



## Assessment of Change Orders Attributes in Preconstruction and Construction Phase

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### Abstract

Construction projects are very complex in nature. Each activity involves multiple varying tasks. Construction industry is the main source of economic growth. When change order occur performance of projects momentarily affected. Change orders often have a serious impact on the quality, time and cost. Eventually it results in disputes, delays, and dissatisfactions among stakeholders and ultimately results in failures of projects. In past several studies have been done to evaluate the causes of change order and its effects. Attempts have been made to quantify these impacts by many researchers, but the aim of this study is to identify the causes of change order in two different phases i.e. preconstruction and construction stage. Views were taken from relevant experts over included factors after in-depth literature review from past researches. A questionnaire was made and floated with different construction players from clients, consultants and contractors side. The data was analyzed by SPSS using average index technique. The analysis of data showed that, Mistakes in specifications, Mistakes in design and Lack of experience in selecting construction team by client are the most critical factors during preconstruction phase. Whereas, Design modification by owner, change in scope at later stage and Delays in payment by client are most critical factors of construction phase, responsible for change order. The extensive discussion of these factors revealed various parameters related to Pakistan construction. This study will enable the clients, consultants and contractors to be aware of factors which causes changes in orders and their consequences on project completion. By the identification of possible reasons, the right decisions can be made to mark the project successful.

*Keywords:* Change Orders; Client; Preconstruction; Construction; Pakistan.

### 1. Introduction

Construction industry being one of the potent industries plays significant role in economic stability and growth of country. Through the times of economic turmoil, it uplifts financial morbidity into a healthy wealthy state. Financial stability triggers infrastructure and holds backs the long term survivability with change of status from developing to developed country. Similarly, economy of United Kingdom is consisting of four sectors mainly: services, production, construction and agriculture. Whereas, services contribute 79.3% of GDP, construction 6.1%, production 14.0% and agriculture as 0.7% [1]. Contending the facts in developing country like Pakistan 30-35% of employment is affiliated with the construction industry, this proves as a tool for revival of economy[2]. Consorting, almost all construction projects up to some extent vary from original design, scope and definition depending upon the various factors; whether

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its small or large but it occurs in every project [3]. Thus, variation and change of orders in construction potentially affects the construction projects and directly or indirectly impacts construction sector in whole [4]. The tenet of amplifying mysterious changes in order or variation leads to change of award as well, this tenet may arduously arise at any stage from design, construction to operation & maintenance varying contract to contract [5]. Conversely, within construction industry various factors are affecting from design to demolition possessing ample impact of cost over run, delays and surrendering quality [6]. Thus, cost variations investigated and identified 34 factors that are responsible for the root cause of cost variations in projects of Malaysian construction tromping change order being the one of the major cause [7].

Forthwith, suitable tools and techniques are adopted to resolve occurring issues keeping in view the type of project and change appropriateness. It is globally accepted that change will occur in every project in the form of change orders that has been well known part of construction project globally [8]. Assaf and Al-Hejji pointed out that most common cause of disputes and failures of projects is the change order [6]. Change has sometime less and sometime vigorous impact on project. It can delay the project and can increase the original cost of project. Sometime it causes disputes between construction industry players and causes dissatisfactions among all. Hao et al. (2008) stated that effectively managing change orders in construction processes is not trivial because change orders are a part of the contract and they need to be strictly managed in terms of contracts [9]. Therefore, it is very important to get solutions to minimize problems among industry and its players where most of change orders issued at the time of construction. Sometimes, change order causes misunderstanding and no unique method is available for avoiding or managing them effectively. The core aim of this paper is to identify critical factors leading to change orders in construction projects of Pakistan. These factors are divided in two different phases i.e. preconstruction & construction phase. The study of such causes is very important for both clients & contractors to understand critical causes that lead to conflicting issue of change order.

## 2. Literature Review

Change orders in construction often have serious impacts on performance of the project. They are difficult to manage without knowing the actual reasons of change, however they can be reduced. Change is an event that causes in addition of the original scope, execution time, and cost of project. Change order will lead to dissatisfaction among all involved in construction projects. A study was conducted by Assaf and Al-Hejji (2006) on time performance of different construction projects in Saudi Arabia; they identified 73 causes in 76 projects, where the most common cause of disputes and failures of projects was the change order [6]. Hao et al. (2008) also stated that effectively managing change orders in construction processes is not trivial because change orders are a part of the contract and they need to be strictly managed in terms of contracts [9]. Various other studies have been conducted for identifying the causes of change order. Similarly, Hanna et al (2002) conducted survey and concluded main causes of change order were 'design errors, design changes and addition to scope [10]. Homaid et al. (2011) identified eleven important causes' leads to a conclusion that the consultant is the most responsible for the change orders [11].

