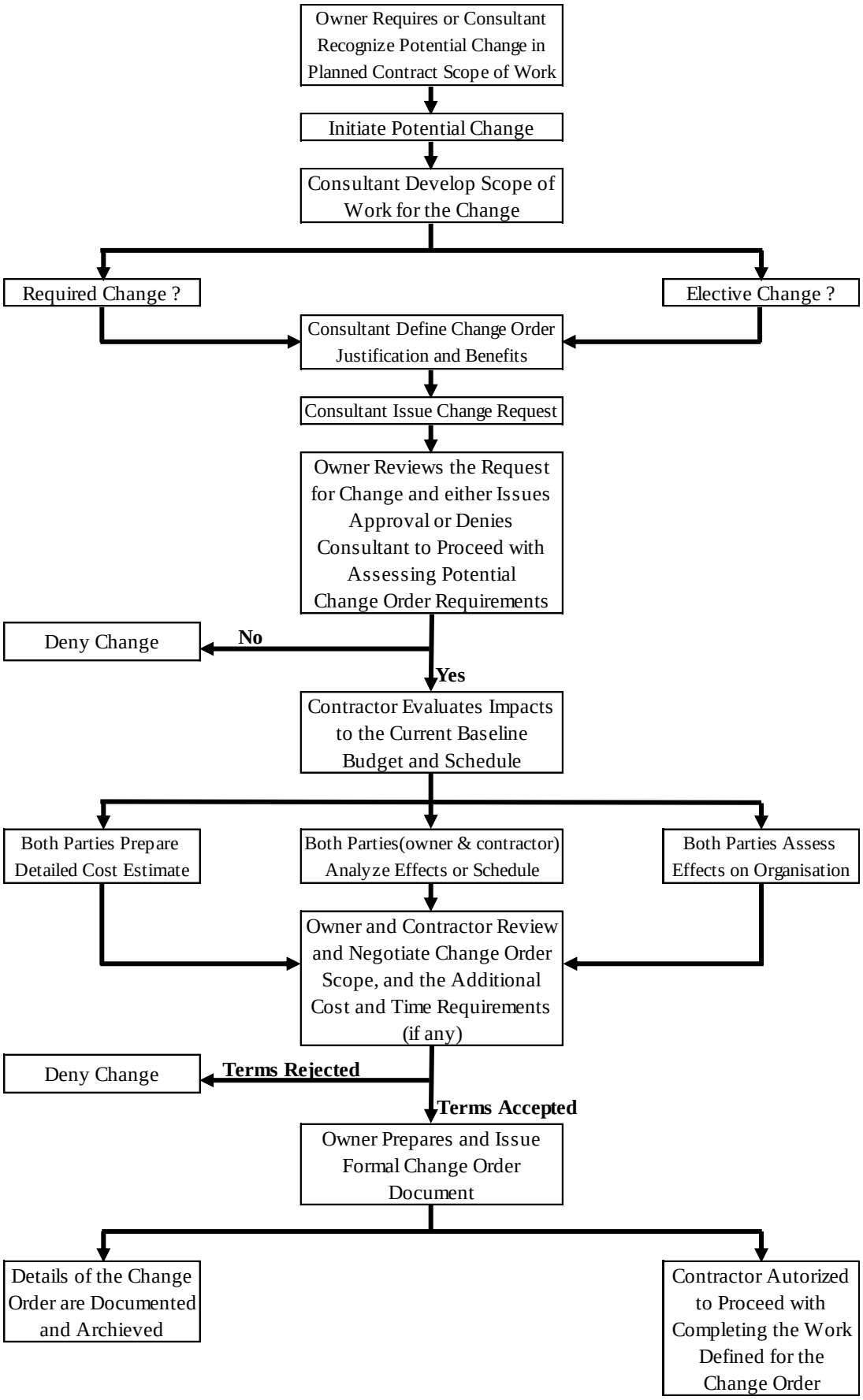

Figure 2: Example of an Owner reqired Construction Change Order Procedure (Adapted from [9])

For the figure 2 which presents the change order procedure from the owner side is as follows: In the first step owner requires or consultant recognize potential change in planned contract scope of work and initiate potential change. Then the consultant develops scope of work for the change. Considering the scope of work for the change, the consultant decides either if the change is required or decides the elective change. Then the consultant defines change order justification and benefits and issues change request. Owner reviews the request for change and either issues approval or denies contractor to proceed with the assessing potential change order requirements. If the owner does not issue approval change denied. If the owner issues approval, consultant evaluates impacts to the current baseline budget and schedule. Then both parties (owner and contractor) prepare detailed cost estimate, analyse effects or schedule and assess effects on organization. Then owner and the contractor review and negotiate change order scope, and the additional cost and time requirements (if any). The owner either reject terms to deny change or accept terms and prepares and issue formal change order document to authorize the contractor to proceed with completing the work defined for the change order. Finally details of the change order are documented and archived.

There is no “one size fits all” process or set of procedures for Change Orders on projects. Project specific requirements, contractor’s, and owner’s, contract types, management preferences, and logical issues are some of the many factors that may affect the structure of the process of Change Management for a given project. Although there are probable variances in the Change Management Process between projects, the above diagram states the basic elements and process that are typically probable during the construction phase of the project [9].

Chapter 3

CONFLICT MANAGEMENT AND DISPUTE RESOLUTION

3.1 Introduction

If the Change Orders are not managed well, they obviously will turn to Conflicts and with the poor management of the Conflicts, further to Disputes.

Conflict and Dispute are two different notations. Conflict happens when the interests of the parties are not matched. It can be managed, in order to avoid its probability of leading to a dispute. Dispute needs resolution. Dispute can be managed and the process of dispute resolution lends itself to third party intervention [7]. The dispute resolution process is time consuming and very costly process. Thus, a good management is significant on conflicts.

In the construction industry, as each party of a project, alters in perceptions, conflicts are not avoidable. Good management should be applied on conflicts; otherwise, they are for sure lead to disputes. One of the leading reasons that frustrate the construction project completion successfully is disputes. Therefore, it is essential to avoid the reasons of disputes so as to finish the project successfully, in the required base of schedule, financial plan and quality [1, 2].

3.2 Causes of Conflict

Conflict has several causes. It may arise when:

- A party is required to engage in an activity that is not congruent with the party's needs or interests.
- A party holds behavioural preferences, the satisfaction of which is incompatible with another person's implementation of his or her preferences.
- A party wants some mutually desirable resource that is in short supply, such that the wants of all parties involved may not be satisfied fully.
- A party possesses attitudes, values, skills, and goals that are salient in directing his or her behaviour but are perceived to be exclusive of the attitudes, values, skills, and goals held by the other(s).
- Two parties have partially exclusive behavioural preferences regarding their joint actions.
- Two parties are interdependent in the performance of functions or activities [29].

3.3 Conflict Resolution and Conflict Management

Conflict resolution includes the deduction, removal, or termination of every kinds of conflict. In the conflict resolution process, negotiation, bargaining, mediation, or arbitration is used generally. Construction industry may have benefits from suitable kinds and stages of conflict. That is the purpose of conflict management, differing from purpose of conflict resolution. Management of conflict doesn't mean conflict resolution.

Conflict management tries to minimize the adverse effects of conflict and gets the use of beneficial results of conflict by the help of improving learning in an association [29].

Learning in an organization is significant. Proper management of conflict rises learning potential by increasing the number of questions in mind to be asked and motivate individuals to try to overcome the settled status quo [30].

3.3.1 How to manage conflict

The main objective of managing conflicts must be of minimizing the effective conflicts in every stage, achieving and preserving to an extent of reasonable conflict, and get benefit from a suitable conflict management approach; to efficiently generate the first two objectives, as well as to match the positions and worries about their goals of the sides in conflict [29].

Managerial approach of conflict should fulfil certain norms in order to be effective. The following principles are mostly helpful, not just for managing the conflicts, but helpful as well as in managerial decisions:

- **Requirements of Participants:** Sometimes more than two participants are engaged in conflicts in associations as well as the objective of conflict management could be to include those participants in a problem resolution process which would result in collective learning and administrative efficiency. In an organization, the positions of employee advocate, client and provider advocate, in addition to environmental and shareholder advocates had better institutionalized.
- **Organizational Learning and Efficiency:** To achieve this aim, managerial approach of conflict must be planned to improve serious as well as innovative thought in order to learn the route of identification and mediation in the right problems.

- **Ethics:** Moral behaviour is important for a wise chief executer, and in order to do that the chief executer must be exposed to innovative learning and should not hesitate to change his decision. In the same way subordinates and other participants have a moral responsibility to exclaim against the judgements of managers when outcomes of those judgements are probable to be critic. Conflict can't be touched without ethical consideration [31].

3.3.2 Steps of Conflict Management

The primary step which is handled by evaluating and responding to the conflict is reactionary. The secondary step which is handled by discerning the way the choice is responded by the employee is proactive. The chief executer tries to generate another strategy, and for the second time, he or she tries to determine the employee's respond. When the chief executer decides the most relevant judgement for the association is made, and the employee's feelings is supported by justice, next the chief chooses weather that conflict case is only for once, or the one that must be composed as strategy. The whole process begins as a responsive circumstance however then goes in the direction of a proactive judgement. It is focused around getting a result that is the most relevant for the association, however underlines the impression of equity for the employee.

The following five steps are identified to managing conflict [32]**:**

i. **Anticipate:** Take time to obtain information that can lead to conflict.
ii. **Prevent:** Develop strategies before the conflict occurs.
iii. **Identify:** If it is interpersonal or procedural, move to quickly manage it.
iv. **Manage:** Remember that conflict is emotional.
v. **Resolve:** React, without blame, and you will learn through dialogue.

3.4 Dispute Resolution

The construction industry is present in an adversarial environment. Conflict is different from Dispute notionally. Conflict occurs whenever there is a mismatch of interest, thus conflict is pandemic. It can be managed, in order to prevent its possibility of leading to a dispute as a result of the conflict. Dispute is associated with distinct justiciable issues. They need resolution. Thus, they can be managed: the process of dispute resolution lends itself to third party intervention

A conflict continuum is offered by [33], ranging from conflict avoidance to violence. Violence is lying beyond any legislative decision. Parts of this continuum are used as the basis for a construction industry conflict continuum, shown in the Figure 3.

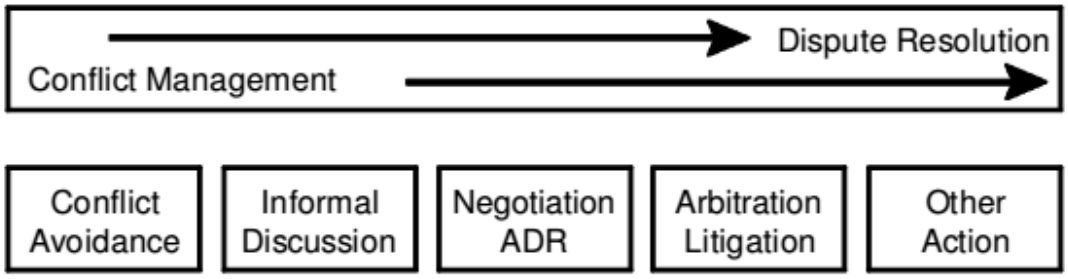

Figure 3: Conflict continuum [33]

The taxonomy proposed. Following the conflict continuum, the subject may be categorized further by the techniques used for the conflict management, that is to say, dispute resolution. Therefore a further splitting may be made between binding and nonbinding processes used for the conflict management or the dispute resolution. Table 3 shows that, although dispute resolution includes binding and non-binding processes, conflict management is exclusively nonbinding.

Table 3: Proposed taxonomy [7]

Conflict management

Non-binding

Dispute review boards
Dispute review advisors
Negotiation
Quality matters
- Total quality management
- Co-ordinated project information
- Quality assurance

Procurements systems

Dispute resolution

Non-binding	*Binding*
	Adjudication
Conciliation	Arbitration
Executive tribunal	Expert determination
Mediation	Litigation
	Negotiation

Dispute Resolution Ladder (DRL). In the resolution of disputes in construction industry, dispute avoidance and resolution techniques (DARTs) are useful method from the stage of prevention up to the stage of arbitration. The altered classification of DARTs are represented by DRL; shown in Figure 4 [7, 34]. Fenn et al. (1997) develop the "conflict continuum" on which DRL has its beginning. It works as a foundation for classifying numerous binding and nonbinding resolution methods. The DART serves different methods within every stair of the DRL, to be aware, mitigate, and resolve conflicts successfully in any projects. Initially a stair is chosen

by the project manager then within that stair, the DART is chosen that is required to be processed for the project. Implementation of the DART may be used avoid probable conflicts while carrying out processes of a project as well as to assist the construction firms establish collaborative relations among the participants [34].

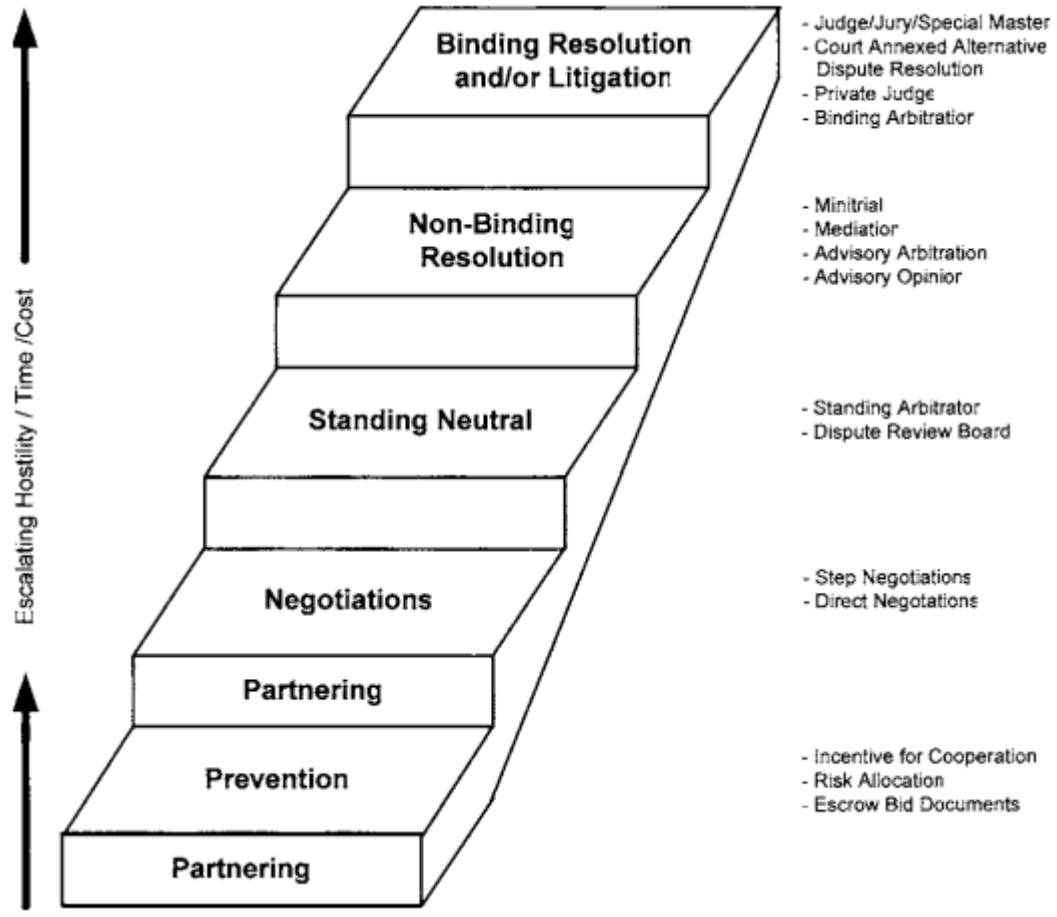

Figure 4: Dispute resolution ladder [7, 34]

While a conflict worsens to the upper levels, causes more and more expenses and aggression among the participants. The amount of alternative methods aiming resolution of the conflict reduces. Executing the four primary levels lets the participants to involve on terms they settle, however in binding arbitration and litigation, there are built principles and strategies, with related confirmation and

documentation needed to help contentions. The participants strictly engaged with the conflict have less involvement, less elasticity, as well as control on the ending result while the conflict worsens to the upper levels in the ladder. Definition of every stair of the dispute resolution ladder is as follows [34]:

- **Prevention:** Methods of prevention aims to minimize the causes of probable conflicts on projects. Various methods of prevention contain; contract execution, significance of constructability analysis and documentation, risk sharing, cost and schedule controls, and escrow bidding documentation.
- **Negotiation:** It is the method that participants talk over their alterations thru meetings and open dialogue aiming to solve the problems fast. It is a method which includes communication among the parties that the intention is to end up with a settlement, as well as assurance about the works to be done. Negotiation process gets the participants ready for managing conflicts as well as to minimize the effects of conflict once they occur.
- **Standing Neutral:** Both parties choose a third party which is at the same distance to both parties; the both parties let the neutral third party to do his or her observation on the processes of the project and assess solve contradictions, once and whether they occur. The purpose of the knowledgeable professional is to serve neutral and balanced feedback in a reasonable time aiming to get rid of argumentative relations from enlarging and worsening. Dispute review board act like a third party neutral with the exception of it is in board form.
- **Nonbinding Resolution:** With the aid of an unbiased expediter who helps in approaching an agreement, the processes of nonbinding dispute resolution end up with a resolution that both sides agrees. Participants can get into the processes

going on willingly and by consensus choose the third party. Hence, the expediter acts as an advisor and the advices are not binding.

- **Binding Resolution:** The most common technic of binding dispute resolution is arbitration. American Arbitration Association (AAA) identified arbitration as "referral of a dispute to one or more impartial persons for final and binding determination. Private and confidential, it is designed for quick, practical, and economical settlements".
- **Litigation:** The last step in the DRL is litigation. In this stage, only one party wins the other party loses, and rewards are compensated financially; although, a dispute continues to litigation, several possibilities can help to recover the issues, such as efficient presentations or solid discovery processes.

Chapter 4

RESEARCH METHODOLOGY

4.1 Introduction

The research examines the North Cyprus construction industry and is standing on the variations and change orders and their causes, effects and how to manage them not to turn to conflict and further to disputes. To do this 37 common change orders are obtained by literature review.

In this research a questionnaire survey is carried out and is held by questioning 52 construction companies in the private sector in North Cyprus. The construction companies are of contracting class 1&2 of the registered construction companies of The Cyprus Turkish Building Contractors Association (CTBCA).

4.2 Sampling

The research is concentrated on the private construction companies selected from the construction industry in Northern Cyprus. The construction companies are selected among the contracting class 1 & contracting class 2 of the registered construction companies of The Cyprus Turkish Building Contractors Association (CTBCA). Then, one of the architects which is the member of chamber of architects (CA) or a civil engineer which is the member of chamber of civil engineers (CCE) is questioned through the questionnaire survey as the representative of the construction company.

20 of those respondents were architect which makes 38.46 % ; the distribution of architects are as follows, 3 director, 5 project manager, 5 project coordinator, 2 site chief, 5 project architect.

32 of those were civil engineer which makes 61.54 % ; the distribution of civil engineers are as follows, 11 director, 5 project manager, 5 project coordinator, 20 site chief, 1 project engineer. The statistics are given in the table 4 below.

Table 4: The positions and the percentages of the respondents in the companies examined.

Respondents	Architect	Civil Engineer	Total	Percentage (%) of Total
Director	3	11	14	26.92
Project Manager	5	5	10	19.23
Project Coordinator	5	5	10	19.23
Site Chief	2	10	12	23.08
Office staff	5	1	6	11.54
Total	20	32	52	100
Percentage (%) of Total	38.46	61.54	100	-

In North Cyprus; there are a total number of 72 construction companies of contracting class 1 & contracting class 2. 52 of these are class 1 and 20 of these are class 2. The information is obtained from the Cyprus Turkish Building Contractors Association (CTBCA). 52 companies out of 72 are questioned and 40 of these respondents are of contracting class1 and 12 of contracting class 2 registered in the CTBCA.

52 companies are questioned out of 72 contracting class 1 & contracting class 2 of the registered construction companies of The Cyprus Turkish Building Contractors

Association (CTBCA). This makes 72.22% which is quite good ratio and number of respondents. The statistics are given in table 5 below. The number of construction companies are less and the construction companies itself are relatively small in North Cyprus compared with the other countries in the world, because it is a part of a small island.

Table 5: The contracting classification of the construction companies registered in the CTBCA.

	Total	Respondents	Percentage(%) in its class	Percentage(%) in total
Contracting class 1	52	40	76.92	55.56
Contracting class 2	20	12	60	16.67
Total	72	52	-	72.22

4.3 Data Collection

The questionnaire survey is prepared through a literature review to satisfy the needs of the construction industry in North Cyprus. The questionnaire survey consist of two sections. One is the general information about the respondent companies. The other section is the consistent of 37 common change order questions gathered from the literature review [5, 11, 35] to be relevant to the needs of the construction industry in North Cyprus.

For the first section the general information about the respondent companies is as follows:

- Number of managers
- Number of technic staff
- Number of non-technic staff
- Total number of staff

- Respondent’s position in the company
- Annual average production
- Annual turnover
- Companies specialized areas
- Targeted client group

For the second section of the questionnaire survey, the carefully selected common 37 change orders by the literature review to fulfil the needs of the construction industry of the North Cyprus are focused on:

- The chances that may occur in the construction phase.
- The change orders considering the influence that may lead to disputes perceived by the Contractors.

The empirical data was gathered by the help of the questionnaire survey. Through the survey, 52 private construction companies were questioned by the questionnaire survey. The questionnaire survey consists of 2 sections. First section includes general questions about the company that defines the organisation under survey; and the second section includes 37 common change order questions that are suitable for the construction companies in North Cyprus to investigate.

