ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL

DESIGN-CONSTRUCTION INTERFACE PROBLEMS IN CONSTRUCTION PROJECTS

M.Sc. THESIS

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Department of Architecture

Project and Construction Management Programme

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To my family,

FOREWORD

This thesis was written for my Master degree in Architecture with specialization in Project and Construction Management at the Istanbul Technical University, Türkiye.

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February 2023

Emine Esra BUĞAN
(B.Sc. Architect)

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ABBREVIATIONS

BIM **:** Building Information Modelling

BDM **:** Building Design Management

CII **:** Construction Industry Institute

DCIP **:** Design – Construction Interface Problems

RII **:** Relative Importance Index

SYMBOLS

N	**:** Number of Responses
p	**:** Probability Value
Sig.	**:** Significance Level
α	**:** Cronbach's Alpha

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DESIGN-CONSTRUCTION INTERFACE PROBLEMS IN CONSTRUCTION PROJECTS

SUMMARY

There is ongoing inefficiency and traditionalism in the construction industry. Throughout the development of Industry in general, the construction industry received the least positive impact. Many different management systems can be applied and developed in the construction industry like agile transformation, lean management etc. Yet the construction industry has not fully implemented any of the developments. However, it is seen that there is a lack of information on lessons learned from past experiences and mistakes. For this reason, budget, time and quality deficits have started to be given due to the increasing incompatibility of the inefficiency from the way of doing business with today's complex projects and resources.

Throughout the lifecycle of the construction projects, the common aim for all participants is to achieve a “perfect” project with less cost at a minimum schedule. The biggest difficulty experienced while advancing the project process is to exhibit the right approach to the problems that arise. A real challenge emerges when deciding how to define and mitigate the causes of design-construction interface problems in the process and reduce the negative impact that is or will be reflected on the project.

The thesis research aims to identify the causes of design-construction interface problems and to determine their frequency of occurrence and degree of importance.

At this point, while analyzing the frequency and importance of these problems from the eyes of industry professionals; it is also important to reveal whether there is any difference in the perspectives of different professionals. In this context, to achieve the mentioned aim, the thesis research is developed in two main parts. The first part includes a comprehensive literature review to find out what are these design-construction interface problems, how they occur and how they impact the construction project life cycle. Databases are searched for in the areas where the problems are thought to originate. These main areas are stakeholders and their relationships and management, construction project phases and situations occurring at the interface of these phases, design phase and design management. At the intersection of all these areas, the problems that occur during the construction project process are listed and grouped according to the project phases in which they occur.

In the second stage, a questionnaire survey is conducted with the design-construction interface problems gathered from the literature to measure the frequency of occurrence and degree of importance of these problems. The first part of the questionnaire gets general information about the respondents, the second and the third parts search for the frequency of occurrence and degree of importance of design-construction interface problems on a 5-point Likert scale, the last part has an open-ended question that aimed to get the opinions of the survey participants on the subject.

The data that is obtained with the help of the questionnaire is analyzed through the SPSS program. In the first step, Cronbach’s alpha reliability test is used to ensure the

reliability of data. Secondly, frequency and descriptive analysis are used to get the frequency of each response. Third, the rankings of all variables are calculated using the Relative Importance Index (RII). Fourth, Skewness-Kurtosis values are evaluated to determine whether the data were normally distributed. Survey participants were divided into groups (designer, consultant and contractor); one-way ANOVA tests were applied to investigate whether there was a statistically significant difference between the groups. Finally, the variables were analyzed in one-way ANOVA test to determine if there is a statistically significant difference between stakeholders. According to the results of ANOVA tests, further post-hoc analyses were applied to the variables to show from which groups the differences came from.

As a result, "PDC16 - Economic Situation" and "PC9 - Construction errors and defective work at the construction site" become the most occurred and most important problems from the consultants' point of view. "PD8 - Lack of proper coordination between various disciplines of the design team" cause is ranked as the most occurred and most important problem from the contractors' point of view. And, "PT5 - Awarding the contract to the lower bidder price regardless of the quality of service" is found as the most occurred and most important problem for the designers. "PT5 - Awarding the contract to the lower bidder price regardless of the quality of service" is ranked at the top both in the lists of designers', consultants' and contractors' . "PDC17 - Fast Track Construction" becomes critical for consultants and contractors; "PD6 - Time limitation in the design phase" and "PD9 - Unstable owner requirements" are important for contractors and designers.