According to a research, change order causes the overall increase in the cost of project up to 11.3%. The research further elaborate that the most important cause of change order was the owner requirements for change in project scope [11]. Ross et al. (2010) presented in the research that the causes of variation and change orders in different categories are, due to owner, consultant, contractor related and other variations. The research found various causes of variations through study such as mistakes and modifications, ambiguous poor design, poor working and drawing details, poor coordination, and variation in specifications by owner [3]. Alnuaimi et al., (2010) investigated the causes of change order in construction projects of Oman; study found the top three causes those were additional work given by owner, modifications in design by owners and un-availability of details and specifications. Study also indicated that contractor getting more benefit from change order as from consultant and then the client [12]. Another study was carried out by Pourrostan (2011); the study indicated that financial difficulties of contractor and construction delays by other contractors previously are important factors of change order [13].

Ijaola et al. (2012) identified that the additional works from client and design modification are the major causes of change order in both Nigeria and Oman [14]. The most important effects of change order are claims and disputes among the parties in Nigeria while "delay in the project completion date and cost overruns" were the most important effects in Oman notifying contractor as the most benefiting parties in change order [14]. Another study was conducted by Alaryan et al. (2014) in Kuwait construction projects and identified the major causes of change order by conducting a questionnaire survey among construction related parties such as owners, contractors and consultants. The most critical five causes of change orders were identified as: change of plans by owner, change of project scope by owner, problems on site, errors and omission in design, poor working drawing details [15].

Conversely, a quantitative research was conducted by Jaydeep N. Desai (2015) to evaluate effects of change order according to this research main affects are variations in scope of work, material quantities, design errors, and unit rate changes [16]. Later, in Jordan study was conducted by Jamal M. Assbeihat (2015). In this study, the most correspondents agreed that factors related to the internal environment of owner, where owner wants modification to design and instructs

additional works are the major factors directly affecting change orders in public construction projects. Exogenous factors like safety rules and regulations are not followed by the contractor's and his team, severe weather conditions on the construction place and changes in laws and regulations by the government [17]. M. Gokulkrthi (2015) identified most important factors of change order in India as owner changes that planned by substitution of materials procedures mistakes and omissions in design, financial problems of owner, change in design by consultant [18].

Moreover, Mujahed Staiti (2016) conducted a research to identify the main causes of change occurred in construction projects in the West Bank and also identified the serious effects of change orders on the construction industry of Palestinian. In addition, to know the current practices of change orders management within the construction companies in the West Bank. Main causes were financial problems of owner, changing and modification in design with owners' requirements, errors and omissions in designs, specifications [19]. Moreover, another study capsulized the fundamental causes of change order were lying in two distinctive areas of high complexity of project and low complexity of project that profoundly relies on conditions occurring such as financial problems of contractor & owners, weathering conditions, inadequate drawings, inadequate details, change in project specification, conflicts in contract documents and inadequate design [20,21]. But the study did not pointed out the factors based on the phases of construction projects. From unfolding of past research, it is found that the construction industry of Pakistan still need more study to investigates the major contribution of factors responsible for the change order in the project. Moreover, it is of more interest to find the factors from the different stages of construction varying from conceptualization to execution in various ways [21,22].

### 3. Research Methodology

This research is concerned with the identification of root causes of change order in construction industry of Pakistan. The root causative factors as limited important areas in which favourable results are absolutely necessary for a particular manager to achieve goals. To approach a proper solution of this problem, a step by step methodology was adopted. The research begins from the literature review from renowned journals of web of science, science direct and Scopus indexed. The unfolding of the past studies from these journals revealed several factors responsible for change order. This work separated the factors initially related to planning and designing and confined the, into pre construction stage. Secondly the factors related to execution of projects were kept in construction stage of project life cycle.