One architect or a civil engineer as a representative of the construction company was questioned. They were asked to rate the change orders in their opinion using their experience in the construction industry considering the North Cyprus environment. The ratings are from 1 to 5 which are:

1= very little effective

2= little effective

3= effective

4= much effective

5= very much effective

The respondent person questioned that represents the company was either an architect or a civil engineer from various positions in the construction company under survey.

The questionnaire survey is presented in the appendix A.

Chapter 5

ANALYSIS AND RESULTS

5.1 Introduction

In the research, the gathered raw data was entered and processed by a computer program called ‘Statistical Package for Social Sciences’ (SPSS).

After the analysis of raw data by SPSS, the result of the statistics which includes the ranking of the change orders in the order of their influences on causing conflict in construction phase is identified.

Further, the statistical analysis and their results are displayed; the descriptive statistics of the 12 most effective Change Orders and the descriptive statistics of the 12 least effective Change Orders are identified.

5.2 Statistical Analysis

In this study, 7 statistical analysis are done for contractors, these are:

- Mean
- Median
- Mode
- Standard Deviation (SD.)
- Variance
- Minimum

- Maximum

For change orders 8 statistical analysis are done, these are:

- Mean
- Median
- Mode
- Standard Deviation (SD.)
- Variance
- Minimum
- Maximum
- And Relative Importance Index (RII)

  which is calculated by the formula [36]:

  RII = ∑W / (AxN); ∑W=Total weight, A=Highest weight (5 in this study), N=Total no. of respondents (52 in this study).

5.3 Descriptive Statistics of the Change Orders

The relative importance index (RII) of the change orders are between 0.269 and 0.769. The mean values of the change orders' rankings are ranging between 1.35 and 3.85. That is to say, the most effective change order's mean value is rated 3.85 which is almost much effective and the least effective change order's mean value is rated 1.35 which is almost very little effective.

Descriptive statistic tables of the change orders are shown in the appendix B.

5.4 The Result of the Statistics of the Change Orders

As a result of the analysis, a ranking from the most effective to the least effective change order is done according to the RII values.

The ranked list in the order from most effective to the least effective change order is in the Table 6.

Table 6: Change Orders ranked in the order of its influence weight

Rank	Item	Types of CHANGE ORDERS	Mean	S.D.	RII
1	C.36	As-builts Used for Design were Incorrect	3.85	0.802	0.769
2	C.30	Late Issue of Design	3.56	0.916	0.712
3	C.32	Change in Timing of Vendor Drawing Approval	3.50	0.852	0.700
4	C.3	Design Changes	3.46	0.917	0.692
5	C.31	Late Receipt of Equipment	3.44	0.916	0.688
6	C.33	Late Procurement Activities	3.33	0.785	0.665
7	C.20	Change in Available Resources	3.27	1.012	0.654
8	C.17	Scope Change	3.25	0.947	0.650
9	C.2	Engineering Errors	3.23	1.165	0.646
10	C.16	Concept Change	3.23	1.022	0.646
11	C.23	Quantity Change	3.19	0.951	0.638
12	C.25	Material Availability	3.19	1.049	0.638
13	C.7	Specification Change	3.15	1.161	0.631
14	C.14	Intended Use Change	3.15	1.017	0.631
15	C.18	Design Evolution Change	3.10	0.823	0.619
16	C.19	Design Coordination Change	3.00	0.863	0.600
17	C.22	Mobilization Delay	3.00	1.103	0.600
18	C.6	Schedule Change	2.96	0.989	0.592
19	C.21	Force Majeure	2.90	0.799	0.581
20	C.1	Omissions	2.85	0.872	0.569
21	C.12	Cost Reduction Change	2.79	1.109	0.558
22	C.37	Change in Engineering Support to Construction	2.75	0.905	0.550
23	C.4	Unforeseen Conditions	2.73	0.952	0.546
24	C.13	Constructability Change	2.65	0.988	0.531
25	C.10	Aesthetic Change	2.63	0.864	0.527
26	C.5	Change in Work Sequence	2.62	0.973	0.523
27	C.11	Value Engineering	2.60	0.748	0.519
28	C.35	Change in Basic Data Requirements	2.48	0.960	0.496
29	C.28	Work Rules(Labour)	2.38	0.973	0.477
30	C.26	Seasonal Work Change	2.35	0.883	0.469
31	C.29	Work Rules(Operations)	2.35	0.968	0.469
32	C.8	Vendor Change	2.31	1.039	0.462
33	C.9	Process Change	2.21	0.848	0.442
34	C.27	Accident-Change in Safety Approach(Construction)	2.15	0.872	0.431
35	C.34	Change in Access to Work Area	1.79	0.750	0.358
36	C.24	Code Change	1.37	0.742	0.273
37	C.15	Regulatory/Permit Change	1.35	0.883	0.269

5.5 Distributions of the Contractors' Categorization

Distribution of the contractors specialized construction areas and the targeted client group are gathered by the first part of the questionnaire survey. Most of the contractors have activities in several branches of the construction industry in the North Cyprus. In this study, the contractors' priorities are considered while categorising their specialized areas in construction and the targeted group of clients. From the analysis of the statistics, considering their priorities, the contractors are categorized as Group 1, Group 2, and Group 3. Groups are identified as follows:

- **Group 1:** The distribution of the contracting classes of CTBCA is presented in the table 5 in chapter 4. 40 contractors are of contracting class 1 and 12 contractors are of contracting class 2.
- **Group 2:** Considering their priorities, the contractors' targeted group of clients is categorized as Public and Private. 37 contractors' targeted client group is Private, and 15 contractors' targeted client group is public.
- **Group 3:** Considering their priorities, the contractors' specialized area of construction is categorized as Residential buildings, Infrastructure and Commercial buildings. 8 contractors' specialized area of construction is infrastructure, 22 contractors' is residential, and 22 contractors' is commercial.

5.6 The Orders of the Most and the Least Effective Change Orders

From the ranked list of change orders the 12 most effective change orders and the 12 least effective change orders are selected to present their pie charts. It makes 24 Change Orders; the remaining 13 Change Orders Mean values lay between 3.15 and 2.63 which have almost average influence on conflict between the owner and the contractor. The 12 most and the 12 least effective change orders are grouped as follows:

- **First Order**; the first 4 most and the first 4 least effective change orders.
- **Second Order**; the second 4 most and the second 4 least effective change orders.
- **Third Order**; the third 4 most and the third 4 least effective change orders.

The frequency tables of each change order are presented in the appendix C.

5.6.1 First Order the 4 Most Effective Change Orders

According to the RII values of the Change Orders, the first order 4 most effective Change Orders are presented as follows:

C.36: As-builts Used for Design were Incorrect. Pie chart showing the influence percentages of the C.36 presented in figure 5.

C.30: Late Issue of Design. Pie chart showing the influence percentages of the C.30 presented in figure 6.

C.32: Change in Timing of Vendor Drawing Approval. Pie chart showing the influence percentages of the C.32 presented in figure 7.

C.3 : Design Changes. Pie chart showing the influence percentages of the C.3 presented in figure 8.

Discussions about the first order 4 most effective change orders are made in the chapter 6 in detail.

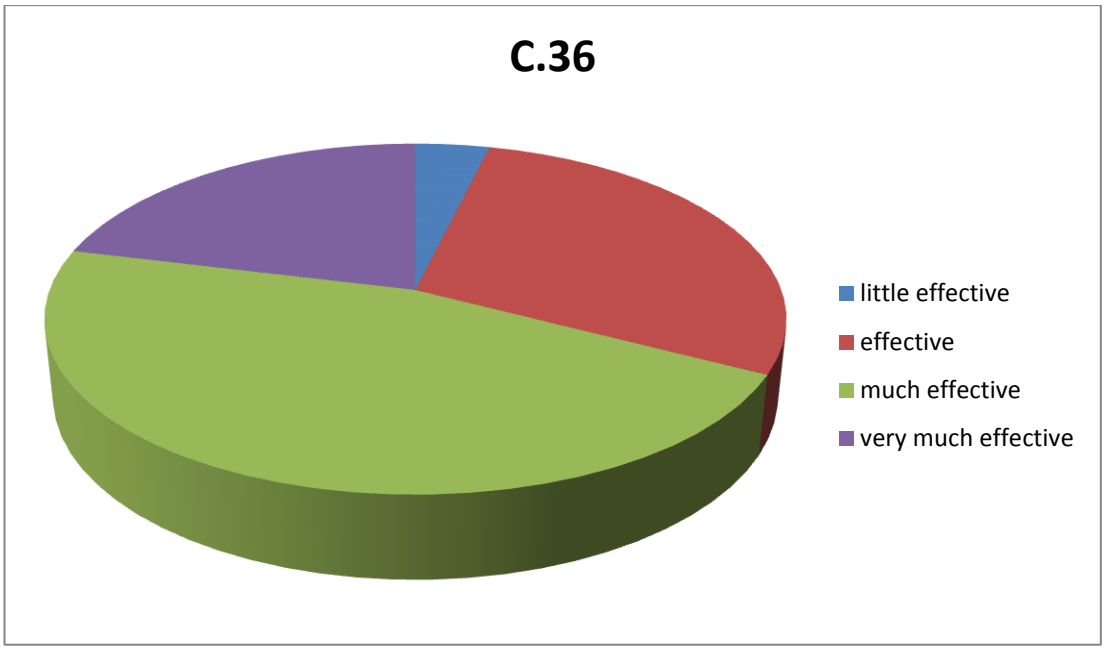

Figure 5: Pie chart showing the influence percentages of the C.36

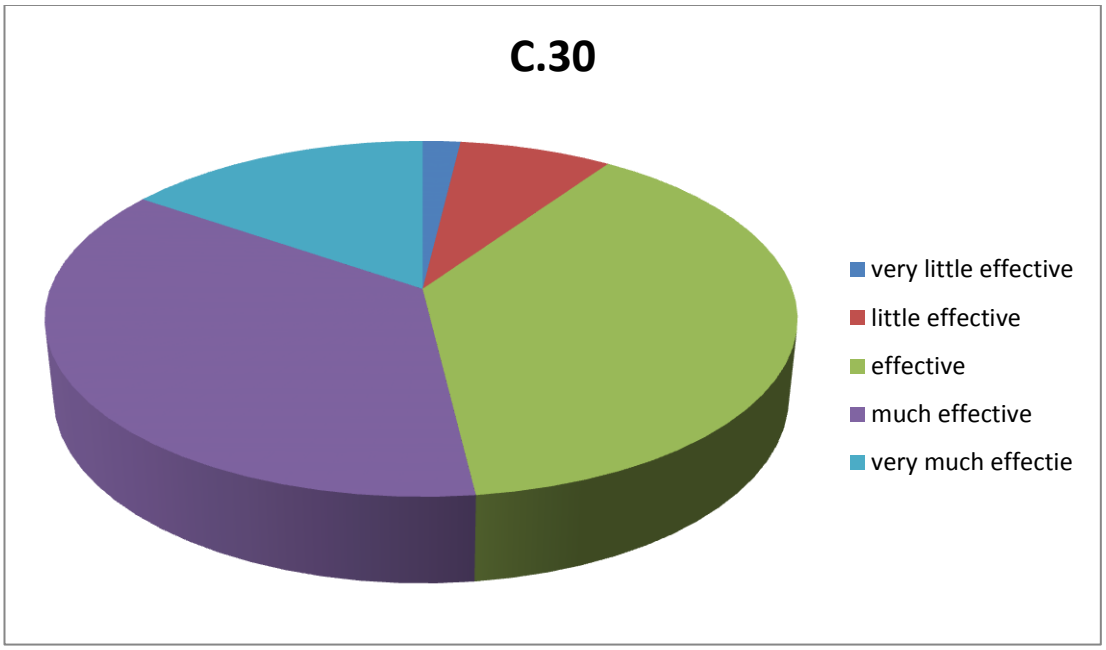

Figure 6: Pie chart showing the influence percentages of the C.30

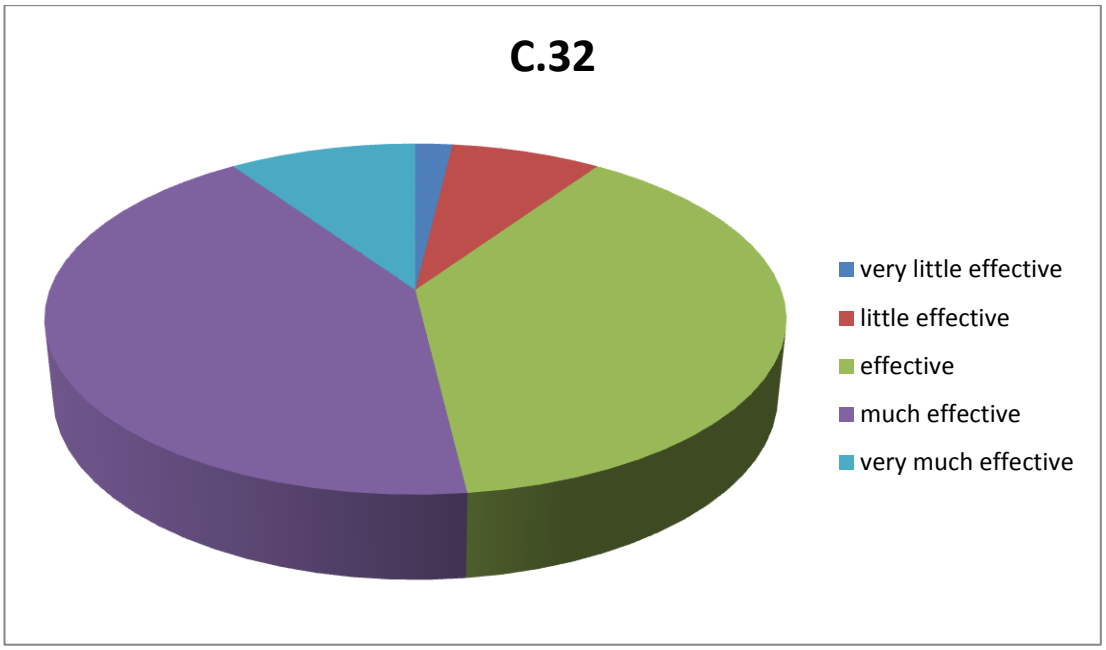

Figure 7: Pie Chart showing the influence percentages of the C.32

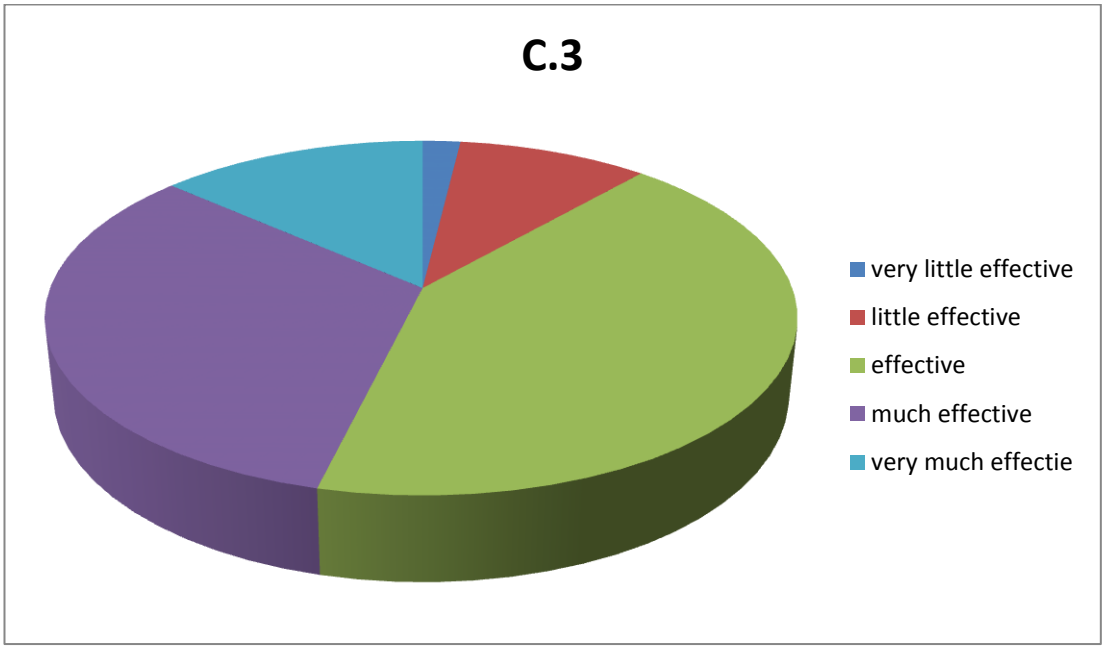

Figure 8: Pie chart showing the influence percentages of the C.3

5.6.2 First Order the 4 Least Effective Change Orders

According to the RII values of the Change Orders, the first order 4 least effective Change Orders are presented as follows:

C.15: Regulatory/Permit Change. Pie chart showing the influence percentages of the C.15 presented in figure 9.

C.24: Code Change. Pie chart showing the influence percentages of the C.24 presented in figure 10.

C.34: Change in Access to Work Area. Pie chart showing the influence percentages of the C.34 presented in figure 11.

C.27: Accident-Change in Safety Approach (Construction). Pie chart showing the influence percentages of the C.27 presented in figure 12.

Discussions about the first order 4 least effective change orders are made in the chapter 6 in detail.