This thesis research identified the causes of design-construction interface problems seen in construction projects according to the project stages; and determined the frequency of occurrence and degree of importance of these problems from the perspective of different construction project professionals. To be aware of problems to detect them when necessary and to raise awareness to take the necessary action when encountered; supported by recommendations. Thus, it has been seen that, although the results vary for each stakeholder, it has been determined that there are similar points. The findings of this thesis research can help construction project professionals by providing an understanding of the design-construction interface primary problems. By having knowledge of the main problems and their impacts, participants can take precautions, make effort to minimize their impacts, and after all make a significant contribution to the successful completion of construction projects.

YAPIM PROJELERİNDE TASARIM-YAPIM ARAYÜZ PROBLEMLERİ

ÖZET

İnşaat sektöründe süregelen bir verimsizlik ve gelenekselcilik bulunmaktadır. Genel olarak endüstri sektöründe gelişmeler yaşanırken, inşaat sektörü bu gelişmelerden en az olumlu etkiyi alan sektör olmuştur. Çevik dönüşüm, yalın yönetim vb. inşaat sektöründe uygulanabilen ve geliştirilebilen birçok farklı yönetim sistemi bulunmaktadır. Ancak, inşaat sektörü bu gelişmelerin hiçbirini tam olarak uygulayamamıştır. Bu noktada, geçmiş deneyimlerden ve hatalardan ders alınarak ilerlenmesi konusunda, öğrenilmiş derslerin uygulanması konusunda bilgi eksikliği olduğu görülmektedir. İş yapım şeklinden gelen verimsizliğin günümüzde giderek karmaşıklaşan projeleri ve çoğalan kaynakları ile artan uyumsuzluğu nedeniyle; bütçe, zaman ve kalite açıkları verilmeye başlanmıştır.

İnşaat projesinin yaşam döngüsü boyunca, tüm paydaşların ortak amacı, minimum sürede daha az maliyetle "mükemmel" projeye ulaşmaktır. Proje sürecini ilerletirken yaşanan en büyük zorluk, ortaya çıkan sorunlara doğru yaklaşım sergilemektir. Süreçteki tasarım-yapım arayüz problemlerinin nedenlerinin nasıl tanımlanıp hafifletileceğine ve projeye yansıyan veya yansıyacak olumsuz etkilerinin nasıl azaltılacağına karar verirken asıl zorluk ortaya çıkmaktadır.

Bu tez çalışmasının amacı yapım projelerinde görülen tasarım-yapım arayüz problemlerinin nedenlerini belirleyerek; bu problemlerin oluşum sıklıklarını ve önem derecelerini ortaya koymaktır. Bu noktada, sektör profesyonellerinin gözünden bu problemlerin oluşum sıklıklarının ve önem derecelerinin analiz edilirken; farklı profesyonellerin konuya bakış açılarında herhangi bir fark olup olmadığının ortaya konması da önem kazanmaktadır. Bu bağlamda, belirtilen amaca ulaşmak için yapılan tez çalışması, iki ana aşamada geliştirilmiştir. İlk aşamada, söz konusu tasarım-yapım arayüzü problemlerinin neler olduğunu, nasıl ortaya çıktıklarını ve yapım projesi yaşam döngüsünü nasıl etkilediklerini ortaya koymak üzere genişletilmiş bir literatür araştırması gerçekleştirilmiştir. Literatür araştırması kapsamında konu ile ilişkili problemlerin ortaya çıktığı düşünülen alanlar belirlenerek, veritabanları taranmıştır. Sözkonusu alanlar paydaşlar ve paydaş ilişkileri, paydaş yönetimi, yapım projesi aşamaları ve bu aşamaların arayüzünde ortaya çıkan sorunlar, tasarım aşaması ve tasarım yönetimi olarak belirlenmiştir. Tüm bu alanların kesiştiği noktada, yapım proje sürecinde ortaya çıkan problemler listelenmiş ve oluştukları proje aşamalarına göre gruplandırılmıştır.

İkinci aşamada, literatürden derlenen tasarım-yapım arayüz problemleri ile bu problemlerin oluşum sıklığını ve önem derecesini ölçmek için bir anket çalışması düzenlenmiştir. Anketin ilk bölümünde anket katılımcıları hakkında genel bilgi alınmış; ikinci ve üçüncü bölümde 5'li Likert ölçeği kullanılarak tasarım-yapım arayüz problemlerinin oluşum sıklıkları ve önem dereceleri tespit edilmiş; son bölümde ise bir adet açık uçlu soru ile anket katılımcılarının konu ile ilgili fikirlerinin alınması amaçlanmıştır. Bu bağlamda, 190 sektör profesyoneline ulaşılmış ve %37,5 yanıt oranı

