

Causes and Effect of Design Change on Building Construction Project: Review

Gizachew Markos Makebo¹, Elsaye Berhanu Basa²

¹MSc, Department of Civil Engineering Wolaita Sodo University, Wolaita Sodo, Ethiopia

²MSc, Department of Civil Engineering Wolaita Sodo University, Wolaita Sodo, Ethiopia

ABSTRACT

Construction is complex and uncertain in nature. Changes in construction projects are very common and likely to occur from different sources, by various causes, at any stage of a project, and may have considerable negative impacts on items such as costs and schedule delays. A critical change may cause consecutive delays in project schedule, re-estimation of work statement, and extra demands of equipment, materials, labor, and overtime. The aim of this study is to review the major cause and effect of design change in building construction projects.

Keyword: - Design Change, Delay, Project performance, construction Industry

1. INTRODUCTION

The construction industry worldwide is beleaguered with delay and cost overruns. Building construction projects worldwide routinely fail to meet their schedule and cost objectives [1]. In construction projects, changes are very common and likely to occur at any stage of the project. Construction project is a complex process, which requires close cooperation and coordination among the stakeholders. The process also consists of different stages, which ultimately make it more complicated and difficult to manage [2]. Unlike manufacturing, construction has conventionally separated planning and design from construction processes which have resulted in some scope and design related changes during the construction [3]. Performance of construction project is much impacted by design changes [4]. Construction is complex and uncertain in nature; and unlike manufacturing and other sectors of the economy, the design and production functions in construction process are usually separated [5]. Design Changes causes disruption of performance of construction projects, especially time and cost performance [6].

2. DEFINITION OF DESIGN CHANGE

A design change is defined as any change in the design or construction of a project after the contract is awarded and signed. Such changes are related not only to matters in accordance with the provision of the contract but also changes to the work conditions [7]. Similarly [16] noted that these changes are any additions, omissions or adjustments made to the original scope of work after a contract is awarded. According to the study conducted by [8] defined design change as to work state, processes or methods that differ from the original construction plan or specification and usually resulted from different in work quality and conditions, scope changes or uncertainties that make construction dynamic and unstable.

3. TYPES/CLASSIFICATION OF DESIGN CHANGE

According to the study conducted by [3] design change caused by client related, contractor related, designer related and external related. Lack of technical knowledge to comprehend and visualize the project, Lesser guidance and support available to Clients by technical persons, Frequent scope change by the Clients, Long time taken by the client for giving decision, Clients changing financial and business conditions necessitates the scope changes and Inappropriate choice of project contract type (unit price, lump sum, etc.) are classified as client related.

Designers lacked the awareness of design to provide commercially focused solutions and constructability, a lack of confidence in preplanning for design work, Designers have difficulties both in capturing clients' needs and

conveying conceptual design options to them, Deficient resources in quality or quantity (e.g. tools, equipment, staff, or financial), Poor coordination and communication between Client and designer as well as designer and contractor, Lack of information flow among parties , Unstructured Design process , No Design checking or 2nd or 3rd party reviews, No system of design checking, Unreasonable Client and End User Expectations, Ineffective utilization of automation , Time Constraints, Designer noninvolvement/unavailability during construction phase, Inadequate information provided to Designer, Short-term conflict of interests of resource allocation between productivity (production) and quality.

Inadequate training/ inexperience, lack of knowledge in (building bye laws, codes etc., constructability, availability and suitability of materials, engineering design techniques, Change of designers Lack of awareness about governmental regulations, municipality requirements, statutes and their modifications, Lack of Design Standards, No involvement of contractor during design phase, Lack of adequate documentation late approvals of design several groups visit project ,late and give late their points too late, Discrepancies between contract documents were classified as designer related.

Inadequate pre-construction study and review of design documents by contractors considering the exotic and complex nature of design, Awarding contract to the lowest price regardless of the quality of services, Lack of experience about new construction technologies, Lack of communication and coordination between various project team , Information problems , Poor project organizational structure, Adversarial/Oblivious relationship between consultant and contractor, Shop drawings' submission, approval and adequacy, Long period between time of bidding and awarding, Incomplete plans and specifications, Insufficient working drawing details , Contractors request on improving the buildability by suggesting alternate construction method and material used, Strict quality tolerances mentioned in the specification results frequent rework were classified as contractor related.