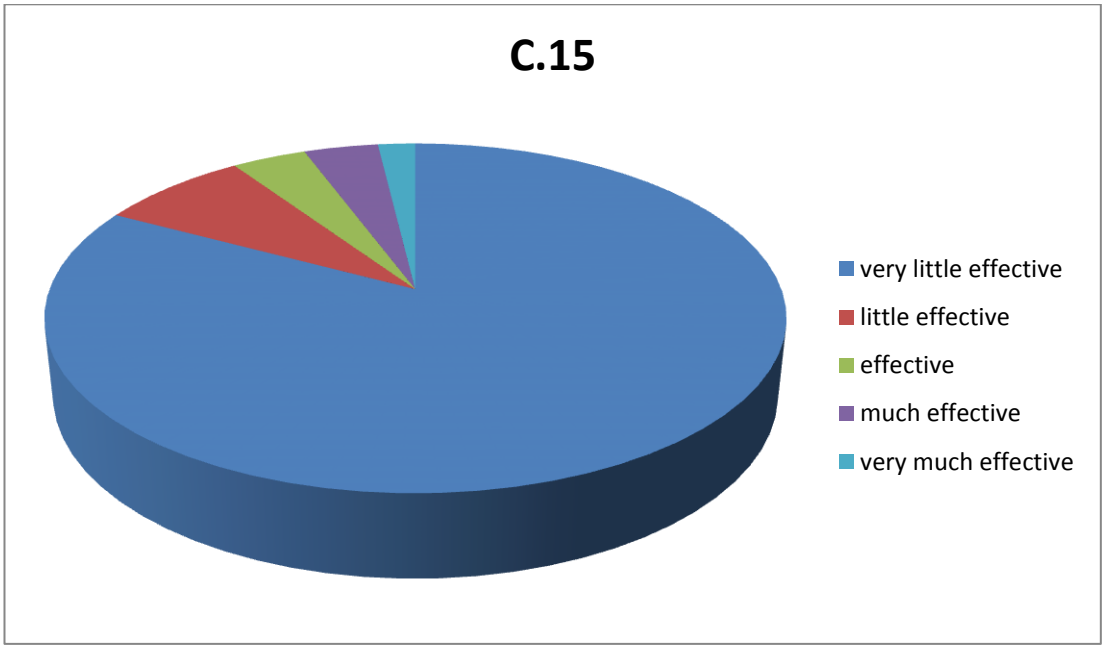

Figure 9: Pie Chart showing the influence percentages of the C.15

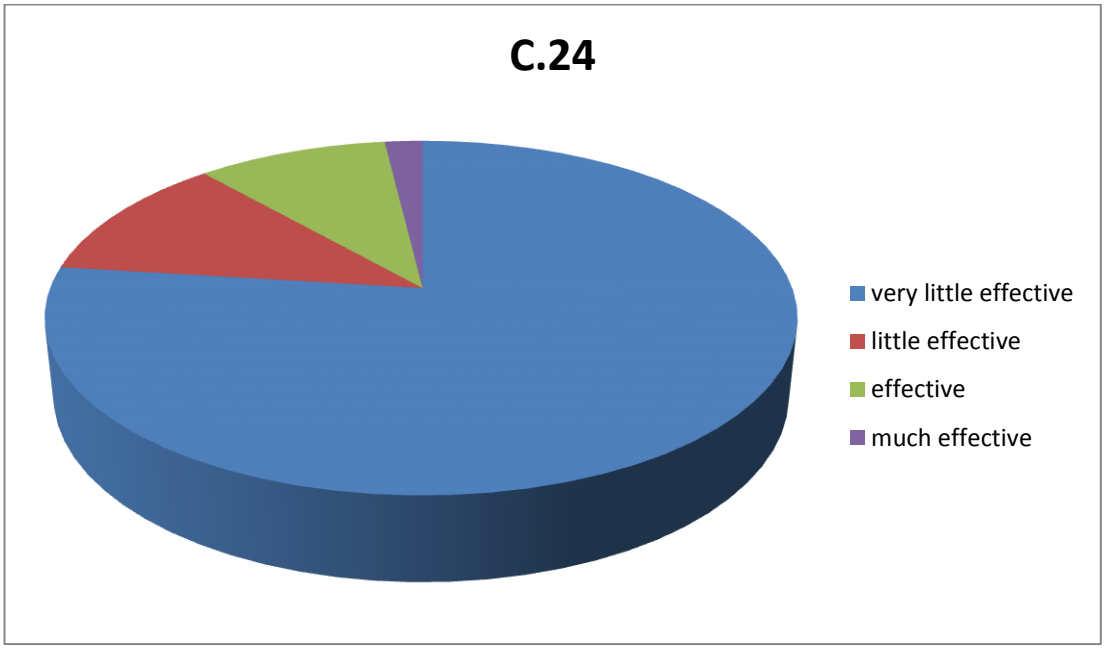

Figure 10: Pie Chart showing the influence percentages of the C.24

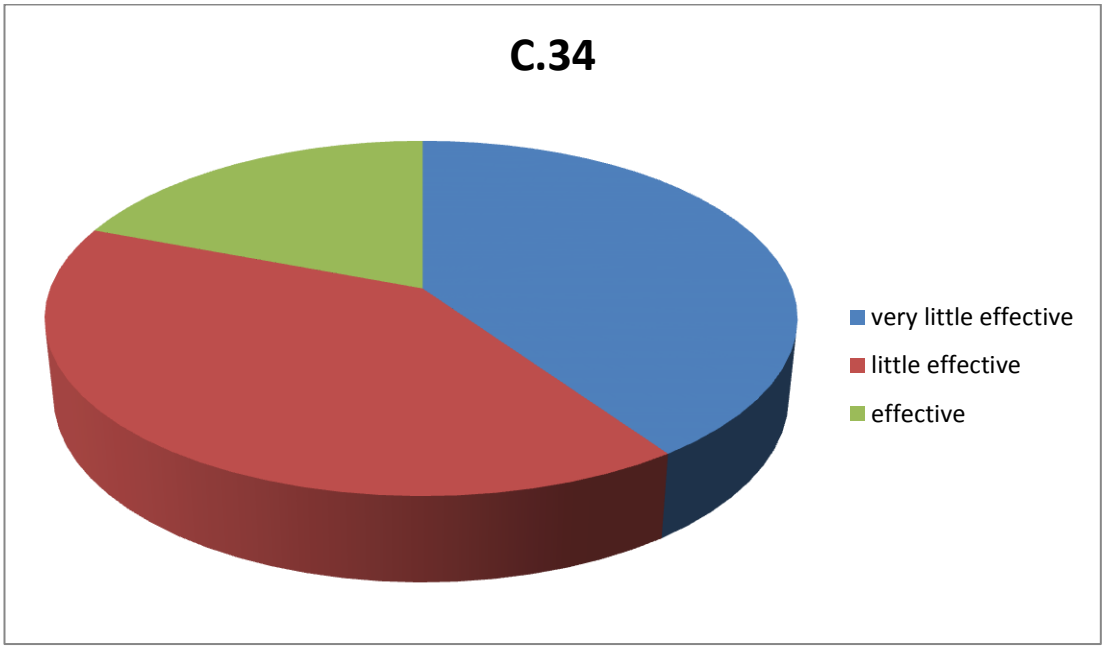

Figure 11: Pie Chart showing the influence percentages of the C.34

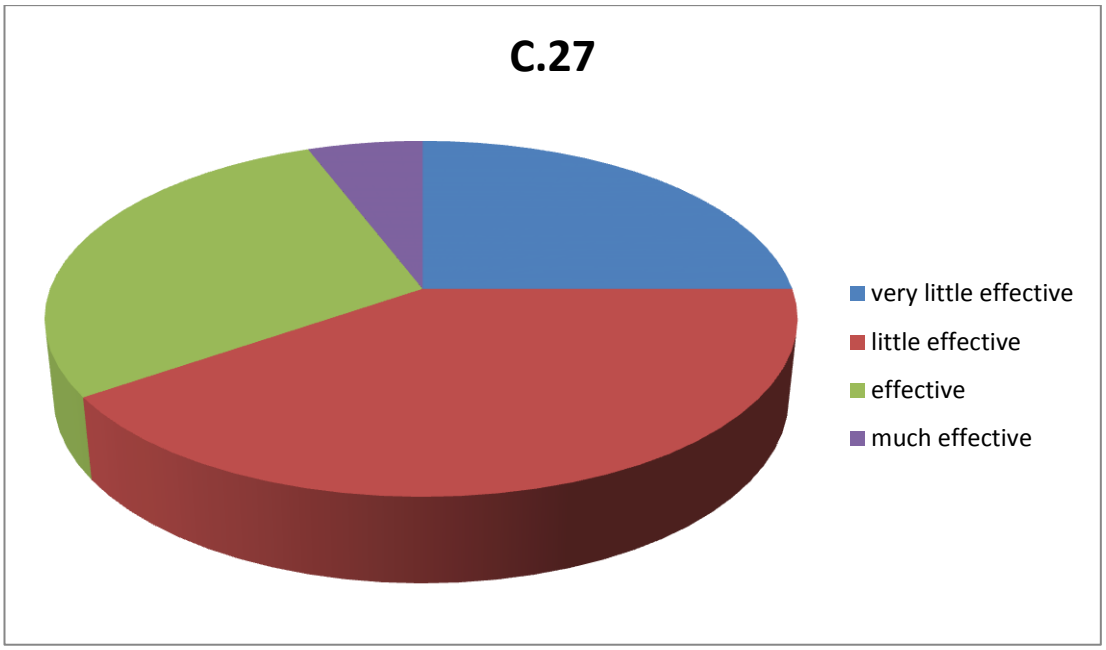

Figure 12: Pie chart showing the influence percentages of the C.27

5.6.3 Second Order the 4 Most Effective Change Orders

According to the RII values of the Change Orders, the second order 4 most effective Change Orders are presented as follows:

C.31: Late Receipt of equipment. Pie chart showing the influence percentages of the C.31 presented in figure 13.

C.33: Late Procurement Activities. Pie chart showing the influence percentages of the C.33 presented in figure 14.

C.20: Change in Available Resources. Pie chart showing the influence percentages of the C.20 presented in figure 15.

C.17: Scope Change. Pie chart showing the influence percentages of the C.17 presented in figure 16.

Discussions about the second order 4 most effective change orders are made in the chapter 6 in detail.

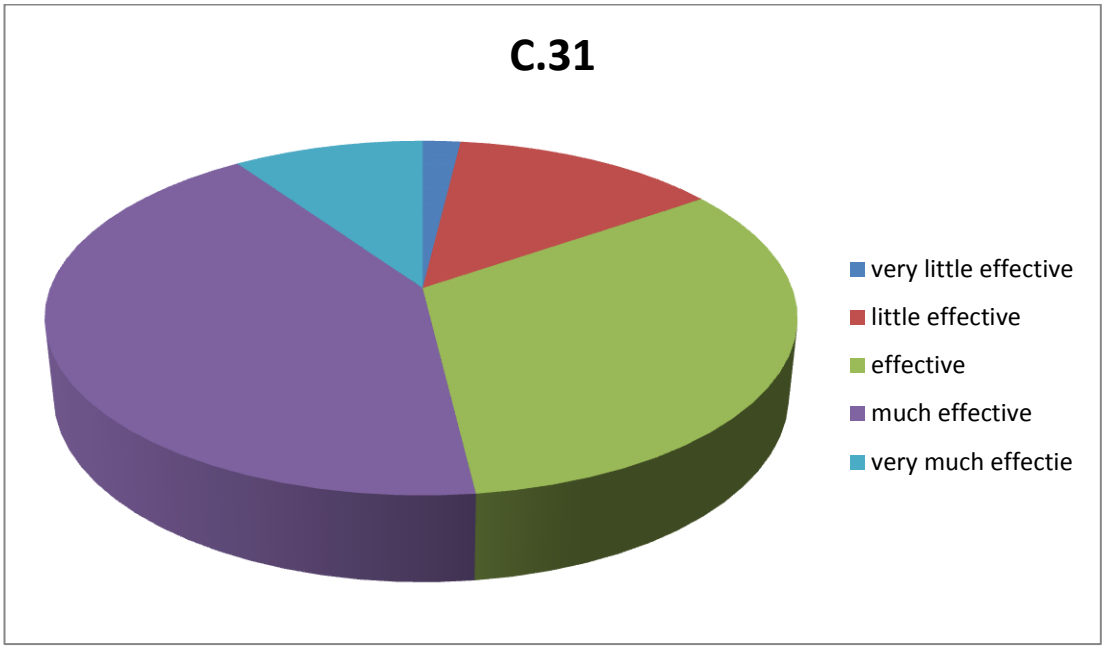

Figure 13: Pie chart showing the influence percentages of the C.31

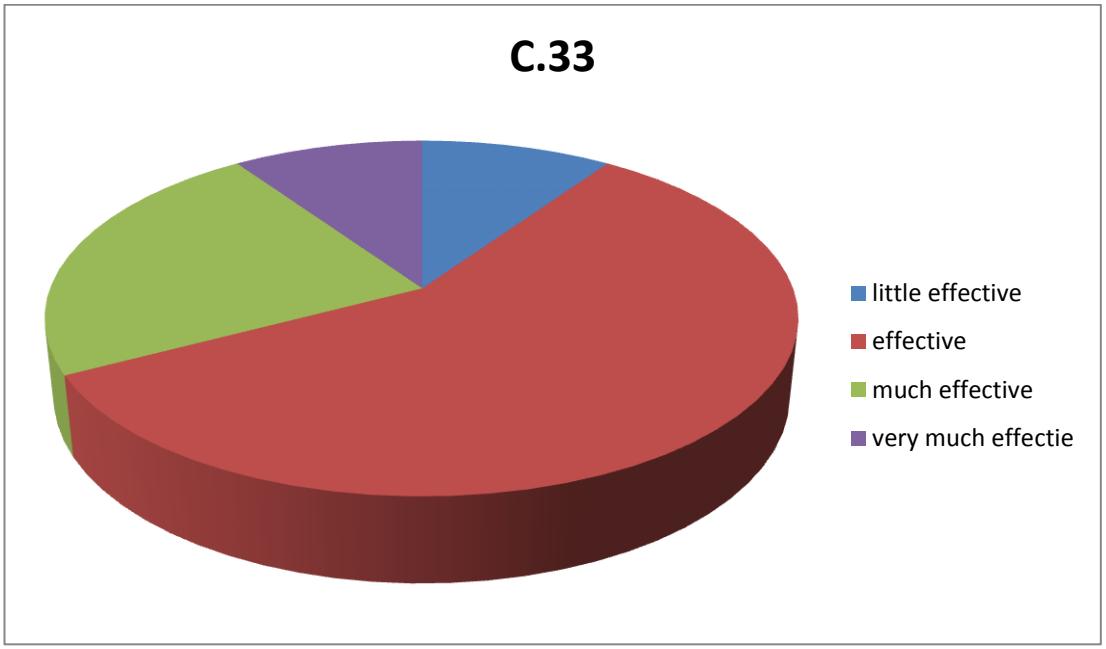

Figure 14: Pie chart showing the influence percentages of the C.33

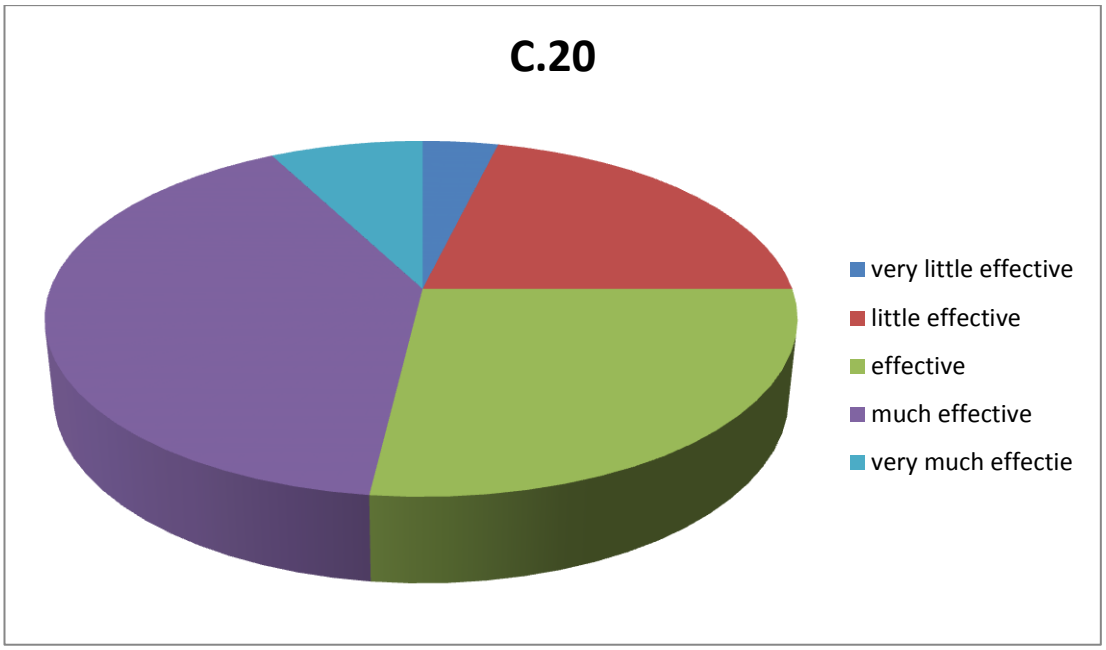

Figure 15: Pie chart showing the influence percentages of the C.20

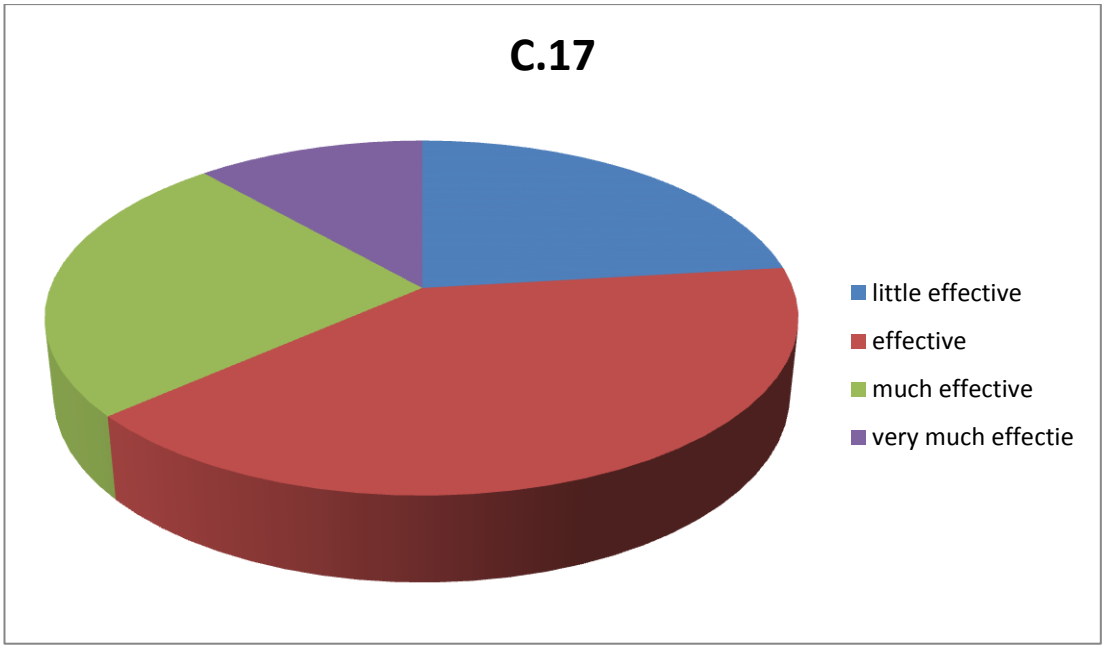

Figure 16: Pie chart showing the influence percentages of the C.17

5.6.4 Second Order the 4 Least Effective Change Orders

According to the RII values of the Change Orders, the second order 4 least effective Change Orders are presented as follows:

C.9 : Process Change. Pie chart showing the influence percentages of the C.9 presented in figure 17.

C.8 : Vendor Change. Pie chart showing the influence percentages of the C.8 presented in figure 18.

C.29: Work Rules (Operations). Pie chart showing the influence percentages of the C.29 presented in figure 19.

C.26: Seasonal Work Change. Pie chart showing the influence percentages of the C.26 presented in figure 20.

Discussions about the second order 4 least effective change orders are made in the chapter 6 in detail.