ile toplam 71 geçerli yanıt toplanmıştır. Anket sonuçları değerlendirildiğinde; katılımcıların %16,9'unun danışmanlık şirketinde, %64,8'inin inşaat şirketinde ve %18,3'ü tasarım firmasında çalışmakta olduğu tespit edilmiştir. Meslek gruplarına bakıldığında ise; katılımcıların %32,4'ünün mimar, %23,9'unun mühendis/proje mühendisi, %21,1'inin proje müdürü veya yardımcısı, %7'sinin saha veya ofis mühendisi ve geriye kalan %15,5'inin denetimci, gayrimenkul geliştirici gibi diğer meslek gruplarından olduğu gözlenmiştir. Katılımcıların deneyim düzeyleri değerlendirildiğinde ise; %18,3'ünün 5 yıldan az, %25,4'ünün 5 yıl ile 10 yıl arası, %14,1'inin 10 yıl ile 15 yıl arası ve son olarak %42,3'ünün 15 yıldan fazla deneyime sahip olduğu görülmüştür.

Anket yardımıyla elde edilen veriler SPSS programı aracılığıyla analiz edilmiştir. İlk adımda verilerin güvenilirliğini sağlamak için Cronbach alfa güvenirlik testi kullanılmıştır. İkinci olarak, anket katılımcılarının verdikleri yanıtların sıklığını belirlemek için sıklık ve betimsel analiz kullanılmıştır. Ardından, anket katılımcıları tarafından değerlendirilen tüm değişkenler, Göreceli Önem Endeksi (RII) kullanılarak hesaplanarak, oluşum sıklığı ve önem derecelerine göre sıralanmıştır. İstatistiksel analiz yapılacak değişkenlerin, Skewness-Kurtosis değerleri incelenerek, normal dağılım gösterip göstermediklerine bakılmıştır. Anket katılımcıları gruplara (tasarımcı, danışman ve yüklenici) ayrılarak; söz konusu gruplar arasında istatistiksel olarak anlamlı bir farkın olup olmadığını araştırmak için tek yönlü ANOVA testi uygulanmıştır. ANOVA testi sonucunda gruplar arasında istatistiksel olarak anlamlı bir farkın görüldüğü değişkenler için post-hoc testleri yapılmış; görülen farkın hangi gruplar arasında olduğu ortaya konmuştur.

Anket çalışması ve aslında tüm bu çalışma boyunca, katılımcıların belirlenen problemler ile hangi sıklıkla karşılaştığı ve bu problemleri ne derece önemli gördükleri saptanmaya çalışılmıştır. Bu doğrultuda, yapılan analizler hem problemlerin görülme sıklığını hem de önem derecelerini belirlemeye yönelik olmak üzere, her iki kıstas için ayrı ayrı ele alınmıştır. Her bir analiz yöntemi anket verilerine biri sıklık, biri önem derecesi için iki kere uygulanmıştır. Sonuçlar kendi içinde ayrı ayrı değerlendirilmiştir.

Cronbach alfa güvenilirlik testi sonrası, sıklık ve betimsel analizler uygulanmıştır. Bu analizlerde her fazda ayrı ayrı olacak şekilde; ilk önce problemlerin görülme sıklığı, ikinci adımda da önem derecelerinin değerlendirildiği veriler kullanılmıştır. Skewness-Kurtosis değerleri incelenmiştir. Tüm değişkenler için -1,5 ve +1,5 değer aralığı sağlanmıştır. Bu çıkarımla, verinin normal dağılıma sahip olduğu yorumu yapılabilmiştir. Böylelikle, parametrik testlerin uygulanabilirliği sağlanmıştır.

Ardından, tüm değişkenlerin sıralamasını görebilmek adına, Göreceli Önem Endeksi (RII) analizi uygulanmıştır. En yüksek değere sahip olan değişken, en sıklıkla görülen ve en önemli bulunan problem olacaktır. Bu analiz, üç ana role (tasarımcı-yüklenici-danışman) göre, sıklık ve önem kategorileri ayrılarak uygulanmıştır. Yapılan analizler sonrasında, problemlerin karşılaşma sıklığı kategorisinde, tasarım aşamasında "PD6 - Tasarım aşamasında zaman sınırlaması" problemi, her üç rolde de en yüksek değere sahip olmuştur. İhale aşamasında ise "PT5 - Hizmet kalitesi ne olursa olsun işin daha düşük teklif verene ihale edilmesi" problemi, yine her üç rolde de ilk sıraya sahip olmuştur. Yapım aşamasında dengeler değişmiştir. "PC15 – Tamamlanmamış çizimler ve spesifikasyonlar", danışmanlar için; "PC10 – Nitelikli veya uzmanlaşmış insan kaynaklarının eksikliği", yükleniciler ve tasarımcılar için en yüksek değere sahip olmuştur. Tasarım-yapım aşamasında ise "PDC16 - Ekonomik Durum" danışmanlar