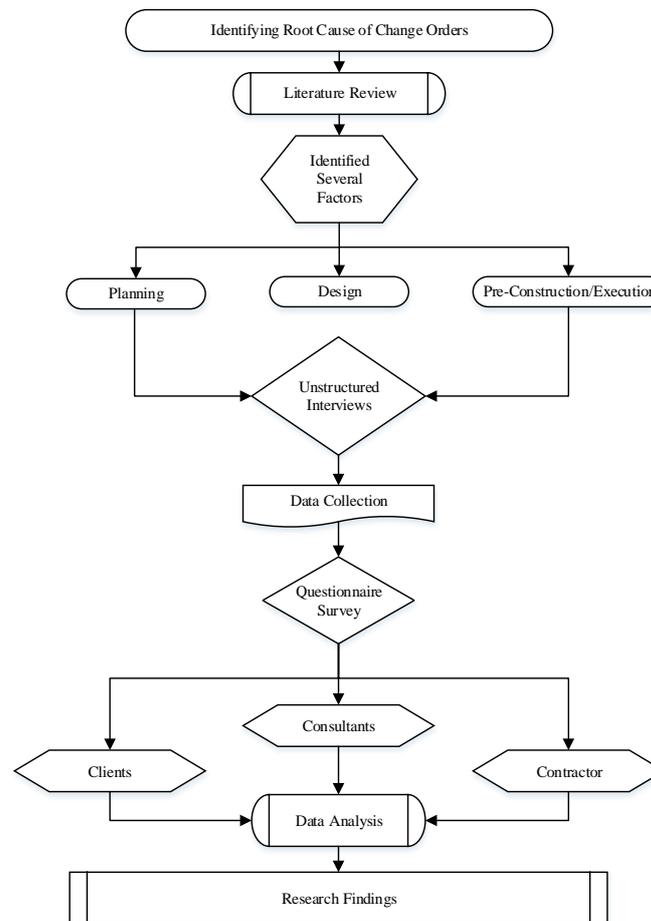


Figure 1. Interoperable Flow Chart of Methodology

The identified factors were then discussed with group of experts to match their applicability for construction projects of Pakistan. Thus after successfully conducting unstructured interviews more factors were added which are in common in construction industry of Pakistan and irrelevant factors were omitted thereafter. Based on literature review results and interviews a questionnaire tool was designed. To collect the data a survey was conducted among construction industry players i.e. clients, consultants and contractors. After collecting the data, analysis was done through Statistical Packages for Social Sciences, SPSS version 24.0. This study comes up with the critical factors affecting the change order in two different phases of construction. Finally, the factors were discussed in the light of construction industry of Pakistan. as given the flow chart below.

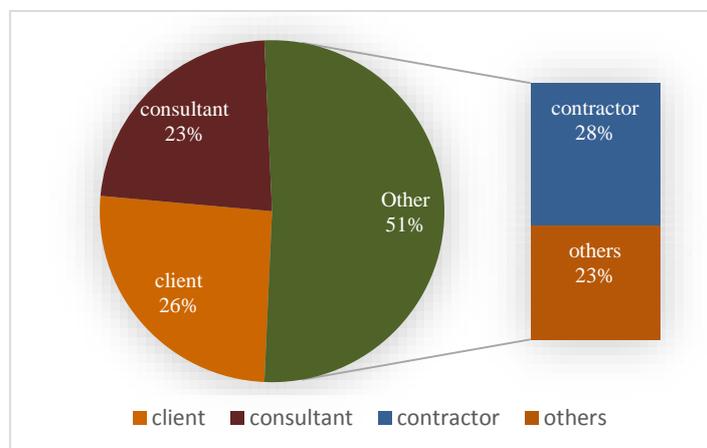
#### 4. Data Collection and Analysis

A questionnaire was designed and administrated for the purpose of collecting data. The designed questionnaire was divided into two parts. 1st part consisted of participant’s demographic information. The 2nd part consists of factors which are responsible for change order in Pakistan construction industry. 75 questionnaires were distributed and 45 were received positively that were valid for analysis. Table 1 shows the statistics of questionnaire.

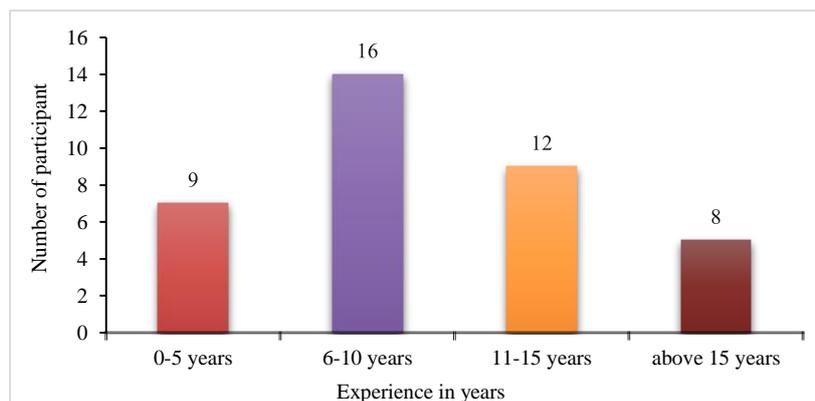
**Table 1. Statistics of questionnaire**