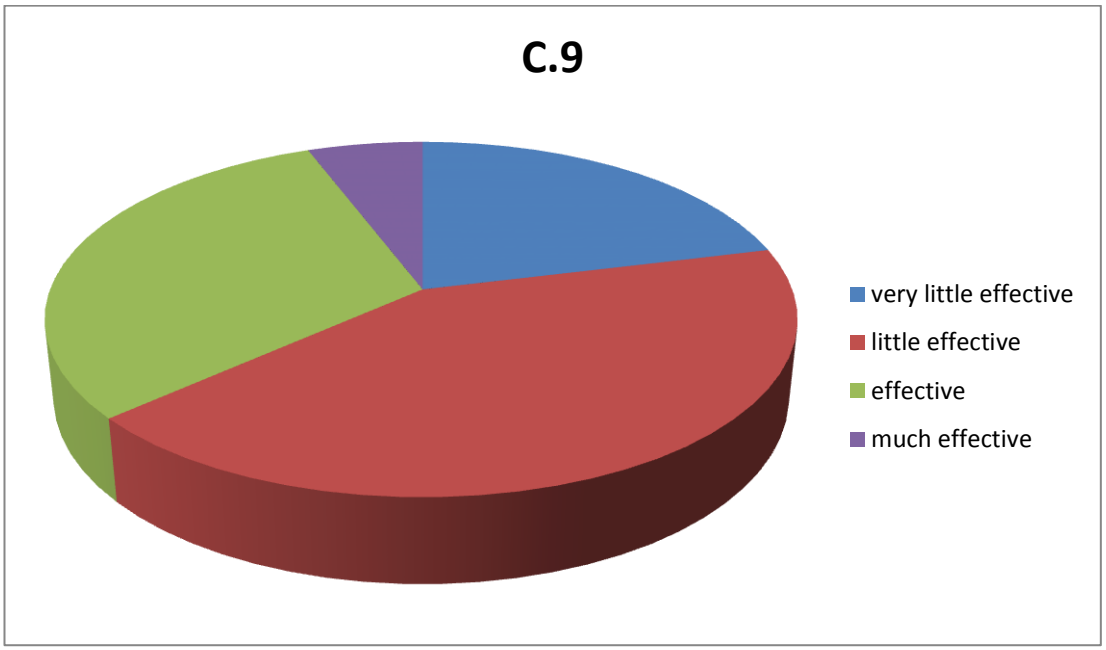

Figure 17: Pie chart showing the influence percentages of the C.9

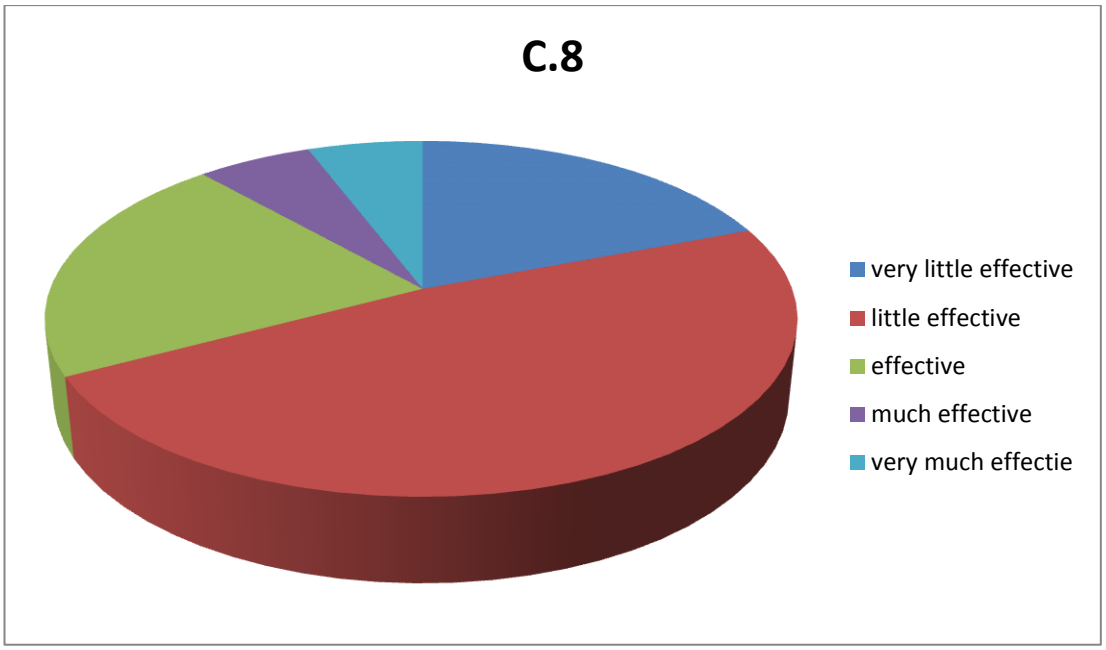

Figure 18: Pie chart showing the influence percentages of the C.8

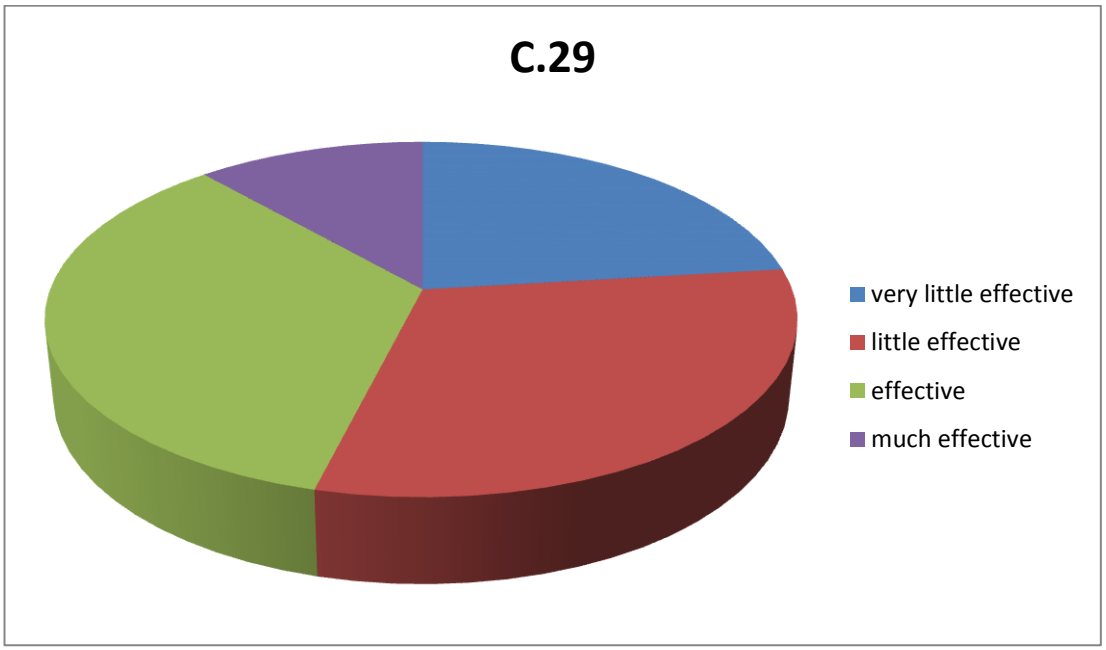

Figure 19: Pie chart showing the influence percentages of the C.29

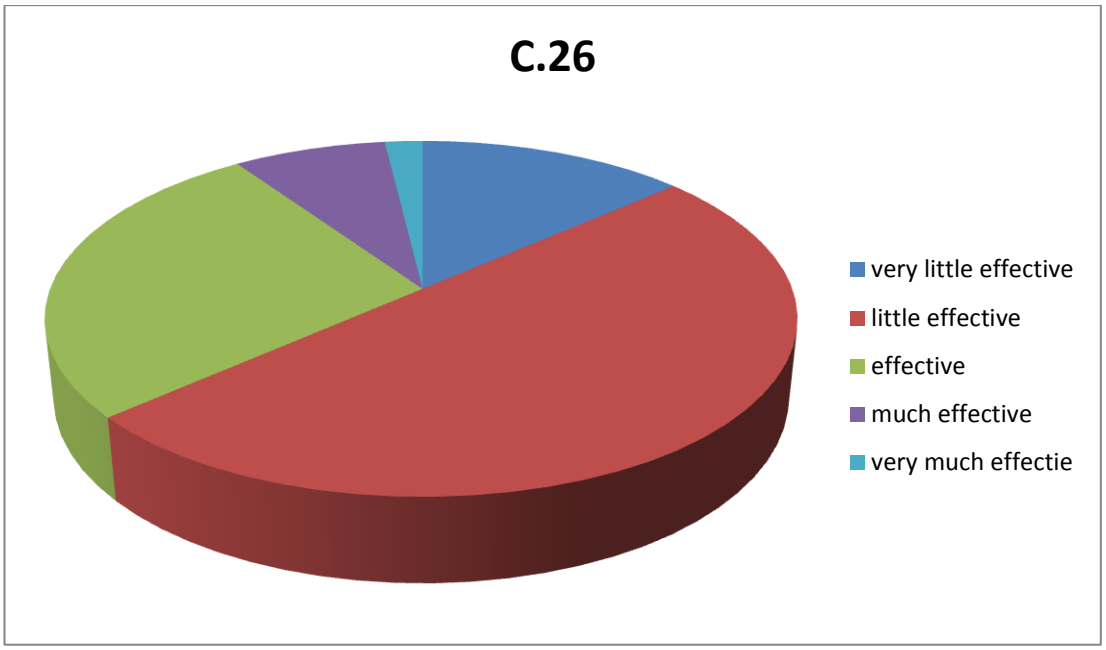

Figure 20: Pie chart showing the influence percentages of the C.26

5.6.5 Third Order the 4 Most Effective Change Orders

According to the RII values of the Change Orders, the third order 4 most effective Change Orders are presented as follows:

C.2 : Engineering Errors. Pie chart showing the influence percentages of the C.2 presented in figure 21.

C.16: Concept Change. Pie chart showing the influence percentages of the C.16 presented in figure 22.

C.23: Quantity Change. Pie chart showing the influence percentages of the C.23 presented in figure 23.

C.25: Material Availability. Pie chart showing the influence percentages of the C.25 presented in figure 24.

Discussions about the third order 4 most effective change orders are made in the chapter 6 in detail.

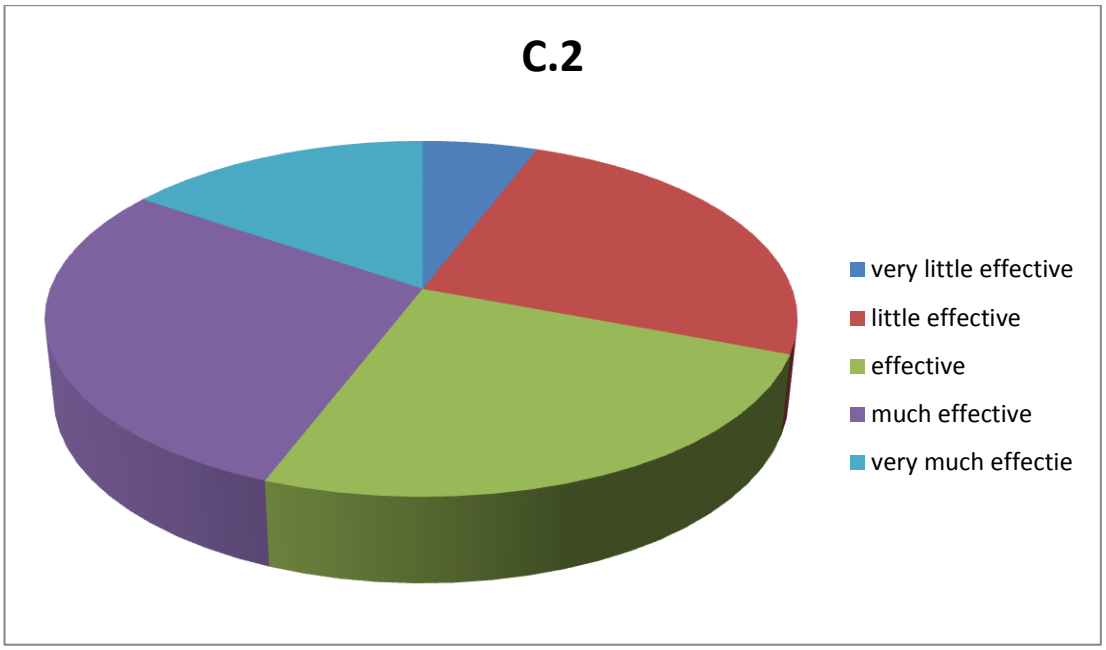

Figure 21: Pie chart showing the influence percentages of the C.2

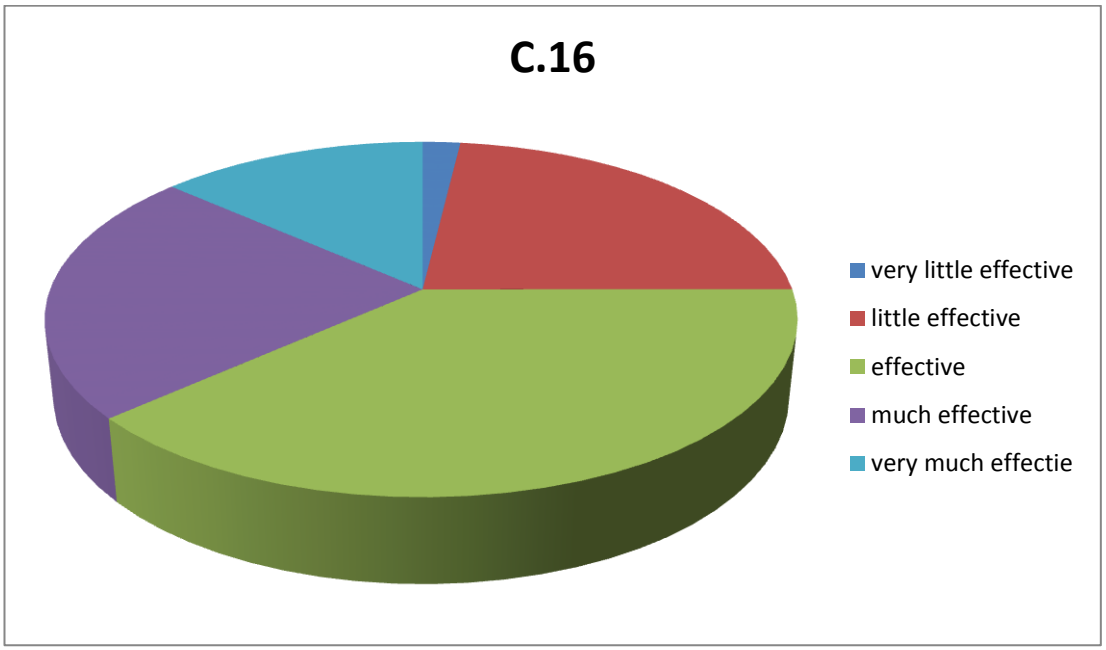

Figure 22: Pie chart showing the influence percentages of the C.16

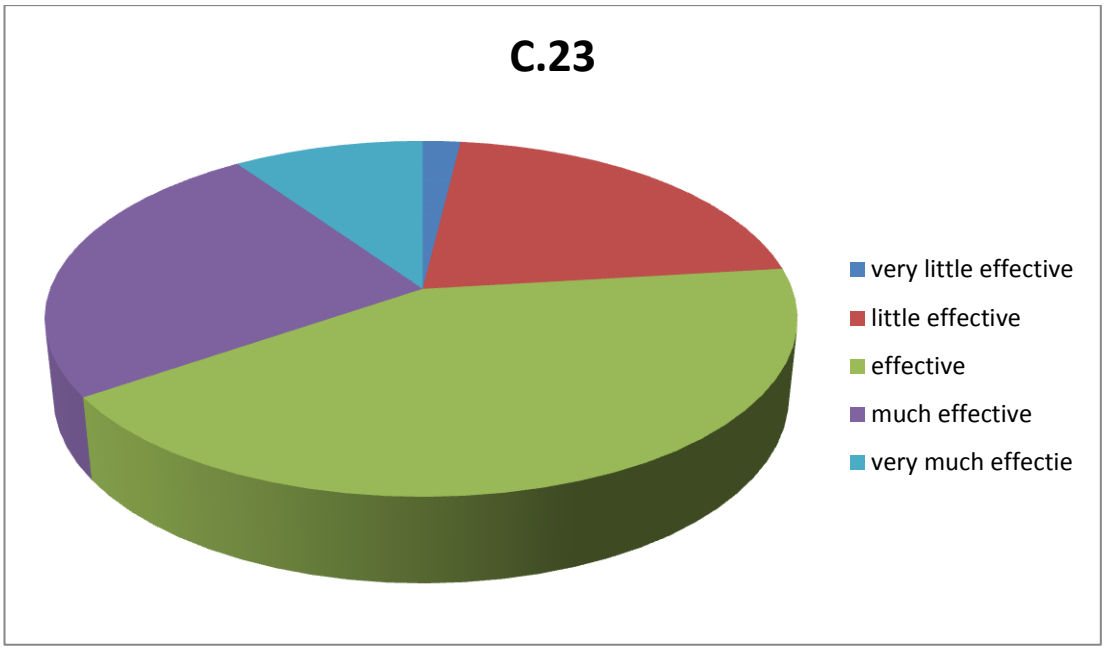

Figure 23: Pie chart showing the influence percentages of the C.23

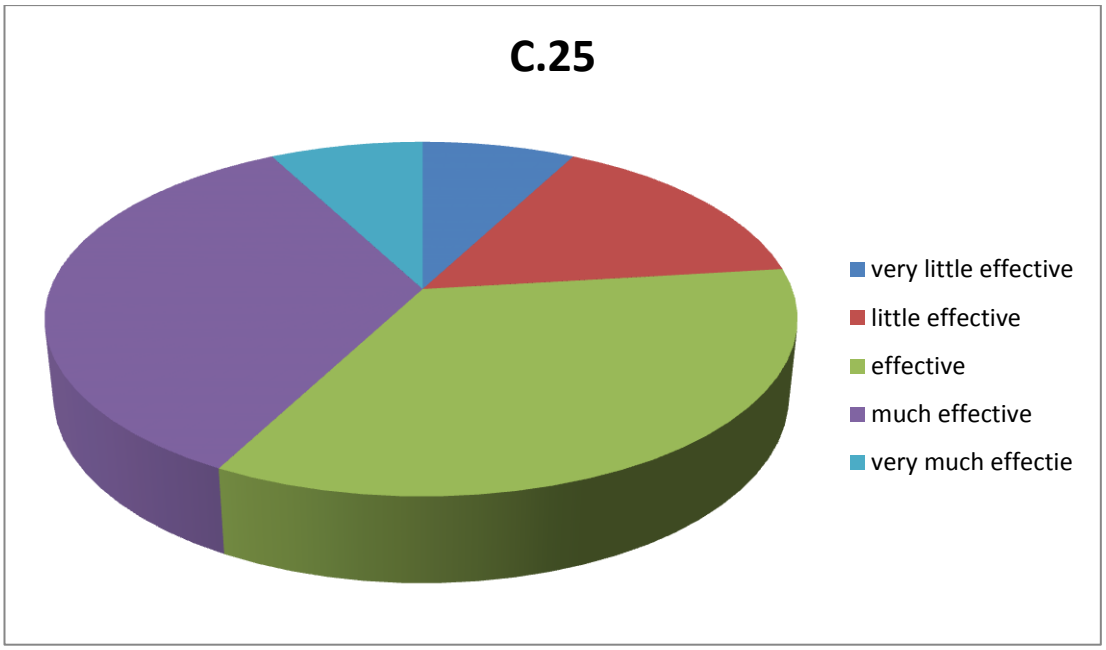

Figure 24: Pie chart showing the influence percentages of the C.25

5.6.6 Third Order the 4 Least Effective Change Orders

According to the RII values of the Change Orders, the third order 4 least effective Change Orders are presented as follows:

C.28: Work Rules (Labour). Pie chart showing the influence percentages of the C.28 presented in figure 25.

C.35: Change in Basic Data Requirements. Pie chart showing the influence percentages of the C.35 presented in figure 26.

C.11: Value Engineering. Pie chart showing the influence percentages of the C.11 presented in figure 27.

C.5 : Change in Work Sequence. Pie chart showing the influence percentages of the C.5 presented in figure 28.

Discussions about the third order 4 least effective change orders are made in the chapter 6 in detail.

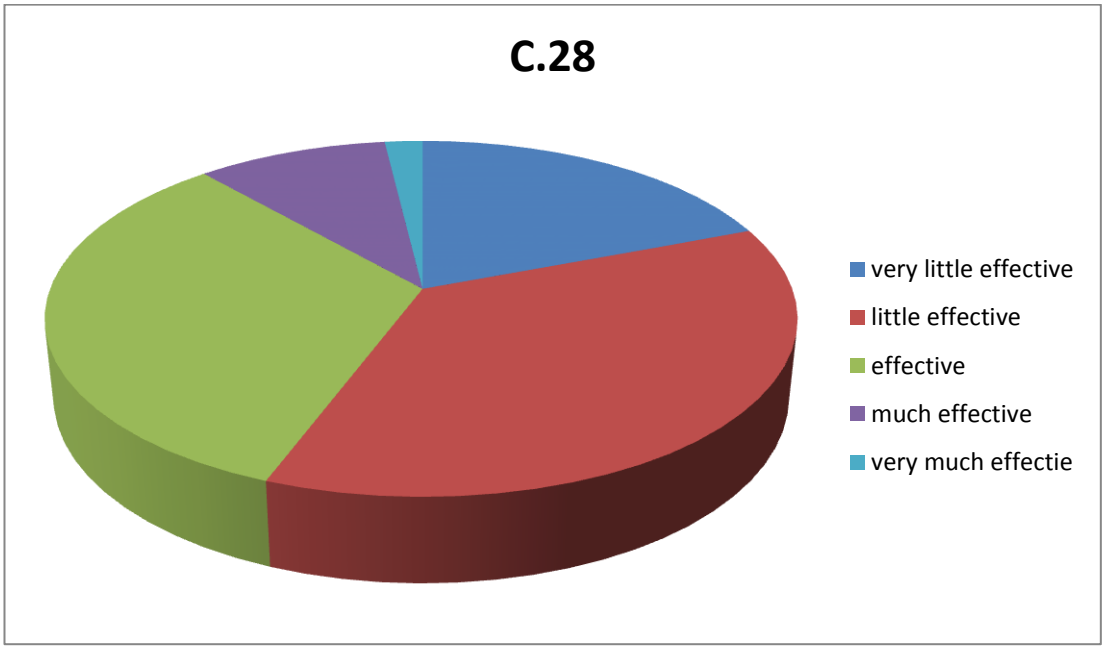

Figure 25: Pie chart showing the influence percentages of the C.28

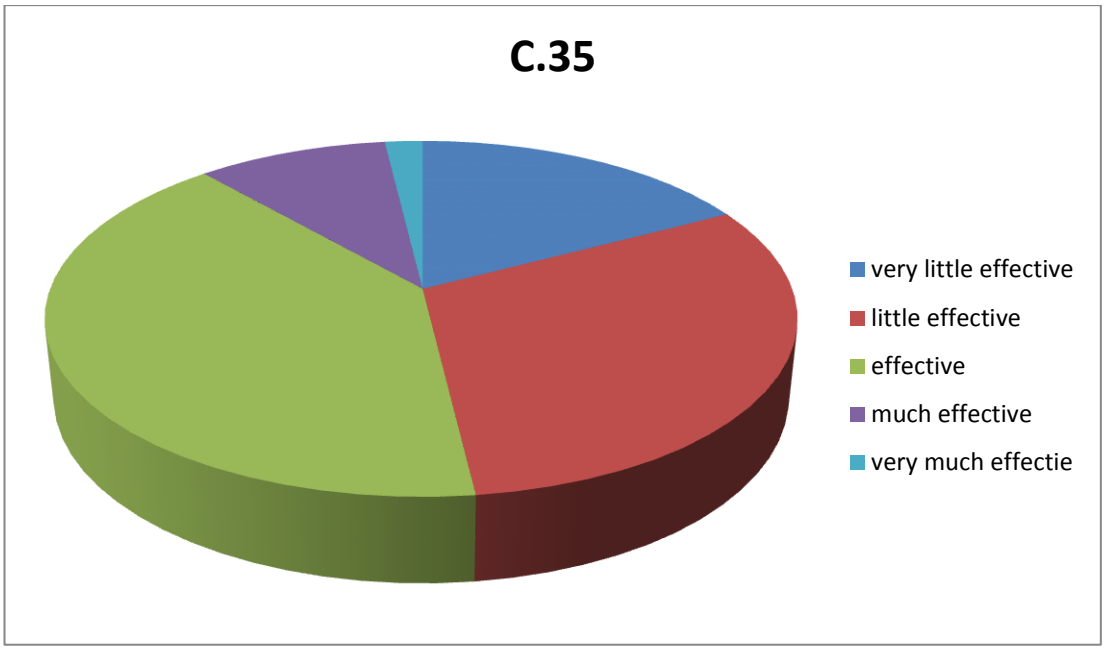

Figure 26: Pie chart showing the influence percentages of the C.35

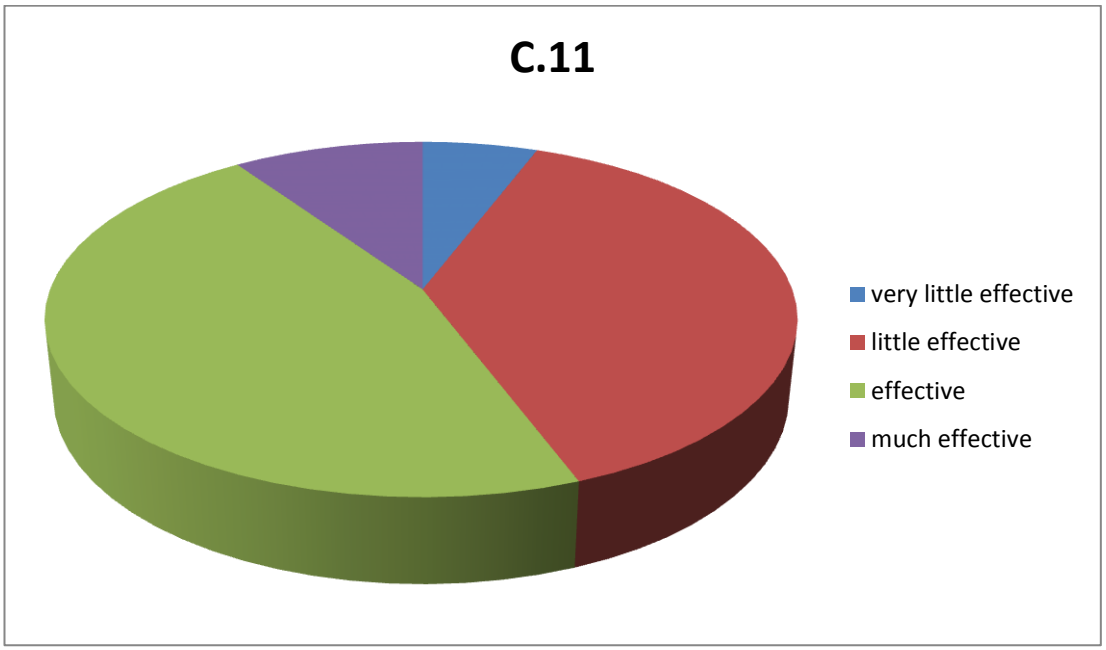

Figure 27: Pie chart showing the influence percentages of the C.11

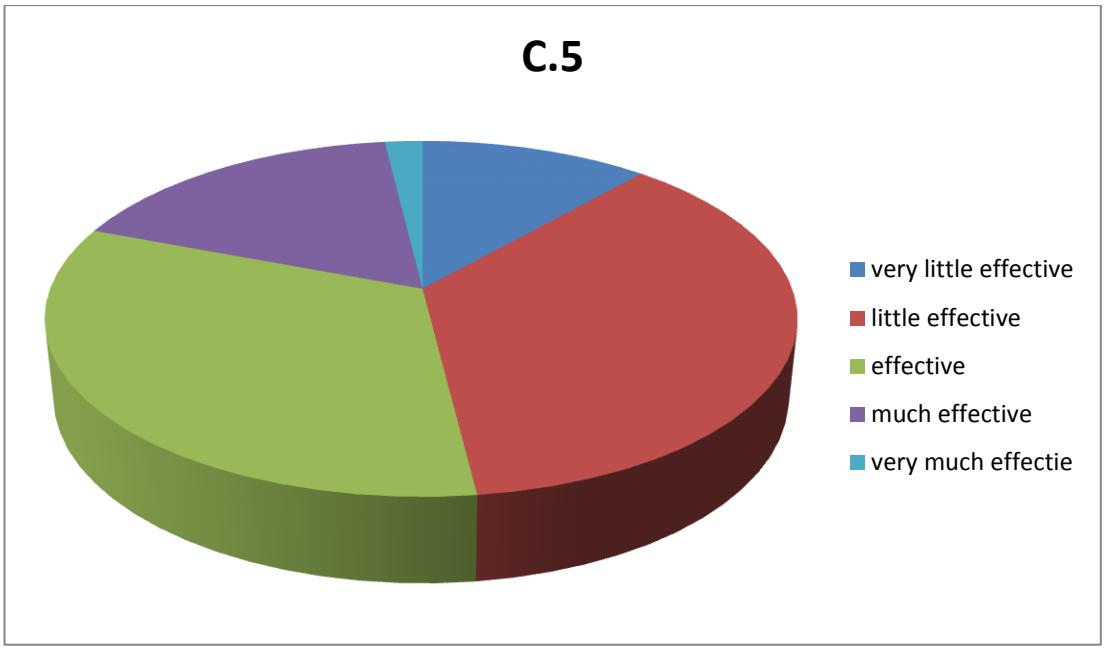

Figure 28: Pie chart showing the influence percentages of the C.5

5.7 Analysing the Results by the use of Radar Charts

Analysis of the change orders are presented by radar charts group by group. In the construction of the radar charts the mean values of the change orders are used. The groups of change orders are identified as first order, second order, and third order in the section 5.6. The analysis of the change order groups are presented by radar charts considering the contractor groups identified in the section 5.5.