için, “PDC17 – Fast Track Construction” yükleniciler için, “PDC34 – Tutarsız planlama” ise tasarımcılar için en çok işaretlenen problem olmuştur. Problemlerin önem derecesinin arandığı bir diğer kategoride ise, tasarım aşamasında, “PD8 - Tasarım ekibinin çeşitli disiplinleri arasında uygun koordinasyon eksikliği” problemi danışman ve yapım grupları arasında; “PD13 – Tasarımcıya sağlanan verinin eksikliği” problemi ise tasarımcılar için en üst sırada yerini almıştır. İhale aşamasında, her üç grupta da en yüksek değeri alan “PT5 - Hizmet kalitesi ne olursa olsun işin daha düşük teklif verene ihale edilmesi” problemi olmuştur. Yapım aşamasında, “PC9 - İnşaat hataları ve şantiyede kusurlu çalışma” danışmanlar için; “PC41 - Nitelikli İnsan Gücü Eksikliği” yüklenici için ve “PC8 – Tasarım hataları” ise tasarımcılar için ilk sırada yer almıştır. Son olarak, tasarım-yapım aşamasında, “PDC16 - Ekonomik Durum” danışmanlar için en önemli problem olarak ilk sırada yer alırken; “PDC17 - Fast Track Construction” yükleniciler için ve “PDC28 – Yetersiz proje yönetimi” ise tasarımcılar için önemli bulunmuştur.

Bir sonraki adımda, tasarımcı, danışman ve yüklenici gruplar arasında istatistiksel olarak anlamlı bir farkın olup olmadığını araştırmak için tek yönlü ANOVA testi uygulanmıştır. “p-value” değerinin 0,05’ten küçük olduğu tespit edilen değişkenler ile bir sonraki adıma, post-hoc testlerini uygulamaya geçilmiştir. Hangi post-hoc testinin uygun olduğunu saptayabilmek amacıyla da Levene’s testi uygulanmıştır. “p-value” değerinin 0,05’ten küçük olduğu değerler homojen olmayan değerlerdir ve bu deüerlere Games-howell post-hoc testi uygulanabilir. Aksi olarak, “p-value” değerinin 0,05’ten büyük olduğu değişkenlerde ise Tukey ve Gabriel post-hoc testleri uygulanabilir. Bu bilgiler ile hangi değişkene hangi test türü uygulanacağı belirlenmiştir.

Analizler sonrasında, “PDC16 - Ekonomik Durum” ve “PC9 – Yapım hataları ve şantiyede hatalı çalışma”, danışman gruplar açısından hem en sık karşılaşılan hem de en önemli sorunlardan biri olarak tespit edilmiştir. “PD8 - Tasarım ekibinin çeşitli disiplinler arasında oluşan koordinasyon eksikliği”, yükleniciler açısından hem en sık karşılaşılan hem de en önemli sorunlardan biri olarak sıralanmıştır. “PT5 - Hizmet kalitesi ne olursa olsun işin daha düşük teklif verene ihale edilmesi” tasarımcılar için hem en sık karşılaşılan hem de en önemli sorunlardan birisi olarak bulunmuştur. “PT5 - Hizmet kalitesi ne olursa olsun işin daha düşük teklif verene ihale edilmesi” problemi hem tasarımcılar, hem danışmanlar, hem de yükleniciler açısından en üst sırada yer alarak, göze çarpmaktadır. “PDC17 - Fast Track Construction” probleminin nedeni danışmanlar ve yükleniciler için kritik olarak belirlenmişken; "PD6 - Tasarım aşamasında zaman sınırlaması" ve "PD9 - Kararsız işveren gereksinimleri" problemlerinin, yükleniciler ve tasarımcılar açısından önem derecesinin yüksek olduğu görülmektedir.

Anketin son kısmında yer verilen ve katılımcılardan görüş/öneri beklenen kısımdan elde edildiği üzere, saptanan problemlerden kaçınabilmek için sunulan en yaygın görüş tasarımcılara projeyi geliştirmeleri için tasarım aşamasında yeterli zamanın tanınmasıdır. Bu fazın verimli geçmesi ile diğer aşamalarda da, özellikle yapım aşamasında, tasarım çıktıları yönünden zorlanılmayacağı bilinmektedir. Ek olarak, ileriki safhalarda yaşanacak çatışmaların da önüne geçilebilecektir. Bir diğer öneri ise, proje yönetim cephesini güçlendirebilmek amacıyla tasarım yönetimi aracını etkin kullanmaktır. Bu sayede tasarım aşamasında karşılaşılan problemler etkin bir şekilde çözümlenebilecek ve tasarım grupları ve çıktıları yetkin gruplar tarafından denetlenebilecektir.