Questionnaires Circulated to Participants	75
Questionnaires Received from Participants	48
Valid questionnaire	45

The respondents were selected from Client, consultants & contractor firms. Table 1 shows the respondents categories. The respondents have diverse rich experience in the construction field. The experience of respondents is shown in Figure. 3. The respondents were requested to rank the factors which are responsible of the change order as per their importance. The scale ranges from 1 to 5, where 1 referred the response as not important, 2 as slightly important, 3 as moderately important, 4 shows very important and 5 shows extremely important. This was followed by Average Index Value (AI) to identify rank of selected causes in change of order, several authors in past have used this technique for ranking factors such as [21,22]. Statistical Software Package (SPSS) was used as tool to analysis the data. The data analysis result is shown in Table 2 and 3 for preconstruction and construction phase respectively.



**Figure 2. Categories of respondents**



**Figure 3. Experience of respondents**

## 5. Results and Discussion

### 5.1. Critical Factors of Preconstruction Phase

A construction projects is a series of several phases starting from the inception of project which normally involves the creativity and innovative ideas by the owner. In order to shape up those ideas the planning phase is a detailed stage to convert them into reality. The planning phase then leads to a design phase where an owner involves the concerned team to work along. The preconstruction phase thus ends up typically with inclusion of planning and design phase. As the phase is quite early in the delivery of a project thus here several changes are expected from owner side. This phase involves many variations from the owner side and mainly occurs due to the several reasons. The critical factors are illustrated in Figure 4.

From the analysis of data, the most critical cause of change order in pre-construction phase is “mistakes in specifications”. Typically, owner involves the designer to prepare the specifications, as mentioned earlier, this is a very early stage of project delivery thus mainly involves the mistakes. Thus this reason is very common in developing countries like Pakistan. It is extremely important to consider because when the specifications are wrongly prescribed than it will cause problems for contractor to execute at later stage and can cause many issues like delays in project which influences project cost ultimately.

**Table 2. Factors responsible for change orders in preconstruction construction with their ranking**

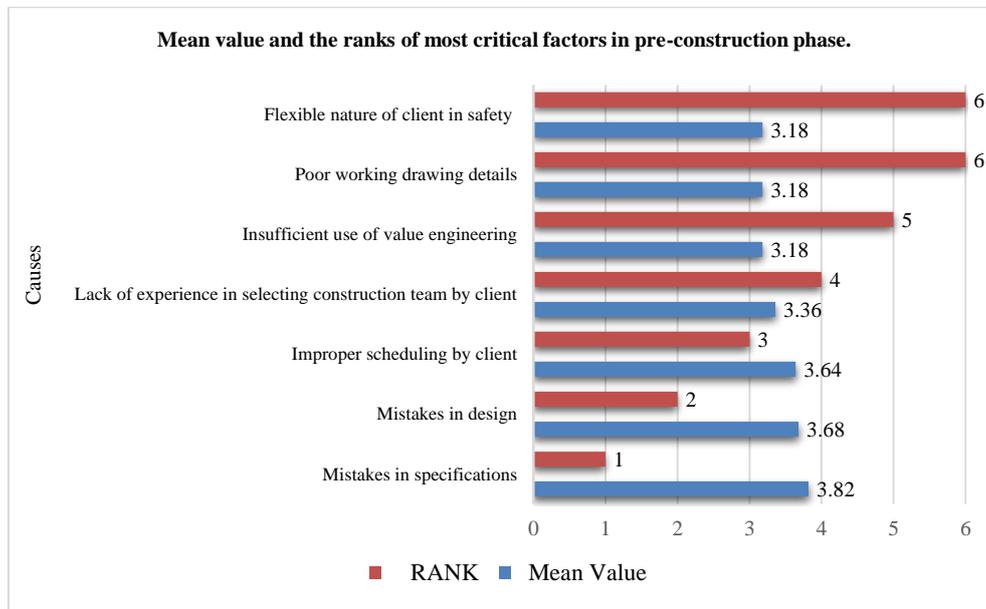
S. NO	Causes	A I	Rank
1	Mistakes in specifications	3.82	1
2	Mistakes in design	3.68	2
3	Lack of experience in selecting construction team by client	3.64	3
4	Improper scheduling by client	3.36	16
5	Insufficient use of value engineering	3.18	19
6	Poor working drawing details	3.18	19
7	Flexible nature of client in safety	3.18	19