Radar chart: A radar chart is a graphical method of displaying multivariate data in the form of a two-dimensional chart of three or more quantitative variables represented on axes starting from the same point. The relative position and angle of the axes is typically uninformative. Radar charts are a useful way to display multivariate observations with an arbitrary number of variables.

For the each order change orders (first, second, and third order), the average influence values are calculated for each group of contractors. They are calculated for group 1 contractors of contracting class 1 and class 2; for group 2 contractors of targeted group of clients is public and private; and for contractors whose specialized area of construction is residential buildings, infrastructure, and commercial buildings.

Results analyzed and obtained from the radar charts are discussed in the chapter 6.

5.7.1 Radar Charts of the First Order Change Orders

First Order Change Orders are presented by Radar Charts as follows:

- The average influence values of the first order change orders for group 1 contractors are presented in the table 7. Radar Chart of the First Order Change Orders considering Contractor classes is presented in the figure 29.
- The average influence values of the first order change orders for group 2 contractors are presented in the table 8. Radar Chart of the First Order Change Orders considering Contractors' targeted client group is presented in the figure 30.
- The average influence values of the first order change orders for group 3 contractors are presented in the table 9. Radar Chart of the First Order Change Orders considering Contractors' specialized area of construction is presented in the figure 31.

Table 7: Average influence values of first order change orders for group 1 contractors.

	First order 4 most effective change orders					First order 4 least effective change orders			
contracting classes	**C.36**	**C.30**	**C.32**	**C.3**		**C.15**	**C.24**	**C.34**	**C.27**
class 1	3.73	3.43	3.38	3.30		1.18	1.20	1.65	1.95
class 2	4.25	4.00	3.92	4.00		1.92	1.92	2.25	2.83

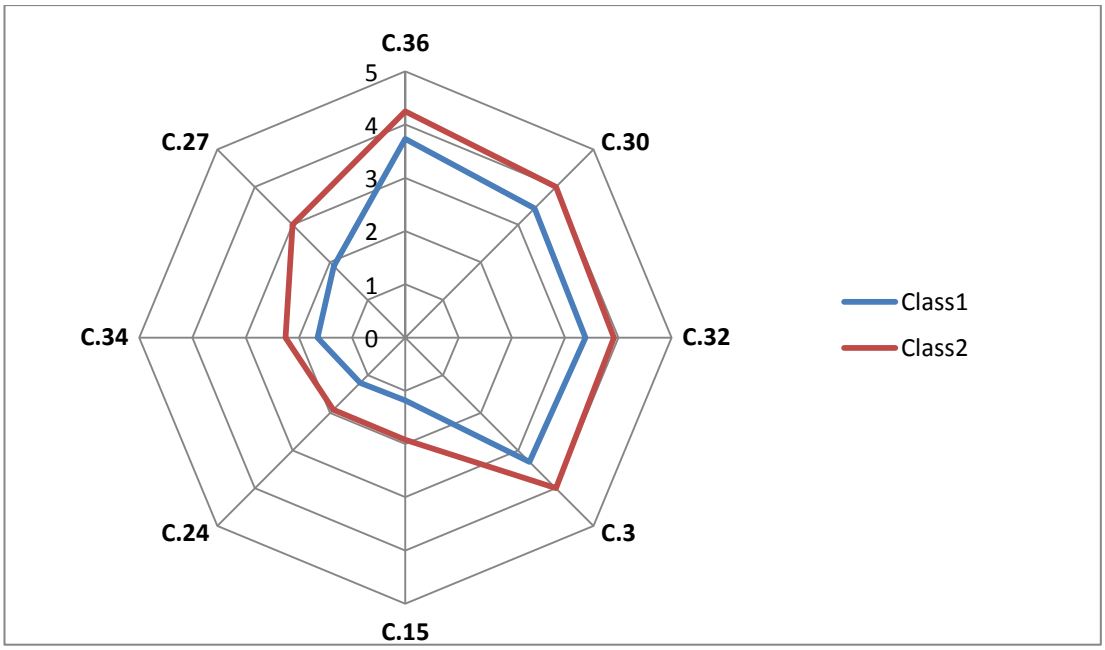

Figure 29: Radar Chart of the First Order Change Orders considering Contractor classes

Table 8: Average influence values of first order change orders for group 2 contractors.

	First order 4 most effective change orders					First order 4 least effective change orders			
client group	**C.36**	**C.30**	**C.32**	**C.3**		**C.15**	**C.24**	**C.34**	**C.27**
Public	3.20	2.93	3.07	2.73		1.20	1.20	1.00	1.20
Private	4.11	3.81	3.68	3.76		1.41	1.43	2.11	2.54

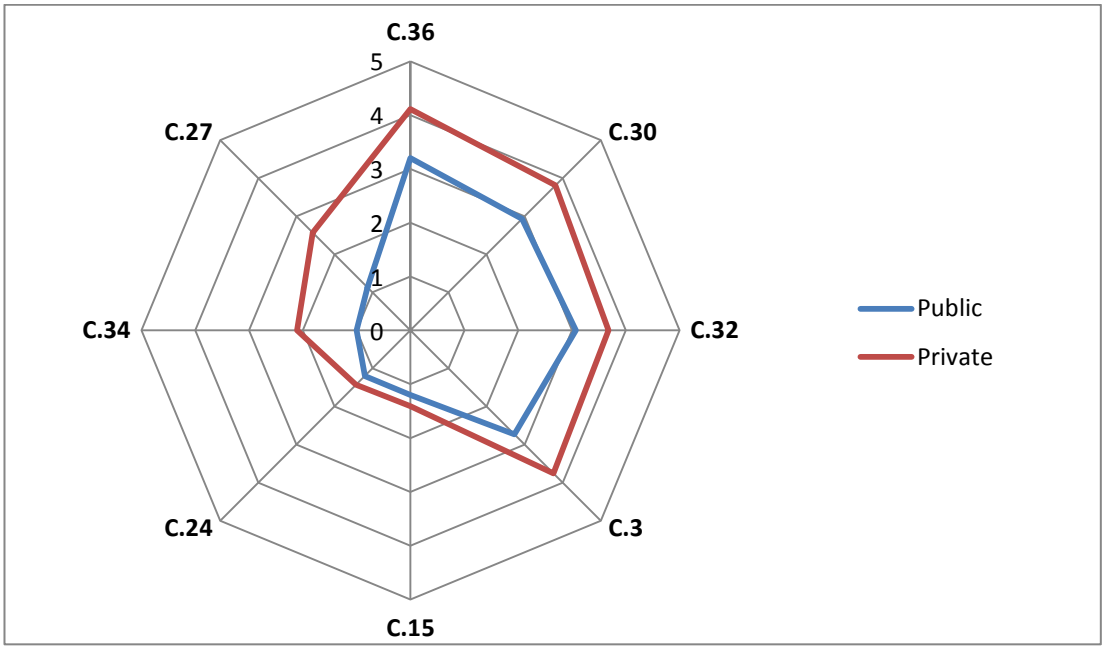

Figure 30: Radar Chart of the First Order Change Orders considering Contractors' targeted client group

Table 9: Average influence values of first order change orders for group 3 contractors.

	First order 4 most effective change orders					First order 4 least effective change orders			
specialized area	**C.36**	**C.30**	**C.32**	**C.3**		**C.15**	**C.24**	**C.34**	**C.27**
Infrastructure	3.50	3.38	3.38	3.13		1.13	1.13	1.38	1.75
Residential	4.27	3.95	3.82	3.91		1.50	1.50	2.36	2.59
Commercial	3.55	3.23	3.23	3.14		1.27	1.32	1.36	1.86

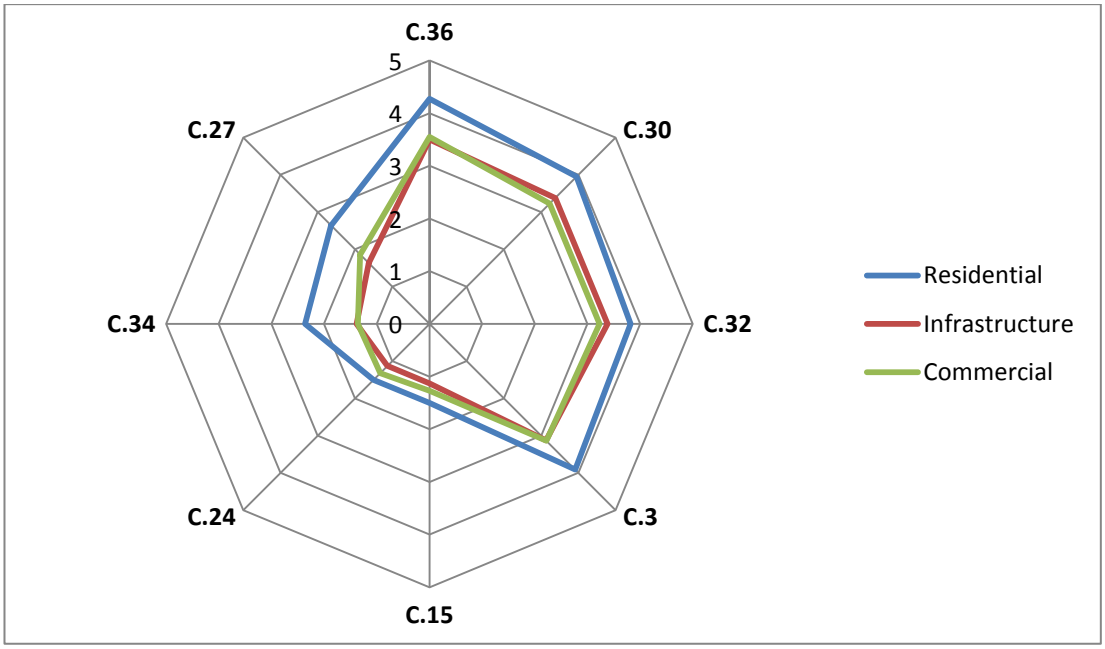

Figure 31: Radar Chart of the First Order Change Orders considering Contractors' specialized area of construction

5.7.2 Radar Charts of the Second Order Change Orders

Second Order Change Orders are presented by Radar Charts as follows:

- The average influence values of the second order change orders for group 1 contractors are presented in the table 10. Radar Chart of the First Order Change Orders considering Contractor classes is presented in the figure 32.

- The average influence values of the second order change orders for group 2 contractors are presented in the table 11. Radar Chart of the First Order Change Orders considering Contractors' targeted client group is presented in the figure 33.
- The average influence values of the second order change orders for group 3 contractors are presented in the table 12. Radar Chart of the First Order Change Orders considering Contractors' specialized area of construction is presented in the figure 34.

Table 10: Average influence values of second order change orders for group 1 contractors.

	Second order 4 most effective change orders					**Second order 4 least effective change orders**			
contracting classes	**C.31**	**C.33**	**C.20**	**C.17**		**C.9**	**C.8**	**C.29**	**C26**
class 1	3.33	3.20	3.05	3.05		2.00	2.03	2.13	2.13
class 2	3.83	3.75	4.00	3.92		2.92	3.25	3.08	3.08

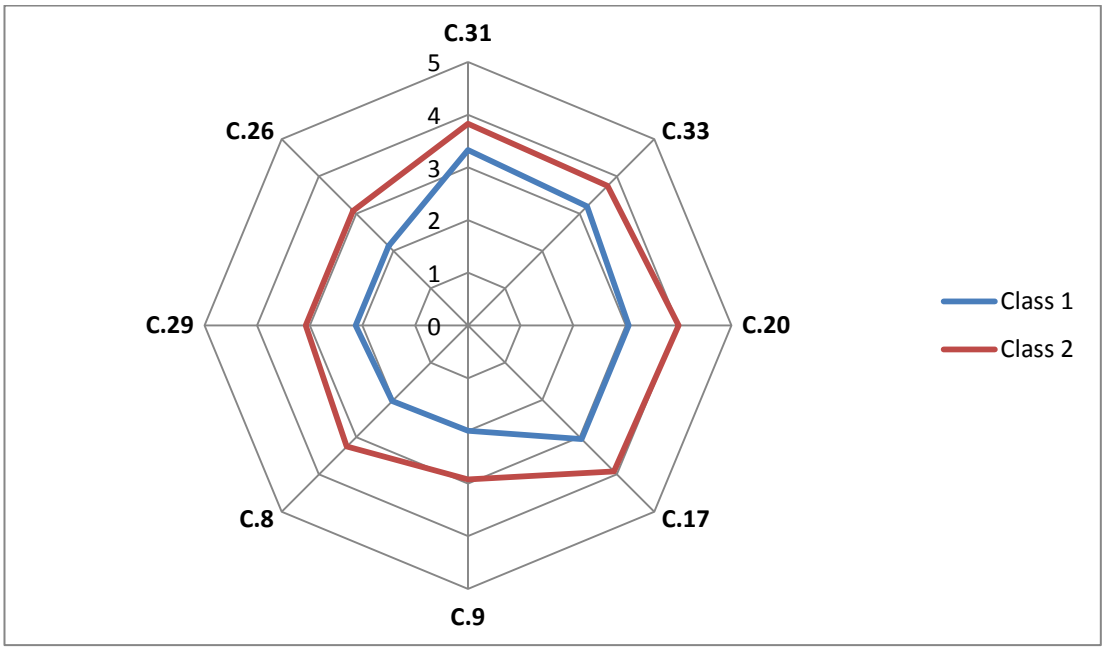

Figure 32: Radar Chart of the Second Order Change Orders considering Contractor classes

Table 11: Average influence values of second order change orders for group 2 contractors.

	Second order 4 most effective change orders					Second order 4 least effective change orders			
client group	**C.31**	**C.33**	**C.20**	**C.17**		**C.9**	**C.8**	**C.29**	**C26**
Public	2.73	2.73	2.13	2.27		1.33	1.33	1.27	1.60
Private	3.73	3.57	3.73	3.65		2.57	2.70	2.78	2.65

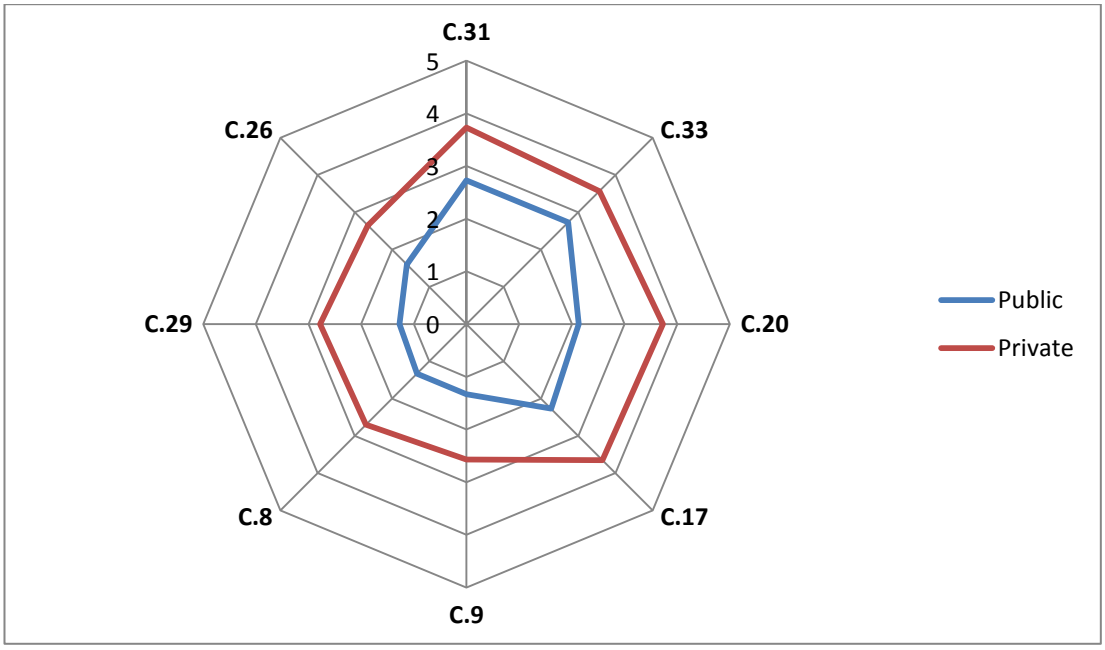

Figure 33: Radar Chart of the Second Order Change Orders considering Contractors' targeted client group

Table 12: Average influence values of second order change orders for group 3 contractors.

	Second order 4 most effective change orders					Second order 4 least effective change orders			
specialized area	**C.31**	**C.33**	**C.20**	**C.17**		**C.9**	**C.8**	**C.29**	**C26**
Infrastructure	3.13	2.88	2.88	2.75		1.75	1.88	1.75	1.88
Residential	3.86	3.77	3.82	3.77		2.68	2.77	2.95	2.91
Commercial	3.14	3.05	2.86	2.91		1.91	2.00	1.95	1.95

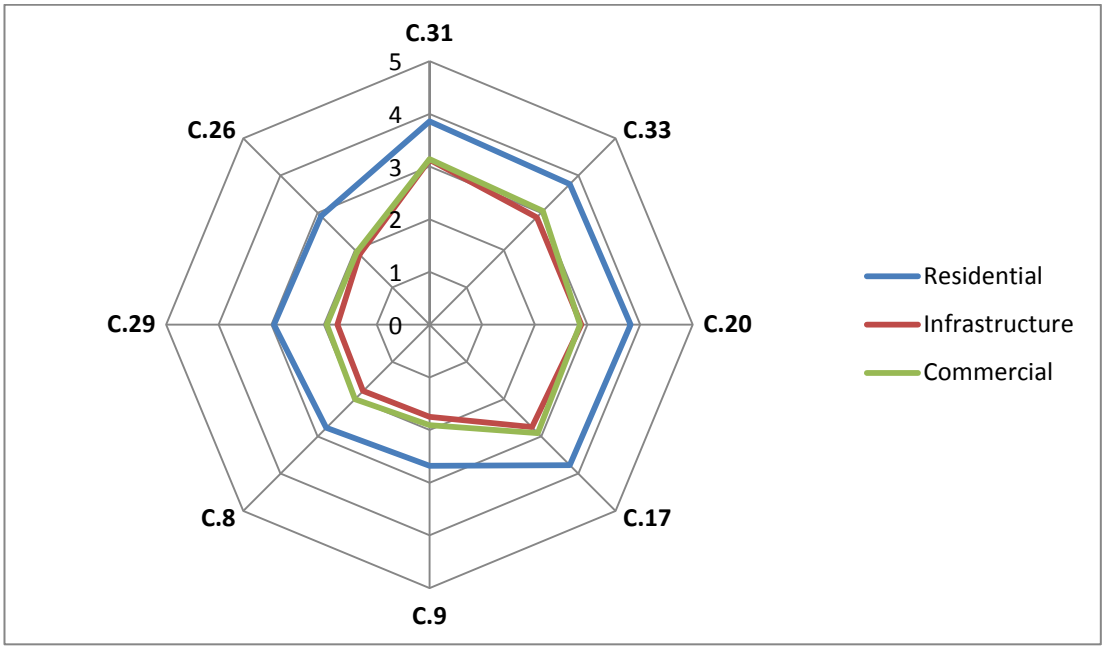

Figure 34: Radar Chart of the Second Order Change Orders considering Contractors' specialized area of construction

5.7.3 Radar Charts of the Third Order Change Orders

Third Order Change Orders are presented by Radar Charts as follows:

- The average influence values of the third order change orders for group 1 contractors are presented in the table 13. Radar Chart of the First Order Change Orders considering Contractor classes is presented in the figure 35.