External related changes include Differing site conditions, Poor economic conditions, Severe Weather, Unexpected changes in material availability, Military actions, Governmental issue ,Shortages of labor and Undetected underground utilities.

According to the study conducted by Hui, Abdul-Rahman, & Chen, (2017) the major causing factors influencing design changes and their conceptual framework as follows

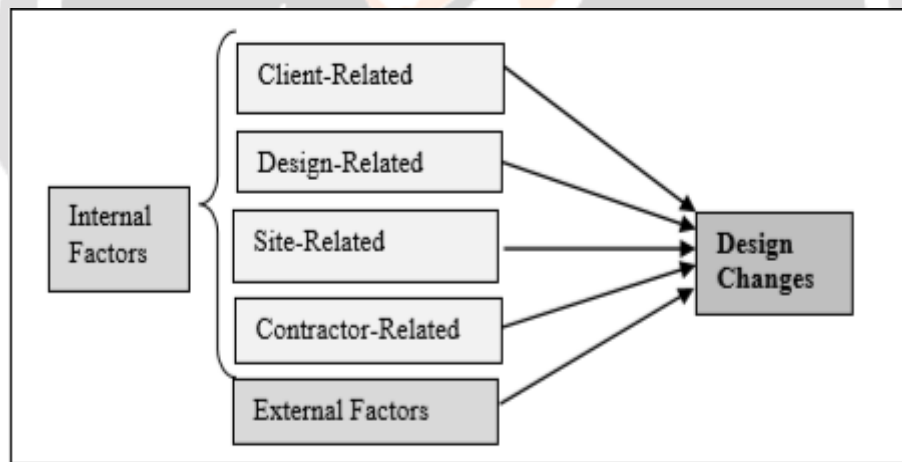


Figure 1: Conceptual framework of causing factors influencing design changes (Source: [1])

4. CAUSES OF DESIGN CHANGE

In building construction, discrepancies frequently occur between design and construction in relation to architectural details, structural details, materials, and quality of construction [9].

According to the study conducted by [4], there were a number of factors have been responsible for the change in the initial design these factors vary in the level on which they affect the design change. From the findings 24 (41%) slightly agree that causes on the changes of design are initiated by the users/clients/owners while 35 (59%) on the same strongly agree that the causes of the design change are initiated by the users/clients. 36 (61%) of the respondents slightly agree that causes of design change are initiated by the architect/consultants, while 23(39%) of the respondents strongly agree that changes in the initial design are initiated by the architect/consultants.

According to the study conducted by [15], discrepancies frequently occur between design and construction in relation to architectural details, structural details, materials, and quality of construction. And identified major design change phases such as design phase, tendering phase, construction phase, and overall project phase.

The design phase category identified 20 causes for design change such as: Contractor is not involved in the conceptual phase of design, Contractor is not involved in the development phase of design, Data provided to designer are incomplete, Data provided to designer is incorrect, Data is provided late to designer, Lack of human resources with designer, Designer busy in too many assignments, Designer's knowledge is lacking in building bye-laws, codes and government rules, Designer's knowledge is lacking in constructability of design, Designer's knowledge is lacking on availability of materials, Designer's knowledge is lacking on engineering design technique and software, Lack of designer's knowledge concerning engineering drafting, Lack of designer's knowledge for suitability of materials, Frequent replacement of designer by the owner, Personal and social problems of designer, Lack of reward, delayed payment or less payment to designer by owner, Too little time is given to designer for completion of the design documents, Lack of project planning and analysis by owner at the project start, Frequent changes in the design due to owner dis-satisfaction, Approving authorities do not check carefully that the structure is designed according to the building bye-laws, codes and government rules but their Relative importance index value differs on clients, clients and contractors.