The owner at later stage provides the updated specification to the contractor and this cause the root cause of claims and conflicts between the parties. The contractors are not so flexible to absorb the changes as it affects their financial part. Thus they demand for the change order from the clients. This research thus highlights the cause so that an owner should be well awarded with this basic problem during the preconstruction phase.

**Table 3. Factors responsible for change orders in construction phase with their ranking in construction phase**

S. NO	Causes	A I	Rank
1	Design modification by owner	4.18	1
2	Change in scope at later stage	3.95	2
3	Delays in payment by client	3.93	3
4	Lack of communication between parties	3.91	4
5	Contractor financial issues	3.90	5
6	Additional work from owner side	3.86	6
7	Safety rules and regulations are not followed by contractor	3.85	7
8	Construction delays by contractor	3.77	10
9	Poor site management by contractor	3.68	11
10	Delay in material delivery by supplier	3.55	13
11	Delays of project schedule	3.45	14
12	Design complexity	3.41	15
13	On site changing in material specifications	3.64	16
14	Late decision making by contractor	3.27	17
15	Lack of workmanship	3.23	18
16	Ineffective supervision by client	3.09	20
17	Bad relationships with supplier by contractor	3.00	21
18	Severe weather conditions on job site	3.00	21

The second most important cause of change order is “mistakes in design”. Similar to the mistakes in preparing the specification, it is very common to have serious errors in the design stage. The design is prepared by the designer on the behalf of owner, when the planning is not clear from the owner side the scope of work is not well covered at this stage. Thus many mistake often occurs in the designing work. The owner at the time of award of work transfer the design to the contractors and the part is thus assumed to follow design properly. At later stage when the owner feels there are errors and mistakes in the design, they decides to have another better design. Here the contractor doesn't want to put the burden on their shoulders and demands the change orders from the client. Such change order are often very hazardous and involves serious clashes. The client never wants to have change order due to increase in the cost and delays in the project. Thus a critical piece of mind is necessary for a client while involving in the design phase.



**Figure 4. Mean value and the ranks of most critical factors in pre-construction phase.**

The clients in many cases appoint his team to work throughout the project such as the project manager, designer, contractors, quantity surveyor etc. It is observed that while choosing the partner the clients often do mistakes because of lack of experience in the project and lacking in previous similar works. Thus this research unfold that the “Lack of experience in selecting construction team by client” is one of the root cause responsible for the change order. This cause has linkage with the top two factors. The mistakes in the specification and design is basically the part of the client team but the client needs more expertise thus needs higher experience while selecting the team. Nevertheless, the client needs to be more sharp and aware with the basic requirements of the intended projects thus keeping in mind those requirements, a capable team selection must be the ultimate goal of the owner to avoid change orders in future. Specially the proper selection of consultant at this stage is very important, because they are responsible for all activities during the preconstruction phase. Apart from these causes the study investigates the other factors illustrated in Table 3 as equally important to be considered by the clients.

## 5.2. Critical Factors of Construction Phase

Construction phase is most important phase of project delivery. Maximum resources are utilized in this phase therefore most of change order occurs in construction phase. In Figure. 5 top most critical causes which are responsible of change order in construction phase ranked by respondents are given. From the analysis of data it can be seen that top most critical factor of change order in construction phase is “Design modification by owner”. During the preconstruction phase particularly the design stage, when the errors and, mistakes done by the designer the clients wants their early remedy but it affects the construction seriously.

The contractor on the other side have already worked and once such modification take place they need to demolish and reconstruct activates which hit at contractor's resources badly. In Pakistan, the experts believe that this is a very common problem. At later stage client needs to enhance or reduce project scope due to many causes such as financial cutoff. Ultimately this leads to the modification in design and become the root cause of change order. Second top most cause is “change in scope at later stage”. Changes in project scope will cause delays and sometimes cause failure of projects. Therefore, it is necessary that project should be such that its scope will remain for long time. But it does not happen most of time, as mentioned the change in scope are very common in Pakistan due to financial cutoff and other reasons.