- The average influence values of the third order change orders for group 2 contractors are presented in the table 14. Radar Chart of the First Order Change Orders considering Contractors' targeted client group is presented in the figure 36.
- The average influence values of the third order change orders for group 3 contractors are presented in the table 15. Radar Chart of the First Order Change Orders considering Contractors' specialized area of construction is presented in the figure 37.

Table 13: Average influence values of third order change orders for group 1 contractors.

	Third order 4 most effective change orders					Third order 4 least effective change orders			
contracting classes	**C.2**	**C.16**	**C.23**	**C.25**		**C.28**	**C.35**	**C.11**	**C.5**
class 1	2.98	3.03	3.03	3.00		2.15	2.23	2.45	2.40
class 2	4.08	3.92	3.75	3.83		3.17	3.33	3.08	3.33

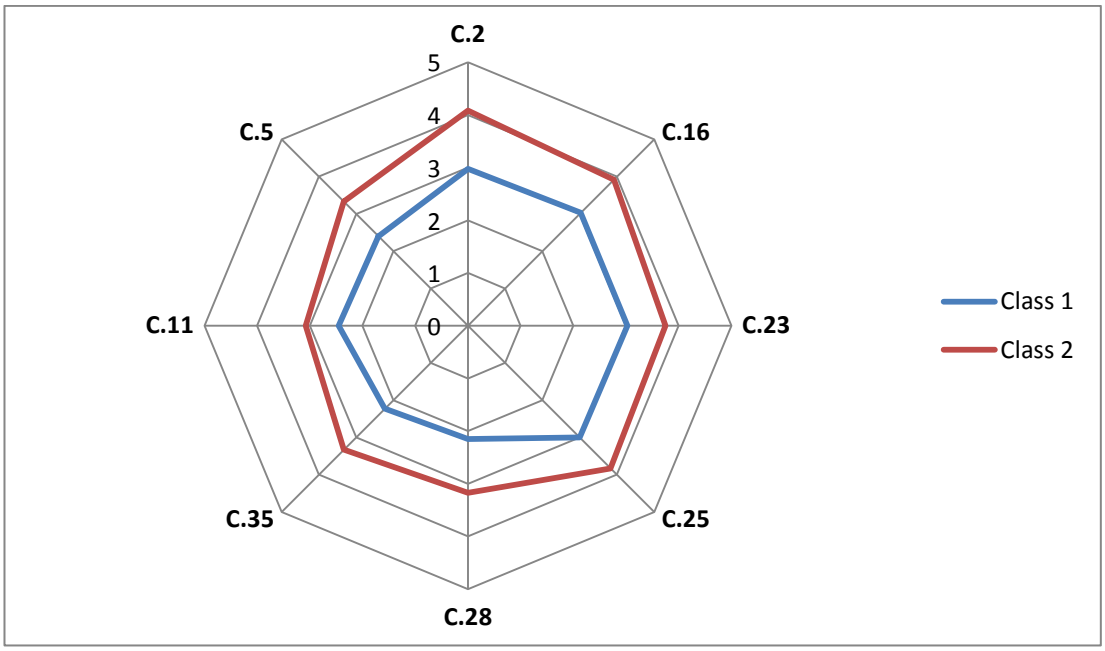

Figure 35: Radar Chart of the Third Order Change Orders considering Contractor classes

Table 14: Average influence values of third order change orders for group 2 contractors.

	Third order 4 most effective change orders					Third order 4 least effective change orders			
client group	**C.2**	**C.16**	**C.23**	**C.25**		**C.28**	**C.35**	**C.11**	**C.5**
Public	2.13	2.40	2.47	2.07		1.67	1.53	1.93	1.73
Private	3.68	3.57	3.49	3.65		2.68	2.86	2.86	2.97

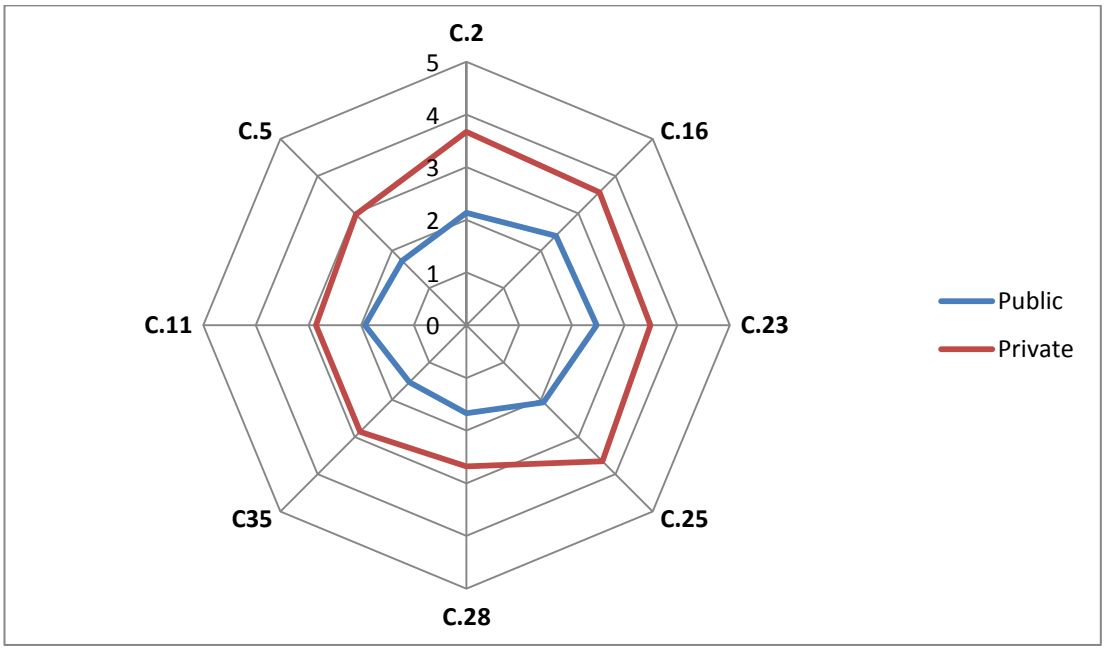

Figure 36: Radar Chart of the Third Order Change Orders considering Contractors' targeted client group

Table 15: Average influence values of third order change orders for group 3 contractors.

	Third order 4 most effective change orders					Third order 4 least effective change orders			
specialized area	**C.2**	**C.16**	**C.23**	**C.25**		**C.28**	**C.35**	**C.11**	**C.5**
Infrastructure	2.63	2.88	2.75	2.88		2.00	2.13	2.38	2.25
Residential	3.95	3.64	3.64	3.77		2.77	3.00	3.00	3.05
Commercial	2.73	2.95	2.91	2.73		2.14	2.09	2.27	2.32

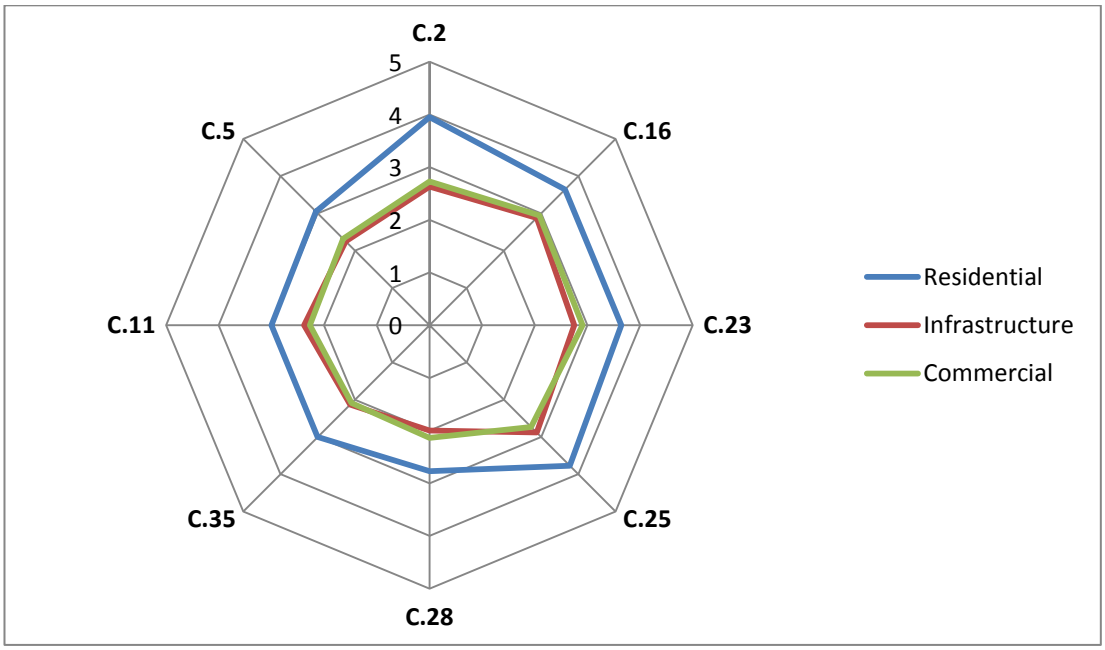

Figure 37: Radar Chart of the Third Order Change Orders considering Contractors' specialized area of construction

Chapter 6

DISCUSSION AND IMPLICATIONS

6.1 Introduction

Discussions on the influence of the Change Orders are done considering the mean values of the influence rates of the change orders. The higher the RII or the mean values have more influence of the change order causing conflicts. So the mean values of the rates obtained from the questionnaire survey points out the weight of the influence of change order in construction phase causing conflict from the contractors' perspective. The discussions are supported by different researchers.

Implications are done from the contractors' perspective in construction phase of a construction project. Implications are gathered by interviewing the respondents during the questionnaire survey. Thus, the implications are based on the experience of the respondents of the construction industry in the North Cyprus environment.

6.2 Discussion of the Results of the Radar Chart Analysis

Discussions of the results obtained from the radar chart analysis are done in 3 groups. The first group analysis consists of the discussion of the ratings for the change orders rated by the contracting class 1 and the contracting class 2 contractors. The second group analysis consists of the discussion of the ratings for the change orders rated by the contractors whose targeted client group priorities are either public or private. The third group analysis consists of the discussion of the ratings for the change orders

rated by the contractors whose construction type priorities are either infrastructure or residential or commercial projects.

For the first group contractors; by the help of the radar chart, it can be seen that first order change orders for contracting class 1 have less influence on conflict than contracting class 2 between the owner and the contractor. The contracting class 1 contractors are more equipped, have more experienced construction professionals and skilled labour and have more financial power than the contracting class 2 contractors. All these things make the class1 contractor more ready for unexpected situations such as changes than the contracting class 2 contractors.

For the second group contractors; by the help of the radar chart, it can be seen that first order change orders for the contractors whose priorities are public projects have less cause of conflict than the contractors whose priorities are private projects between the owner and the contractor. This is because the public projects have fewer changes than the private projects. In public projects once the designs are finalized there aren't much changes. However, in private projects because of the hesitant nature of the owner much more changes occur.

For the third group contractors; by the help of the radar chart, it can be seen that first order change orders for the residential projects have more conflict than the other two which are infrastructure and commercial projects. First order change orders have almost the same influence on conflict between the owner and the contractor for infrastructure and commercial project contractors. Infrastructure and commercial projects have little amount of changes, because the owner knows what he wants and the consultant knows what to do from the beginning of a construction project. Once

the design is finalized, the contractor does not face much change orders related with the owner or the consultant. However, in residential projects an individual client who buys a house, a flat or an apartment may require lots of changes from the flooring materials to ceiling, from wall tiles to painting, from lavatories to kitchen etc. Some of the clients want even design changes. Thus, residential projects cause more conflict than the infrastructure and the commercial projects between the owner and the contractor.

6.2.1 General Discussion of the First Order Change Orders

For the first order change orders, the 4 most effective change orders are As-built used for design were incorrect, Late issue of design, Change in timing of vendor drawing approval, and Design changes. As it can easily be seen, the all 4 most effective change orders are related with the design. If any delay, error, complexity, inadequateness, ambiguousness occur in the designs, it affects the construction progress of a construction project the most. So, before construction phase, the construction project should be properly studied in the design phase in order to minimize the difficulties and changes in the construction phase due to designs. It may cause additional changes resulting in delay in the completion time, increase in the overall cost, quality degradation of a construction project. Thus, design related change orders may cause conflict between the owner and the contractor the most. The first order 4 most change orders in this section are discussed in the section 6.3 in detail.

For the first order change orders, the 4 least effective change orders are Regulatory/Permit change, Code change, Change in access to the work area, and Accident-Change in safety approach. As it can be seen the 3 least effective change

orders are related with the regulatory changes, and the one is related with the access to the work area. The regulatory changes are governmental changes which is very little effective in the construction progress of a construction project, as regulatory changes do not affect much the continuing construction. Here in the North Cyprus, all the permits are taken and all the designs are approved before starting a construction legally, and the newly made regulatory changes are not binding for the continuing construction. So, any change in regulations has very little influence on a continuing construction project. Finally, change in access to the work area has also very little influence on the progress of a construction project, as the work area can be accessed somehow. Thus, these first order the 4 least change orders have almost very little influence on the conflict between the owner and the contractor. The first order 4 least change orders in this section are discussed in the section 6.3 in detail.

6.2.2 General Discussion of the Second Order Change Orders

For the second order change orders, the 4 most effective change orders are Late receipt of equipment, Late procurement activities, Change in available resources, and Scope change. As it can easily be seen, the 3 most effective change orders are related with the procurement problems; and one is related with the scope. In poor procurement processes delays occur. Procurement delays have various negative effects on other processes in the construction cycle of a construction project [3]. Additional changes may occur as a result. Furthermore procurement problems affect the completion time, quality, and the overall cost of a construction project. Thus, procurement problems cause conflict between the owner and the contractor. For the scope change, if any change occurs in plan or scope of a construction project, it generates one of the most significant causes of change in the construction project. It is usually the result of insufficient planning at the project definition stage, or because

of lack of involvement of the owner in the design phase [11] of a construction project or because of the hesitant nature of the owner. Thus, conflict is inevitable between the owner and the contractor. The second order 4 most effective change orders in this section are discussed in the section 6.3 in detail.

For the second order change orders, the 4 least effective change orders are Process change, Vendor change, Work rules (operations), and seasonal work change. For the process change, as the construction industry is a labour intensive industry, by the experienced construction professionals, process change can be solved, can be adapted to the new process easily without causing much problem. For the vendor change, it is actually a procurement problem, but the questioned contractors in the North Cyprus didn't see much problem, because the resources can be bought from a different vendor without causing much problem. For the work rules (operations), as the construction industry is a labour intensive industry, by the experienced constructional professionals, any change in work rules on operations can be adopted with a little effort. For the seasonal work change, as the North Cyprus is part of an island in the Mediterranean Sea, the climate is warm and there are not much temperature changes among the seasons, only in winter time there is some rainy days that is it. So, the construction can continue process without interruptions or very little amount of interruptions due to the seasonal work change throughout the year. Thus, these second order the 4 least change orders have almost little influence on the conflict between the owner and the contractor. The second order 4 least change orders in this section are discussed in the section 6.3 in detail.

6.2.3 General Discussion of the Third Order Change Orders

For the third order change orders, the 4 most effective change orders are Engineering errors, Concept change, Quantity change, Material availability. For the engineering errors, engineering errors are various, it can occur in the construction phase or it can be in the design phase that can be realized during the process in the construction phase. Engineering errors may cause significant changes, delays, and rework and demolition. Thus, engineering errors can cause conflict between the owner and the contractor. For the concept change, concept change is usually needs design changes. So, this means that the construction may stop until the design is updated. So, like the other design changes the concept change is a cause of conflict between the owner and the contractor. For the quantity change, any change in quantity directly affects the overall revenue and the profitability of the contractor obtained from a construction project. Thus, the quantity change is one of the causes of conflict between the owner and the contractor. For the material availability, it is related with the procurement problems. In poor procurement processes delays occur. Procurement delays have various negative effects on other processes in the construction cycle of a construction project [3]. Additional changes may occur as a result. Furthermore procurement problems affect the completion time, quality, and the overall cost of a construction project. Thus, material availability cause conflict between the owner and the contractor. The third order 4 most effective change orders in this section are discussed in the section 6.3 in detail.

For the third order change orders, the 4 least effective change orders are Work rules (labour), Change in basic data requirement, Value engineering, and Change in work sequence. For the work rules (labour), as the construction industry is a labour

intensive industry, any change in work rules about labour, for an experienced contractor and construction professionals is not a hard duty to be prepared and adapted for it. So, change in work rules (labour) has almost little influence on conflict between the owner and the contractor. For the change in basic data requirement, the effect of lack of data in the design phase is adversely experienced by the contractor in the construction phase of a construction project. Additionally Basic Data is needed by the contractor to carry out the work successfully in the construction phase of a construction project. So, change in basic data requirements is a cause of conflict between the owner and the contractor, but with an almost little influence. For the value engineering, any confusion or incompatibility between the owner and the contractor in value engineering may cause conflict between the owner and the contractor and further between the contractor and the subcontractor. For the change in work sequence, change in work sequence should be well planned considering the priorities of the works in the construction process cycle of a construction project. These kinds of changes may affect the proceeding work sequence. So, contractor may come up with delays. Thus, this may cause conflict between the owner and the contractor. The third order 4 least effective change orders in this section are discussed in the section 6.3 in detail.

6.3 Discussion and Implications of the 37 Change Orders from the Questioned Contractors' Perspective

The discussion and implications are done in the order of their mean influence weights rated by the contractor questioned during the questionnaire survey. The more effective discussed the first; the least effective one discussed the last. The discussion and implications about each change order in the questionnaire survey are presented below:

As the change Orders are examined during the construction phase, it is a great cause of conflict between the owner and the contractor to have an incorrect design for as-builts. Because, as a contractor is carrying out work in construction phase of a construction project, it may strongly cause stopping construction until it is done correctly. Additionally changes can be faced due to as-builts for design were incorrect resulting in most likely rework and demolition. Thus this causes increased overall cost, and delay in completion time in a construction project. Because, usually the new ones are combined with the as-built ones (C.36: As-builts used for Design were incorrect, Mean=3.85, RII=0.769).

Late Issue of Design may be as a result of design changes; because, here in the North Cyprus, all the drawings and designs are finalized and should be approved by the municipality before starting a construction. Although the finalized and approved design, changes are also frequent in construction phase in the North Cyprus. Such changes can affect the project in various ways depending on the timing of the change. As the change Orders are examined during the construction phase, it is a great cause of conflict between the owner and the contractor not to have the design on time. As the contractor is carrying out work in construction phase, it causes the contractor to wait until the issue of design is ready to continue or even to start the construction (C.30: Late Issue of Design, Mean=3.56, RII=0.712).

As the change Orders are examined during the construction phase, it is a great cause of conflict between the owner and the contractor not to have the approval of vendor drawings on time. Because, a contractor may arrange lots of work to be done after the approval of vendor drawings, it may stop the contractor until getting the approved drawings to continue construction resulting in delays of a construction

project. Additional changes may occur due to the change in timing of vendor drawing approval resulting in delays in the completion time of the construction project. This can be minimized by the experienced construction professionals. The contractor may carry out different works in the construction cycle until getting the approved vendor drawings. (C.32: Change in Timing of Vendor Drawing Approval, Mean=3.50, RII=0.700).

Change in design for improvement by the consultant is a norm in contemporary professional practice [11]. Changes in design are frequent in projects where construction starts before the design is finalized [3]. However, here in the North Cyprus, all the drawings and designs are finalized and should be approved by the municipality before starting a construction. Although the finalized and approved design, changes are also frequent in construction phase in the North Cyprus. Such changes can affect the project in various ways depending on the timing of the change. As the change Orders are examined during the construction phase, it is a great cause of conflict between the owner and the contractor not to have the on time. Because, lots of work may be arranged to be done after the changed design is ready, it may stop the contractor until getting the drawings to continue construction (C.3: Design Changes, Mean=3.46, RII=0.692).

Unavailability of equipment is a procurement problem that can affect a construction project completion [4]. Late receipt of equipment has various negative effects on different activities in the construction phase of a construction project [3]. It affects the completion time, quality and success of a construction project. As the change Orders are examined during the construction phase, it is a great cause of conflict between the owner and the contractor not to have the equipment on time. Since, lots

of work may be arranged to be done after the receipt of equipment, it may stop the contractor until receiving the equipment to continue construction (C.31: Late Receipt of Equipment, Mean=3.44, RII=0.688).

Late Procurement Activities have various negative effects on different activities in the construction phase of a construction project [3]. Changes may occur because of other activities affected by late procurement activities in the construction phase of a construction project. The contractor may need to accelerate the construction processes to reach the deadline of the completion time determined in the contract of a construction project. This can be a cause of change because of the increased overall cost and extra effort and time. Lots of work are arranged to be done after the procurement activities. So any delay in procurement activities, cause delay in numerous construction activities. Thus, this may cause of conflict between the owner and the contractor (C.33: Late Procurement Activities, Mean=3.33, RII=0.665).