Tendering Phase identified seven causes for design change such as : Incomplete or inaccurate design documents unintentionally provided with bidding documents, Incomplete or inaccurate design documents intentionally provided with bidding documents, Type of construction contract in use, Contractor did not consider that the design is exotic, complex or difficult to build, and he does not have the required expertise, Selection of contractor on the basis of lowest bid, Amount of performance security and retention money, Absence of third-party validation during defect liability period.

Construction Phase identified seven causes for design change such as: Owner proposes changes because he had planned to make changes during construction, Owner proposes changes during construction due to sudden changes in his requirements/ expectations, Owner proposes changes during construction due to change in ownership, Owner proposes changes to assert his authority and make undue interference in construction, Owner proposes changes due to financial problems, Slowness in decision making process by owner, Changes in building codes, byelaws and government rules, Delayed revision of drawings by designer, Drawings not properly stamped or certified by designer, Custody and supply of drawings at site, Delayed approval of drawings by owner or consultant, Material changes due to shortage of particular material in the market, Material changes due to procurement delays by contractor, Contractor does not follow recommended construction methods and reluctant to use proper construction equipment, Contractor lacks in skilled manpower, Contractor lacks in comprehension of drawing details, Contractor lacks in coordination and management during construction, Contractor's staff facing shortage of tools and/or equipment for measurement, alignment and/or for adjustment at corners, Contractor and his staff focusing on other projects, Lack of awareness of the designer about the ongoing construction process, Unanticipated weather conditions, Unforeseen problems and differing site conditions, Timing of proposed changes, i.e., whether at the start or at the end of construction, Approving authorities do not check carefully that the structure is constructed according to the approved building plans. In addition the author ranked Categories of incompatibilities. Design phase ranked first on side of client and consultant and second on contractor side with (RII= 0.608, 0.595 & 0.526 respectively). Design change as a result of tendering phase ranked as 3rd on Client, Consultant Contractor with (RII= 0.582, 0.556 and 0.499) respectively and construction phase ranked second on client & consultant side and first on contractor side with (RII= 0.588, 0.584 & 0.528 respectively).

According to the study conducted by [3] the possible causes of change orders in construction of large buildings are: change of planes by owner, owner financial difficulties, owner change of schedule, defined project objective, substitution of material or procedures, conflict between contract and document, change in design, scope of work for the contractor, error and omissions in design, lack of coordination, value engineering, technology change, differing site conditions, contractor desire to improve his financial conditions, contractor financial difficulties, unavailability of skills, unavailability of equipment, defective workmanship, safety consideration, weather condition, new government regulations.

5. EFFECTS OF DESIGN CHANGE

Changes in construction projects are very common and likely to occur from different sources, by various causes, at any stage of a project, and may have considerable negative impacts on items such as costs and schedule delays. A critical change may cause consecutive delays (time overrun) in project schedule, re-estimation of work statement, and extra demands of equipment, materials, labor, and overtime. Changes, if not resolved through a formalized

change management process, can become the major source of contract disputes, which is a severe risk contributing to project failure [10].

According to the study conducted by [6], design change resulted on decrease in productivity, delay completion schedule, dispute between owner and contractor, decrease in quality, increase in project cost, additional money for contractor, delay of material and tools, work on hold, increase in overhead expenses, delay in payment, demolition and rework.

The impact of design changes on cost in construction projects become a well-known fact that design changes are inevitably the cause of cost overrun [3]. According to the study conducted by [11] design discrepancies and frequent design changes are the most important factors resulting into cost overrun, and ultimately leads to complete failure of projects. Design changes also increase indirect cost due to the later events of claims and disputes during the projects [12].

6. CONCLUSION

Changes in construction projects are very common and likely to occur from different sources, by various causes, at any stage of a project. From the above point of views the following conclusions are drawn:

- As the study conducted by different authors the design changes classified as client related, design related, site related, contractor related and external related.
- Different authors find out that changes occurred on design phase, tendering phase, construction phase, and overall project phase.
- And design change resulted up on considerable negative impacts on items such as costs and schedule delays. A critical change may cause consecutive delays (time overrun) in project schedule, re-estimation of work statement, and extra demands of equipment, materials, labor, and overtime.

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