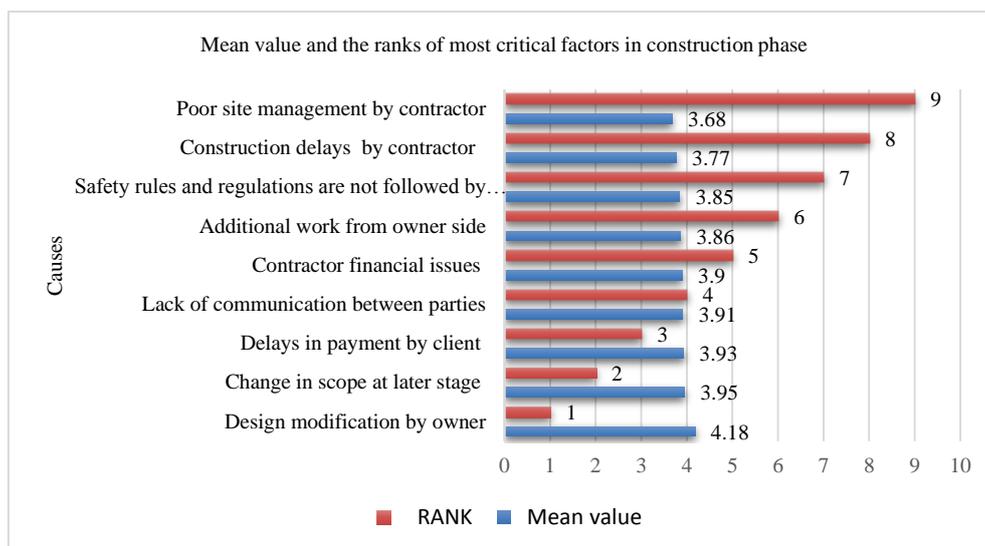


Figure 5. Graphical illustration of average index of critical causes in construction phase

Irrespective of those reasons, as it is out of scope of this research, ultimately the change orders occur. Actually the change in design is the part of change of scope or vice versa. The pinpoint to brainstorm here is to initially have a better planning in the preconstruction phase and with the help of capable team and specially the designer such issues could be resolved. Another critical cause is “delays in payment by client”, project execution needs resources and resources come from budget. When client fails to have timely payment than it will cause delays in project time. These delays are sometimes so seriously that contractor could not complete the work and at later stage require change orders from the clients. Almost in all developing countries the finance is basis issue of the public clients. When the departments are out of budget such delays are usually occurs. On the other hand, the contractor has to meet the project deadlines thus end results is contractor demands for the change orders. There is thus direct link of timely payment and the change order. The project owner must careful tackle this issues by reserving the funds for the intended projects which they wish to have at exact time with stipulated cost and imagined best quality. In similar way “Lack of communication between parties” is another important cause. Construction works require integration at each stage. When there is miss communication between any parties, a lot of changing in work take places thus require such changing in contracts. “Contractor financial issues” is also an important cause. When contractor is financially not sound, they cause trouble. For e.g. even for small work they go for change orders, which otherwise a financially strong contractor could do without it.

## 6. Conclusion

Change orders are most common part of construction works pertaining to several causes. Almost every project except a very few require change order at later stage. Since several parties are involved during construction thus it was of greater interest to divide the causes in two major phases i.e. preconstruction and construction phase. During preconstruction phase, clients and consultant are involved however, contractors involved in construction phase of project life cycle. Thus this research identifies the factors in these different phases to correlate them with the concerned parties. The study involved in depth literature review and various unstructured interviews along with physical site visits of various projects and their post project reviews. The study thereafter concludes critical factors in both phases. From the results of critical factors of preconstruction, it is concluded that the client usually does several mistakes in the planning and designing stage which later on resulted in change orders. The appointment of consultants and the monitoring of activities is not properly done due to which mistake and errors found in the design stage. Similarly, the results of construction stage present that critical causes are again due to the client. Here frequent changes by the client and delays in payment by the client significantly affects the project delays and increased cost, thus resulted in demands of change orders by the contractor. Thus construction clients are the part which is highly responsible for such change orders in Pakistan. These clients need to be efficiently work during the planning and designing phase and further to properly monitor the project during execution to avoid these orders. In the future this study can be extended in many directions. As this study only focused on causes of change order, further the effects of change orders on projects can be studied. The study can be done on disputes identification which will arise between the construction industry players due to change order.

## 7. Conflicts of Interest

The authors declare no conflict of interest.

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