As the North Cyprus is a part of an island, change in available resources may cause the contractor to import the new resource. So, the construction may stop or slow down until obtaining the new resources. Change in Available Resources may have various negative effects on the other activities in the construction phase of a construction project. If other activities in the construction phase are affected by the change in available resources, additional changes may occur, resulting in delays in completion time, rise in overall cost and dissatisfaction of the owner. Thus, this may also be a cause of conflict between the owner and the contractor **(**C.20: Change in Available Resources, Mean=3.27, RII=0.654).

Changes in plan or scope of the project is one of the most important causes of changes in construction projects [18], and is usually the result of insufficient planning at the project definition stage, or because of lack of involvement of the owner in the design phase [11] of a construction project, or because of the hesitant nature of the owner. A construction project is the result of the collective work of the construction professionals engaged, who have to carry out work at the different interfaces of a construction project [11, 22]. The owner's persistent nature on scope change may result in important changes at various interfaces of a construction project resulting in delay in completion time and increase in overall cost of a construction project. Scope Change is usually needs design changes. So, this means that the construction stops until the design is prepared. So, like the other design changes the Scope Change is time-consuming. Thus this is a cause of conflict between the owner and the contractor (C.17: Scope Change, Mean=3.25, RII=0.650).

Errors in design are an important cause of project delays [11]. Depending on the timing of the errors in a construction project, delays and changes may occur. Engineering Errors are various, it can occur in the construction phase or it can be in the design phase that can be realized during the process in the construction phase. So, engineering errors may cause conflicts between the owner and the contractor, as it can be difficult or time-consuming to recover or overcome the engineering errors. It may cause rework and demolition (C.2: Engineering Errors, Mean=3.23, RII=0.646).

A construction project is the result of the collective work of the construction professionals engaged, who have to carry out work at the different interfaces of a construction project [11, 22]. The owner's persistent nature on concept change may result in various changes at different interfaces of a construction project resulting in

delay in completion time and increase in overall cost of a construction project. Concept Change is usually needs design changes. So, this means that the construction may stop until the design is updated. So, like the other design changes the Concept Change is a cause of conflict between the owner and the contractor (C.16: Concept Change, Mean=3.23, RII=0.646).

Quantity Change may be as a result of the either financial problems of the owner or the scope change of a construction project. Change of plan or scope of the project is one of the most significant causes of change in construction projects [18], and is usually the result of insufficient planning at the project definition stage, or because of lack of involvement of the owner in the design phase [11]. The owner's financial problems can affect project progress and quality [4, 21]. These problems can lead to quantity change of a construction project. Additional changes and delay may occur as a result. The contractor may need time, money and extra effort for the preparation of the recent changes and the quantity of the work. Quantity Change directly affects the overall revenue and the profitability of the contractor obtained from a construction project. Considering all these, change in quantity may also cause conflict between the owner and the contractor. (C.23: Quantity Change, Mean=3.19, RII=0.638).

Material availability is a procurement activity. Procurement delays have negative effects on different activities in the construction phase of a construction project [3]. Any problem or change in material availability may result in additional changes in the construction phase. As the North Cyprus is a part of an island, change in material availability may cause the contractor to import the new material from abroad. Importing the material specified in the specifications or newly decided material from abroad causes delay in project completion time, and increase in overall cost of the

construction project. So, the construction may stop or slow down until receiving the new material. Thus, this may also be a cause of conflict between the owner and the contractor (C.25: Material Availability, Mean=3.19, RII=0.638).

Changes in specification requested either by the owner or by the consultant. Changes in specification are frequent in construction projects with inadequate project objectives [4] of the owner. If the owner decides to change the specification of a design or requirement, then this may lead to changes in the construction phase. Changes in specification may result in variations to the project, leading to delay and increased overall cost. Change in specification may also cause conflict between the owner and the contractor, as the contractor prepared everything according to the specification signed before starting construction. So, the preparations can be changed and it may need time, effort and money. It effects profitability of the contractor (C.7: Specification Change, Mean=3.15, RII=0.631).

Intended Use Change may be as a result of inadequate project objectives or change in mind of the owner. Inadequate project objectives can cause change in construction projects [23], leading to the designer being restricted in designing a suitable design that may lead to changes at a later stage of the construction process [5]. Change in mind of the owner may be as a result of the change in economic condition of the market or change in economic climate of the country. Economic conditions are one of the influential factors that may affect a construction project [3]. Thus, additional changes may occur during the construction phase of a construction project. Intended Use Change may cause design changes or may need different processes to differ it to the newly decided use. Time, effort and money is needed, thus it is another reason of

conflict between the owner and the contractor (C.14: Intended Use Change, Mean=3.15, RII=0.631).

Design evolution is necessary to overcome the dissatisfaction causing from design complexity, inadequate working drawing details, and necessity of detailed drawings to make poor drawings clear and precise. Complex designs require unique skills and construction methods [11]. Complexity affects the flow of construction activities, whereas simpler and linear construction works are relatively easy to handle [3]. Thus, changes may occur due to the complex construction designs. To convey a complete concept of the project design, the working drawings must be clear and concise [10]. Inadequate working drawing details can cause misinterpretation of the actual requirements for the construction project [11], resulting in changes in the construction project. During construction phase, design evolution change may be needed to overcome a difficulty in the construction phase by a detailed drawing of a section or a part of a work. So, any change in design evolution may cause waste of time, and more effort. Thus, it is a cause of conflict between the owner and the contractor (C.18: Design Evolution Change, Mean=3.10, RII=0.619).

While carrying out processes in construction phase, changes in design may be required in design due to various reasons. This can happen due to consultant, change in mind or requirement of the owner or due to a necessity realized by the contractor while proceeding works in the construction phase. So, the coordination between the parties as well as the construction professionals should be proper. Lack of coordination between parties may result in crucial changes with adverse effect on the construction project [11], resulting in rework, and changes. Thus the owner may not be satisfied from the overall process. During construction, a good coordination in

design is necessary to speed up the design process. So, any change in design coordination may be time-consuming. As like all the other time-consuming works, it causes conflict between the owner and the contractor (C.19: Design Coordination Change, Mean=3.00, RII=0.600).

Mobilization delay can cause acceleration of the work in the construction process to reach the completion time. Acceleration of the work can cause inadequate safety conditions, resulting in rising in the accident rates in the construction. Additionally, acceleration of the work in the construction process affects the quality adversely of a construction project. Quality degradation and rising in accident rates in the construction phase of a construction project affects negatively the reputation of the contractor. Also, quality degradation may cause rework and demolition, resulting in increase in overall cost. Any delay in mobilization, construction cannot even start. Time and money start to be lost from the beginning. So, conflict between the owner and the contractor may be faced at the very beginning of the construction phase of a construction project (C.22: Mobilization Delay, Mean=3.00, RII=0.600).

Schedule Change often occurs as a result of poor planning of the construction phase of a construction project. Proper schedule planning is an important aspect not to face with the changes in the construction process from the very beginning of the construction phase. Additionally, schedule change may affect the completion time of a construction project. If schedule chance occurs, the change schedule should be done properly not have any further changes. Schedule Change may change the works done in the construction cycle in the order of the contractor’s preparations. These kinds of changes may affect the proceeding works. So, contractor may come across with waste of time. Thus, this may cause conflict between the owner and the

contractor. A knowledgeable construction manager has a significant importance on proper schedule programming. (C.6: Schedule Change, Mean=2.96, RII=0.592).

Force Majeure may have adverse effect on the continuing works in the construction phase of a construction project. Force Majeure may cause changes, may affect the schedule, the completion time of a construction project. The contractor has the schedule, equipment, labour, finance etc. according to the previous planned schedule of the construction work processes of a construction project. The new conditions may be hard to be adopted by the contractor. Thus, Force Majeure has influence on conflicts between the owner and the contractor (C.21: Force Majeure, Mean=2.90, RII=0.581).

Omissions in design are an important cause of project delays [11]. Depending on the timing of the omissions in a construction project, delays and changes may occur. Omissions are various, it can occur in the construction phase or it can be in the design phase that can be realized during the construction phase. So, omissions may cause conflict between the owner and the contractor, as it can be difficult or time-consuming to recover or to overcome the deficiencies they cause. It may cause rework and demolition (C.1: Omissions, Mean=2.85, RII=0.569).

Changes may occur due to the desired profitability of the main contractor carrying out the works [5]. Changes are considered a common source of additional work for the contractor [4]. Thus, changes can be considered as an increase in the overall revenue and in the profitability obtained from a construction project for the contractor. So, Cost Reduction Change most probably leads reduction in the overall revenue and in the profitability of the contractor. Cost reduction change may reduce

the quality and quantity of work. Thus, it can be a cause of conflict between the owner and the contractor (C.12: Cost Reduction Change, Mean=2.79, RII=0.558).

Change in Engineering Support to Construction, may cause lack of coordination and communication in the continuing work processes in the construction phase of a construction project. This may result in changes that affect the continuing construction adversely leading to demolition and rework. Change in Engineering support to Construction may cause dissatisfaction of the owner leading to conflict between the owner and the contractor as the newly come engineer needs time to know well the project and to be a part of the coordination and communication. So, this needs time, but for an experienced and knowledgeable construction professional, this time (to construct the communication, coordination, and to get into the job) can be minimized easier (C.37: Change in Engineering Support to Construction, Mean=2.75, RII=0.550).

Unforeseen conditions are usually faced by professionals in the construction industry [4, 21]. These unforeseen conditions, if not resolved, may cause changes in the construction project. Unforeseen Conditions in the construction may cause conflict between the owner and the contractor, as the contractor is not prepared for the new conditions. It may need time to identify the new conditions and to prepare the works to be done to overcome and resolve the unforeseen conditions. So, this needs time, effort, and money. Experienced construction professionals are more capable in identifying, resolving or to overcome the unforeseen conditions (C.4: Unforeseen Conditions, Mean=2.73, RII=0.546).

Some works need skilled manpower or equipment to be applied. Construction industry is a labour intensive industry. Skilled manpower is one of the major resources required in the construction industry. Any change in constructability may require additional skilled manpower or special equipment. Unavailability of these may cause delays in the construction phase of a construction project. Constructability Change is another cause of conflict, as it can be hard to apply new work in the construction. It can be time-consuming. Time-consuming costs money, so this may cause conflict between the owner and the contractor (C.13: Constructability Change, Mean=2.65, RII=0.531).

Aesthetic Change usually cause design change and additional changes such as material change. The replacement of new materials may be more expensive, and may need change in procedure or method of application of it. The replacement of new materials or procedures of application for aesthetic change may lead to additional changes during the construction phase of a construction project. The substitution of procedures includes changes in application methods [17]. Aesthetic Change needs more works to be done or even may need design change. More work or design change needs time, effort and money affecting the completion time and overall cost. Considering all these, Aesthetic Change may cause conflict between the owner and the contractor (C.10: Aesthetic Change, Mean=2.63, RII=0.527).

Change in Work Sequence may be as a result of poor planning of the construction processes in the construction cycle of a construction project. Some works in the construction process cycle have priority. Change in Work Sequence should be well planned considering the priorities of the works in the construction process cycle of a construction project. A knowledgeable construction manager has a significant

importance on proper schedule programming in order not to face the additional changes in the construction cycle. Change in Work Sequence, may change the works done in the order of the contractor's preparations. These kinds of changes may affect the proceeding work sequence. So, contractor may come up with waste of time. Thus, this may cause conflict between the owner and the contractor (C.5: Change in Work Sequence, Mean=2.62, RII=0.523).

The most ideal stage of value engineering is to be carried out during the design phase [15]. If value engineering is carried out during the construction phase, it can become a very costly process and may cause changes. Value Engineering is a dominant aspect affecting the profitability of the contractor. Any confusion or incompatibility between the owner and the contractor in value engineering may cause conflict between the owner and the contractor and further between the contractor and the subcontractor (C.11: Value Engineering, Mean=2.60, RII=0.519).

Lack of data may result in misinterpretation of the real requirements of a construction project [14]. If there is not enough data in hand to the consultants then the design is based more on the consultants' own perception of the requirements of the construction project [5]. If these perceptions come out wrong, changes will occur during the construction phase in the construction project. Data about available materials and equipment is an important factor for developing a comprehensive design [10]. If the consultant has a poor knowledge of available materials or equipment that can be used in the construction process, changes are more likely to happen during the construction phase of a construction project [5]. The effect of lack of data in the design phase is adversely experienced by the contractor in the construction phase of a construction project. Additionally Basic Data is needed by

the contractor to carry out the work successfully in the construction phase of a construction project. By the basic data a material may be chosen, or the basic data may be bill of quantity to get payment from the owner or to pay the subcontractor, or may be a detailed drawing to speed up the work processes in the construction phase of a construction project. But, these kinds of changes do not often happen and can be overcome by the experience of the construction professionals. So, Change in Basic Data Requirements is a cause of conflict between the owner and the contractor, but with an almost little influence (C.35: Change in Basic Data Requirements, Mean=2.48, RII=0.496).

Construction industry is a labour intensive industry. Change in Work Rules about Labour is a regulatory issue. As the construction industry is a labour intensive industry, any change in work rules about labour for an experienced contractor and construction professionals is not a hard duty to be prepared and adapted for it. Change in Work Rules (Labour) has almost little influence on conflicts between the owner and the contractor, because any change can be adapted by the contractor. It may need a little effort and money but can be solved without causing much problem (C.28: Work Rules (Labour), Mean=2.38, RII=0.477).

Adverse weather conditions can affect outside activities in construction projects [4, 5]. The weather conditions have negative effects and cause delays in the construction works, changes may happen to recover time loss in the schedule and additional costs in the works of the construction process in a construction project. However, as the North Cyprus is an island in the Mediterranean Sea, Seasonal Work Change does not make big problems in the construction industry in the North Cyprus environment. The climate is warm in winters and hot in summers. Only a few months in a year are

rainy; and in rainy months several days rains, thus it makes several weeks rainy in general in a year. There are not big changes between the seasons; the overall work loss is not significant due to the weather conditions. Thus, Seasonal Work Chance has almost little influence on conflicts between the owner and the contractor (C.26: Seasonal Work Change, Mean=2.35, RII=0.469).

Change in Work Rules about Operations is a regulatory issue. Any change in work rules about operations for an experienced contractor and construction professionals is not a hard duty to be prepared for it. Change in Work Rules (Operations) has almost little influence on conflicts between the owner and the contractor, because any change can be adopted by the contractor. It may need a little effort and money but can be solved without causing much problem (C.29: Work Rules (Operations), Mean=2.35, RII=0.469).

The vendor change may be a procurement problem. Procurement delays have various adverse effects on other processes in the construction cycle [3]. Other processes in the construction phase may be affected by poor procurement activities, changes may occur as a result. Any change in vendor may cause delays considering the distance of the new vendor to the construction site; the prices may be different, the new vendor may hardly satisfy the needs of the contractor etc. The vendor, the contractor used to work with may be better in coordination and communication, but with a little effort of the construction professionals such as project manager, the problems can be overcome. Thus, Vendor Change has almost little influence on conflicts between the owner and the contractor (C.8: Vendor Change, Mean=2.31, RII=0.462).

Construction industry is a labour intensive industry. Any change in process may need skilled manpower. Skilled manpower is one of the major resources needed when a change in process occurs. Additionally process change may need new equipment. Unavailability of the skilled manpower and/or the new equipment for the recent process may result in delays. Any change in process can be hard to be applied. It can be time-consuming, but usually it can be learned how to apply the new process with a little effort by the experienced construction professionals. So, this may have almost little influence on cause of conflict between the owner and the contractor (C.9: Process Change, Mean=2.21, RII=0.442).

Safety is a significant factor for the successful completion of a construction project [21]. Accident-Change in Safety Approach is a regulatory aspect. Obeying safety regulations may result in changes in the design aspects of a construction project, and also some additional precautions may be needed in the construction phase. The construction companies take precautions on health and safety before starting construction. So, any change in Accident-Change in Safety Approach (Construction), can be adopted with little effort, time and money. Thus, Accident-Change in Safety Approach (Construction) has almost little influence on conflicts between the owner and the contractor (C.27: Accident-Change in Safety Approach (Construction), Mean=2.15, RII=0.431).

Change in access to the work area may be as a result of safety factors, governmental precautions and obstructions or environmental factors such as neighbouring obstruction. Change in access to work area is almost little effective on conflicts between the owner and the contractor, because a contractor can access to the work

area in any case, may be harder but still can access and can continue construction (C.34: Change in Access to Work Area, Mean=1.79, RII=0.358).

As the change Orders are examined during the construction phase, any change in codes does not affect the continuing construction processes of a construction project. Because, while preparing designs and engineering calculations, the previous codes such as earthquake codes or codes of standards are used and approved before starting construction. In the North Cyprus regulations it is not a must to use the new codes as a construction project has to be approved before starting construction. However, the recent codes are evaluated by the contractor and the consultant and the new codes may be chosen by a contractor or an owner if it is more beneficial for them. Thus, Code Change has almost very little influence on the cause of conflicts between the owner and the contractor (C.24: Code Change, Mean=1.37, RII=0.273).

As the change Orders are examined during the construction phase, all the permits, approvals are taken before starting a construction. Hence, any change in regulations does not affect the construction phase because as mentioned above all the approvals and permits are taken according to the previous regulations. According to the North Cyprus Laws, the regulations newly made do not affect the continuing construction in the approvals and permits point of view. However, the recent regulations are evaluated by the contractor and the consultant and the new regulations may be chosen by a contractor or an owner if it is more beneficial for them. Thus, Regulatory / Permit Change has almost very little influence on the cause of conflicts between the owner and the contractor (C.15: Regulatory/Permit Change, Mean=1.35, RII=0.269).

Chapter 7

CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

This research aims to define the most effective and the least effective Change Orders, on the success of a project completion, without leading to disputes, in the construction phase, from the contractors' perspective.

To do this, a wide review of literature is done. From the literature review, common Change Orders are selected to fulfil the needs of the construction industry of the North Cyprus environment.

A wide questionnaire survey is done and the gathered data is analysed. From the analysis, the Change Orders are ranked in the order of their influence weight. The ranking gives insight to the construction industry for North Cyprus environment, as it is used to define the influences of Change Orders likely leading to disputes.

To give insight to the construction industry of North Cyprus, the causes of Change Orders, the effect of variations and Change Orders are put. To handle the causes and effects, the procedures and managerial recommendations of the Change Orders are proposed to the construction industry of North Cyprus.

In this study, the causes of Conflict and how to manage Conflict are also defined. Furthermore, the Dispute Resolution steps are defined as well.

7.2 Conclusion of the results of the analysis

From the analysis of the 37 change orders, 4 of them are identified to be the most effective and 4 of them are appeared to be the least effective. In this study, 4 most effective and 4 least effective Change Orders are identified from the point of their influences on leading to Disputes, in the construction phase from the contractors' perspective.

7.2.1 Conclusion of the 4 most effective Change Orders

The all 4 most effective Change Orders are related with the late or incorrect drawings. They are "as-built used for design were incorrect", "late issue of design", "change in timing of vendor drawing approval", and "design changes". As it can easily be seen, the all 4 most effective change orders are related with the design. If any delay, error, complexity, inadequateness, ambiguousness occur in the designs, it affects the construction progress of a construction project the most. So, before construction phase, the construction project should be properly studied in the design phase in order to minimize the difficulties and changes in the construction phase due to designs. These Change Orders can be a significant cause of conflict; if those conflicts are not well managed the influence of those conflicts can easily lead to disputes.

7.2.2 Conclusion of the 4 least effective Change Orders

The 4 least effective Change Orders are "regulations/permit change", "code change", "change in access to the work area", and "accident-change in safety approach (construction)". The 3 of them are related with the laws and regulations, which a contractor or an owner cannot be affected by the new regulations/permit or code

changes as the codes used and regulations/permits taken and approved before starting construction. For the “accident-change in safety approach (construction)”, it is also governmental regulations that a contractor or an owner should obey. So, it is not an effective cause of conflict between the owner and the contractor. The remaining one of the 4 least effective Change Orders is “change in access to the work area”, it can be changed, but the work area can be accessed somehow, it is not an effective cause of conflict between the owner and the contractor.

7.3 Recommendations of the Study

While proceeding construction projects, mostly causing from the changing in mind of the owner, too many decisions must be made, generally relying on the incomplete information, assumptions, and experience of the construction professionals [8].

It is understood that, in almost every construction project, Changes are inevitable. Thus, Change management is crucial in construction industry. From the findings obtained by observing and analysing the respondents’ reaction, some recommendations are proposed in this study. The proposed recommendations are made generally from the contractors’ perspective, which is the aim of this study, are as follows:

- Before beginning a construction project, the owner should prepare the finance needed for the whole project to finalize the construction, and not to need changes during construction phase due to lack of finance.
- Establishing a comprehensive system for budget and schedule baseline control is important [9].
- Project objectives of the owner should be adequate.

- A construction project should be properly studied in the design phase in order to minimize the difficulties and changes in the construction phase.
- The owner should be involved in the design phase effectively, he/she should be informed well in every stage of the design phase to minimize the design changes in later stages.
- The owner shouldn't be hesitant. Hesitation of the owner in decision making in the design phase causes changes in later stages of a construction project.
- Involvement of the contractor in the design may assist in developing better designs by accommodating his creative and practical ideas [11].
- Conflict between contract documents can result in misinterpretation of the actual requirement of a project [13]. It is essential that contract documents are clear and precise [5].
- It is essential to avoid from Change Orders. Changes may be avoided or at least limited to minimum via successfully prepared contract, and while processing a construction project, proper project management, additionally sustainability in the participants' and construction professionals' relationships is needed [5].
- The operational principles of the main participants should be good in general, in construction projects [8].
- It is important to have an experienced and knowledgeable site chief in the construction site, so that some of the changes can be avoided before they are occurred.
- The communication especially operational communication should be also good in construction projects between all parties and also between the all parties and the construction professionals [8].

- Negotiations of Change Orders are important to be done through an experienced and knowledgeable people [8].
- The most effective way to carry on the construction operations is the use of written approval [8, 9].
- Verbal notice can be accepted only in urgent cases, and can only be done by the owner under very important circumstances [8, 9].
- From the very beginning, a proper change order procedure is crucial for the continuation of the construction operations [8].
- A check list is very helpful to follow the steps of the procedure, and to establish a good control system [8].

7.4 Conclusion in General

Regardless of effort and the best intentions, project planning is an imperfect process. Change Orders are an inevitable occurrence on any construction project. Although the owner can take steps to help mitigate the number of changes on a project, it is impossible to fully eliminate the issues that impact a project's planned cost and schedule performance. There are simply too many unknowns and variables that are outside the control of the management on any given project [9].

Often Change Orders can become a polarizing factor between the parties. The owner's objectives are to minimize the impact of Change Orders to the greatest extent possible as a measure of control over a project's budget and schedule. Comparatively, the contractor's interests may involve expanding the scope of work beyond the defined by the contract, in addition to boosting its project revenue. The differing objectives between the parties can result in divergent positions and the inability to attain fair and equitable relations in changes. If the owner and/or the

contractor elect to ignore or postpone the negotiation and settlement of Change Orders until the end of a project, the issues that may have been previously solvable have a greater potential of being disputed and becoming claims.

For a project to be successful, it is important for management to be committed to be processing Change Orders in an attentive and unbiased manner. It is beneficial for a project to establish a Change Order process with a defined set of procedures that is best suited to the requirements of a project, promotes open communications, is objective, and is structured to foster the resolution of Change Orders in an expeditious manner.

As Change Orders are negotiated and finalized, the information should be addressed as updates to the project record, including the project budget and schedule. The timely addition of change-related information provides management with a current perspective of the overall condition of a project, compared to its plan. This information also offers the ability for the parties to a contract to more accurately forecast the cost and time that will be required to complete the work for a project.

7.5 Summarized Conclusion and Suggestions for Further Studies

It is obvious that, Change Orders are one of the main causes of Conflict; Conflicts are needed to be managed in order not to turn to Disputes; and Disputes are needed to be resolved. The Dispute Resolution process is timely manner and costly. Thus, the Change Orders should be avoided or at least managed well [5], because it can quickly turn to conflict. The Conflicts are manageable, and a good management is required. If it is not so, it easily turns to Dispute. However, Disputes are associated with distinct justiciable issues; therefore it requires resolution such as mediation,

negotiation, arbitration, etc. [1, 2, 7]. Unfortunately, Dispute resolution process is timely manner and very costly as it may need litigation to be resolved [7, 28].

The researches and studies on variations and Change Orders, and their causes and effects are still limited. Further researches and studies should be done in order to have more information and knowledge in hand to fulfil the requirements of the construction industry. The researches should be done in the design, contract, and construction phase. It has a significant importance for the studies to be done especially in the construction phase which is the case of this study. So that, the researchers will have more data, information and knowledge in hand for further studies and the construction industry will get benefit from them.

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APPENDICES

Appendix A: Questionnaire Survey

I. General Information about the Firm:

1- Firm's Name:

2- Firm's Address:

3- Firm's Tel:

4- Firm's URL:

5- Firm's e-mail:

6- The Number of yearly employed people in your Firm:

	NUMBER	POSITION
Top Management		
Technical people		
Non-technical people		
Total number		

7- Your position in the Firm:

8- Yearly produced amount of the Firm (in m^2 construction area) and the total produced value:

Total Produced Amount (m^2)	
Total Produced Value (GBP or TL)	

9- Any specialized area that your firm pretends to be:

No	Specialized Area
1	
2	

10- Is there any specific customer group in the market targeted by the firm? If yes, Please Specify it:

1	Governmental Organizations	
2	Private Organizations	
3	Individuals	High Income level: Medium Income level: Low Income level:

II. Rank the Change Orders considering their influence leading to Disputes:

No	TYPES OF CHANGES ORDERS	very little effective 1	little effective 2	effective 3	much effective 4	very much effective 5
C.1	Omissions					
C.2	Engineering Errors					
C.3	Design Changes					
C.4	Unforeseen Conditions					
C.5	Change in Work Sequence					
C.6	Schedule Change					
C.7	Specification Change					
C.8	Vendor Change					
C.9	Process Change					
C.10	Asthetic Change					
C.11	Value Engineering					
C.12	Cost Reduction Change					
C.13	Constructibility Change					
C.14	Intended Use Change					
C.15	Regulatory/Permit Change					
C.16	Concept Change					
C.17	Scope Change					
C.18	Design Evolution Change					
C.19	Design Coordination Change					
C.20	Change in Available Resources					
C.21	Force Majeure					
C.22	Mobilization Delay					
C.23	Quantity Change					
C.24	Code Change					
C.25	Material Availability					
C.26	Seasonal Work Change					
C.27	Accident-Change in Safety Approach(Construction)					
C.28	Work Rules(Labor)					
C.29	Work Rules(Operations)					
C.30	Late Issue of Design					
C.31	Late Receipt of Equipment					
C.32	Change in Timing of Vendor Drawing Approval					
C.33	Late Procurement Activities					
C.34	Change in Access to Work Area					
C.35	Change in Basic Data Requirements					
C.36	As-builts Used for Design were Incorrect					
C.37	Change in Engineering Support to Construction					

Appendix B: Descriptive Statistics of Change Orders

Table B.1: Descriptive Statistics of the Change Orders no. from C.1 to C.8

Change Orders		C.1	C.2	C.3	C.4	C.5	C.6	C.7	C.8
N	Valid	52	52	52	52	52	52	52	52
	Missing	0	0	0	0	0	0	0	0
Mean		2.85	3.23	3.46	2.73	2.62	2.96	3.15	2.31
Median		3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00
Mode		3	4	3	3	2	3	3	2
SD.		0.872	1.165	0.917	0.952	0.973	0.989	1.161	1.039
Variance		0.760	1.357	0.842	0.906	0.947	0.979	1.348	1.080
Minimum		1	1	1	1	1	1	1	1
Maximum		5	5	5	5	5	5	5	5
Sum		148	168	180	142	136	154	164	120
RII		0.569	0.646	0.692	0.546	0.523	0.592	0.631	0.462

a. Multiple modes exist. The smallest value is shown.

Table B.2: Descriptive Statistics of the Change Orders no. from C.9 to C.16

Change Orders		C.9	C.10	C.11	C.12	C.13	C.14	C.15	C.16
N	Valid	52	52	52	52	52	52	52	52
	Missing	0	0	0	0	0	0	0	0
Mean		2.21	2.63	2.60	2.79	2.65	3.15	1.35	3.23
Median		2.00	2.00	3.00	3.00	2.50	3.00	1.00	3.00
Mode		2	2	3	3	2	3	1	3
SD.		0.848	0.864	0.748	1.109	0.988	1.017	0.883	1.022
Variance		0.719	0.746	0.559	1.229	0.976	1.035	0.780	1.044
Minimum		1	1	1	1	1	1	1	1
Maximum		4	5	4	5	5	5	5	5
Sum		115	137	135	145	138	164	70	168
RII		0.442	0.527	0.519	0.558	0.531	0.631	0.269	0.646

a. Multiple modes exist. The smallest value is shown.

Table B.3: Descriptive Statistics of the Change Orders no. from C.17 to C.23

Change Orders		C.17	C.18	C.19	C.20	C.21	C.22	C.23
N	Valid	52	52	52	52	52	52	52
	Missing	0	0	0	0	0	0	0
Mean		3.25	3.10	3.00	3.27	2.90	3.00	3.19
Median		3.00	3.00	3.00	3.00	3.00	3.00	3.00
Mode		3	3	3	4	3	3	3
SD.		0.947	0.823	0.863	1.012	0.799	1.103	0.951
Variance		0.897	0.677	0.745	1.024	0.638	1.216	0.903
Minimum		2	1	2	1	1	1	1
Maximum		5	5	5	5	4	5	5
Sum		169	161	156	170	151	156	166
RII		0.650	0.619	0.600	0.654	0.581	0.600	0.638

a. Multiple modes exist. The smallest value is shown.

Table B.4: Descriptive Statistics of the Change Orders no. from C.24 to C.30

Change Orders		C.24	C.25	C.26	C.27	C.28	C.29	C.30
N	Valid	52	52	52	52	52	52	52
	Missing	0	0	0	0	0	0	0
Mean		1.37	3.19	2.35	2.15	2.38	2.35	3.56
Median		1.00	3.00	2.00	2.00	2.00	2.00	4.00
Mode		1	3[a]	2	2	2	3	3
SD.		0.742	1.049	0.883	0.872	0.973	0.968	0.916
Variance		0.550	1.100	0.780	0.760	0.947	0.937	0.840
Minimum		1	1	1	1	1	1	1
Maximum		4	5	5	4	5	4	5
Sum		71	166	122	112	124	122	185
RII		0.273	0.638	0.469	0.431	0.477	0.469	0.712

a. Multiple modes exist. The smallest value is shown.

Table B.5: Descriptive Statistics of the Change Orders no. from C.31 to C.37

Change Orders		**C.31**	**C.32**	**C.33**	**C.34**	**C.35**	**C.36**	**C.37**
N	Valid	52	52	52	52	52	52	52
	Missing	0	0	0	0	0	0	0
Mean		3.44	3.50	3.33	1.79	2.48	3.85	2.75
Median		4.00	4.00	3.00	2.00	3.00	4.00	3.00
Mode		4	4	3	1[a]	3	4	3
SD.		0.916	0.852	0.785	0.750	0.960	0.802	0.905
Variance		0.840	0.725	0.617	0.562	0.921	0.643	0.819
Minimum		1	1	2	1	1	2	1
Maximum		5	5	5	3	5	5	5
Sum		179	182	173	93	129	200	143
RII		0.688	0.700	0.665	0.358	0.496	0.769	0.550

a. Multiple modes exist. The smallest value is shown.

Appendix C: Frequency Tables of Change Orders

Table C.1: Frequency Table of the Change Orders C.1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	3	5.8	5.8	5.8
	little effective	12	23.1	23.1	28.8
	effective	30	57.7	57.7	86.5
	Much effective	4	7.7	7.7	94.2
	Very much effective	3	5.8	5.8	100.0
	Total	52	100.0	100.0	

Table C.2: Frequency Table of the Change Orders C.2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	3	5.8	5.8	5.8
	little effective	13	25.0	25.0	30.8
	effective	13	25.0	25.0	55.8
	Much effective	15	28.8	28.8	84.6
	Very much effective	8	15.4	15.4	100.0
	Total	52	100.0	100.0	

Table C.3: Frequency Table of the Change Orders C.3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	1	1.9	1.9	1.9
	little effective	5	9.6	9.6	11.5
	effective	22	42.3	42.3	53.8
	Much effective	17	32.7	32.7	86.5
	Very much effective	7	13.5	13.5	100.0
	Total	52	100.0	100.0	

Table C.4: Frequency Table of the Change Orders C.4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	4	7.7	7.7	7.7
	little effective	18	34.6	34.6	42.3
	effective	20	38.5	38.5	80.8
	Much effective	8	15.4	15.4	96.2
	Very much effective	2	3.8	3.8	100.0
	Total	52	100.0	100.0	

Table C.5: Frequency Table of the Change Orders C.5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	6	11.5	11.5	11.5
	little effective	19	36.5	36.5	48.1
	effective	17	32.7	32.7	80.8
	Much effective	9	17.3	17.3	98.1
	Very much effective	1	1.9	1.9	100.0
	Total	52	100.0	100.0	

Table C.6: Frequency Table of the Change Orders C.6

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	3	5.8	5.8	5.8
	little effective	14	26.9	26.9	32.7
	effective	20	38.5	38.5	71.2
	Much effective	12	23.1	23.1	94.2
	Very much effective	3	5.8	5.8	100.0
	Total	52	100.0	100.0	

Table C.7: Frequency Table of the Change Orders C.7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	7	13.5	13.5	13.5
	little effective	4	7.7	7.7	21.2
	effective	21	40.4	40.4	61.5
	Much effective	14	26.9	26.9	88.5
	Very much effective	6	11.5	11.5	100.0
	Total	52	100.0	100.0	

Table C.8: Frequency Table of the Change Orders C.8

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	10	19.2	19.2	19.2
	little effective	25	48.1	48.1	67.3
	effective	11	21.2	21.2	88.5
	Much effective	3	5.8	5.8	94.2
	Very much effective	3	5.8	5.8	100.0
	Total	52	100.0	100.0	

Table C.9: Frequency Table of the Change Orders C.9

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	11	21.2	21.2	21.2
	little effective	22	42.3	42.3	63.5
	effective	16	30.8	30.8	94.2
	Much effective	3	5.8	5.8	100.0
	Very much effective	-	-	-	100.0
	Total	52	100.0	100.0	

Table C.10: Frequency Table of the Change Orders C.10

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	2	3.8	3.8	3.8
	little effective	25	48.1	48.1	51.9
	effective	16	30.8	30.8	82.7
	Much effective	8	15.4	15.4	98.1
	Very much effective	1	1.9	1.9	100.0
	Total	52	100.0	100.0	

Table C.11: Frequency Table of the Change Orders C.11

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	3	5.8	5.8	5.8
	little effective	20	38.5	38.5	44.2
	effective	24	46.2	46.2	90.4
	Much effective	5	9.6	9.6	100.0
	Very much effective	-	-	-	100.0
	Total	52	100.0	100.0	

Table C.12: Frequency Table of the Change Orders C.12

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	6	11.5	11.5	11.5
	little effective	16	30.8	30.8	42.3
	effective	17	32.7	32.7	75.0
	Much effective	9	17.3	17.3	92.3
	Very much effective	4	7.7	7.7	100.0
	Total	52	100.0	100.0	

Table C.13: Frequency Table of the Change Orders C.13

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	5	9.6	9.6	9.6
	little effective	21	40.4	40.4	50.0
	effective	14	26.9	26.9	76.9
	Much effective	11	21.2	21.2	98.1
	Very much effective	1	1.9	1.9	100.0
	Total	52	100.0	100.0	

Table C.14: Frequency Table of the Change Orders C.14

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	2	3.8	3.8	3.8
	little effective	12	23.1	23.1	26.9
	effective	19	36.5	36.5	63.5
	Much effective	14	26.9	26.9	90.4
	Very much effective	5	9.6	9.6	100.0
	Total	52	100.0	100.0	

Table C.15: Frequency Table of the Change Orders C.15

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	43	82.7	82.7	82.7
	little effective	4	7.7	7.7	90.4
	effective	2	3.8	3.8	94.2
	Much effective	2	3.8	3.8	98.1
	Very much effective	1	1.9	1.9	100.0
	Total	52	100.0	100.0	

Table C.16: Frequency Table of the Change Orders C.16

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	1	1.9	1.9	1.9
	little effective	12	23.1	23.1	25.0
	effective	20	38.5	38.5	63.5
	Much effective	12	23.1	23.1	86.5
	Very much effective	7	13.5	13.5	100.0
	Total	52	100.0	100.0	

Table C.17: Frequency Table of the Change Orders C.17

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	-	-	-	-
	little effective	12	23.1	23.1	23.1
	effective	21	40.4	40.4	63.5
	Much effective	13	25.0	25.0	88.5
	Very much effective	6	11.5	11.5	100.0
	Total	52	100.0	100.0	

Table C.18: Frequency Table of the Change Orders C.18

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	1	1.9	1.9	1.9
	little effective	10	19.2	19.2	21.2
	effective	26	50.0	50.0	71.2
	Much effective	13	25.0	25.0	96.2
	Very much effective	2	3.8	3.8	100.0
	Total	52	100.0	100.0	

Table C.19: Frequency Table of the Change Orders C.19

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	-	-	-	-
	little effective	17	32.7	32.7	32.7
	effective	20	38.5	38.5	71.2
	Much effective	13	25.0	25.0	96.2
	Very much effective	2	3.8	3.8	100.0
	Total	52	100.0	100.0	

Table C.20: Frequency Table of the Change Orders C.20

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	2	3.8	3.8	3.8
	little effective	11	21.2	21.2	25.0
	effective	14	26.9	26.9	51.9
	Much effective	21	40.4	40.4	92.3
	Very much effective	4	7.7	7.7	100.0
	Total	52	100.0	100.0	

Table C.21: Frequency Table of the Change Orders C.21

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	3	5.8	5.8	5.8
	little effective	10	19.2	19.2	25.0
	effective	28	53.8	53.8	78.8
	Much effective	11	21.2	21.2	100.0
	Very much effective	-	-	-	100.0
	Total	52	100.0	100.0	

Table C.22: Frequency Table of the Change Orders C.22

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	6	11.5	11.5	11.5
	little effective	10	19.2	19.2	30.8
	effective	17	32.7	32.7	63.5
	Much effective	16	30.8	30.8	94.2
	Very much effective	3	5.8	5.8	100.0
	Total	52	100.0	100.0	

Table C.23: Frequency Table of the Change Orders C.23

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	1	1.9	1.9	1.9
	little effective	11	21.2	21.2	23.1
	effective	22	42.3	42.3	65.4
	Much effective	13	25.0	25.0	90.4
	Very much effective	5	9.6	9.6	100.0
	Total	52	100.0	100.0	

Table C.24: Frequency Table of the Change Orders C.24

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	40	76.9	76.9	76.9
	little effective	6	11.5	11.5	88.5
	effective	5	9.6	9.6	98.1
	Much effective	1	1.9	1.9	100.0
	Very much effective	-	-	-	100.0
	Total	52	100.0	100.0	

Table C.25: Frequency Table of the Change Orders C.25

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	4	7.7	7.7	7.7
	little effective	8	15.4	15.4	23.1
	effective	18	34.6	34.6	57.7
	Much effective	18	34.6	34.6	92.3
	Very much effective	4	7.7	7.7	100.0
	Total	52	100.0	100.0	

Table C.26: Frequency Table of the Change Orders C.26

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	7	13.5	13.5	13.5
	little effective	26	50.0	50.0	63.5
	effective	14	26.9	26.9	90.4
	Much effective	4	7.7	7.7	98.1
	Very much effective	1	1.9	1.9	100.0
	Total	52	100.0	100.0	

Table C.27: Frequency Table of the Change Orders C.27

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	13	25.0	25.0	25.0
	little effective	21	40.4	40.4	65.4
	effective	15	28.8	28.8	94.2
	Much effective	3	5.8	5.8	100.0
	Very much effective	-	-	-	100.0
	Total	52	100.0	100.0	

Table C.28: Frequency Table of the Change Orders C.28

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	10	19.2	19.2	19.2
	little effective	19	36.5	36.5	55.8
	effective	17	32.7	32.7	88.5
	Much effective	5	9.6	9.6	98.1
	Very much effective	1	1.9	1.9	100.0
	Total	52	100.0	100.0	

Table C.29: Frequency Table of the Change Orders C.29

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	12	23.1	23.1	23.1
	little effective	16	30.8	30.8	53.8
	effective	18	34.6	34.6	88.5
	Much effective	6	11.5	11.5	100.0
	Very much effective	-	-	-	100.0
	Total	52	100.0	100.0	

Table C.30: Frequency Table of the Change Orders C.30

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	1	1.9	1.9	1.9
	little effective	4	7.7	7.7	9.6
	effective	20	38.5	38.5	48.1
	Much effective	19	36.5	36.5	84.6
	Very much effective	8	15.4	15.4	100.0
	Total	52	100.0	100.0	

Table C.31: Frequency Table of the Change Orders C.31

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	1	1.9	1.9	1.9
	little effective	7	13.5	13.5	15.4
	effective	17	32.7	32.7	48.1
	Much effective	22	42.3	42.3	90.4
	Very much effective	5	9.6	9.6	100.0
	Total	52	100.0	100.0	

Table C.32: Frequency Table of the Change Orders C.32

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	1	1.9	1.9	1.9
	little effective	4	7.7	7.7	9.6
	effective	20	38.5	38.5	48.1
	Much effective	22	42.3	42.3	90.4
	Very much effective	5	9.6	9.6	100.0
	Total	52	100.0	100.0	

Table C.33: Frequency Table of the Change Orders C.33

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	-	-	-	-
	little effective	5	9.6	9.6	9.6
	effective	30	57.7	57.7	67.3
	Much effective	12	23.1	23.1	90.4
	Very much effective	5	9.6	9.6	100.0
	Total	52	100.0	100.0	

Table C.34: Frequency Table of the Change Orders C.34

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	21	40.4	40.4	40.4
	little effective	21	40.4	40.4	80.8
	effective	10	19.2	19.2	100.0
	Much effective	-	-	-	100.0
	Very much effective	-	-	-	100.0
	Total	52	100.0	100.0	

Table C.35: Frequency Table of the Change Orders C.35

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	9	17.3	17.3	17.3
	little effective	16	30.8	30.8	48.1
	effective	21	40.4	40.4	88.5
	Much effective	5	9.6	9.6	98.1
	Very much effective	1	1.9	1.9	100.0
	Total	52	100.0	100.0	

Table C.36: Frequency Table of the Change Orders C.36

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	-	-	-	-
	little effective	2	3.8	3.8	3.8
	effective	15	28.8	28.8	32.7
	Much effective	24	46.2	46.2	78.8
	Very much effective	11	21.2	21.2	100.0
	Total	52	100.0	100.0	

Table C.37: Frequency Table of the Change Orders C.37

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little effective	3	5.8	5.8	5.8
	little effective	18	34.6	34.6	40.4
	effective	22	42.3	42.3	82.7
	Much effective	7	13.5	13.5	96.2
	Very much effective	2	3.8	3.8	100.0
	Total	52	100.0	100.0	