Bu tez çalışması, yapım projelerinde görülen tasarım-yapım arayüz problemlerinin nedenlerini proje aşamalarına göre belirleyerek; bu problemlerin oluşum sıklıklarını ve önem derecelerini farklı profesyonellerin bakış açısıyla ortaya koymuştur. Gerektiğinde tespit etmek için sorunların farkında olmak ve karşılaşıldığında gerekli önlemleri almak için farkındalık yaratmak; problemlerin çözümlerine yönelik önerilerle desteklenmiştir. Böylece sonuçlar her paydaş için farklılık gösterse de benzer noktaların olduğu görülmüştür. Bu tez araştırmasının bulgularının, tasarım-yapım arayüzündeki birincil problemlerin anlaşılmasını sağlayarak yapım projelerinde rol alan profesyonellere yardımcı olabileceği düşünülmektedir. Profesyoneller, bu çalışma ve sonuçlarından elde edilen kazanımlar ile, ana sorunlar ve etkileri hakkında bilgi sahibi olarak önlem alabilir, etkilerini en aza indirmek için çaba sarf edebilir ve sonuçta yapım projelerinin başarıyla tamamlanabilmesine önemli katkı sağlayabilirler.

1. INTRODUCTION

This chapter involves an introduction to the research on design-construction interface problems in construction projects. The problem statement, aim and objectives, research questions, methodology, scope and structure of the study are included in this section.

1.1 Background and Problem Statement

The construction industry is usually a locomotive sector for the country's economies. It has many fragments and characteristics, lots of variables, resources and different participants that come together for achieving their aim. For any construction project, time, cost and quality are the base constraints to achieve the project's success. In general, these factors should be well managed to get the expected results in a limited time and budget. But this has been achieved in almost very few projects. It usually happens with increases in time, overruns in cost or undesired quality. There are lots of reasons that cause an unsuccessful project process but generally, the most occurred reasons are related to interface problems between project participants at project phases.

The main attitude is to achieve the determined goals of the construction projects. To manage this in the process, the project team selection and defining the members of the team becomes a very important step. Because the project team is one of the most essential elements of the project. There is not just one team obviously, it consists of organizations and sub-organizations. Each organization has its own culture, system, method, and etc. It is important to keep balance in the organization and especially between organizations. Communication and coordination among parties are the key essentials. According to Shokri et al. (2016), one of the problems of today's disjointed projects is managing the relationships among stakeholders.

Construction projects frequently involve numerous temporary groups working in unregulated circumstances (Daniels, 2014). There are lots of interface issues that appear between various construction parties. If these interfaces are not managed well, these in-between situations cause problems at the management level as well. It causes

a lack of communication, coordination, and interaction between parties; should be well managed to get success in the process. One problem can be the most important item for a stakeholder but less important for another. The integration of all components and their smooth operation in the project process can be achieved with interface management. As the use of efficient interface management methodologies spreads, project teams become more collaborative, which boosts profitability, lowers costs, improves time management and strengthen customer/client relationships (Manoj, 2010).

Several professionals and clients have noticed that design is a critical step that must be carefully handled (Male et al. 2007). Because every construction project starts with a design process and mostly, interface problems arise at the interface of the design and construction phases. For this reason, firstly design management and after that, interface management becomes critical management factor for the project's success. As the projects started to become larger and more complex, the specializations required for each project began to differ, and the number of stakeholders required for these specializations began to increase. There is a need to create interfaces between these stakeholders and the disciplines they are interested in, and to manage this interface network.

Design-construction interface problems have the biggest influence on the effective delivery of construction projects. These problems can affect just one measure like cost, time, quality, resource etc. but usually, it affects the overall project performance. The important thing is to identify these design-construction interface problems at the right time and define and address them at the appropriate location.

There are many research in the literature which have studied many types of construction projects at national or international level, in different countries. Also, some studies have dealt with interface problems between two stakeholders or more. Mostly, some causes differ in studies but in general, the exact and similar problems appear without exception. This is exactly why this master’s thesis offers an extensive selection of research. The design-construction interface problems that gathered from the literature were grouped in different ways like according to project phases, participants, management systems etc. But, as a result, the problems encountered in a project show similarity at some levels, no matter what title the problems are collected.

Accordingly, this study investigates the design-construction interface and its related problems in the construction sector without selecting any type of construction project or any parties. The selected general problems at interfaces between such parties provide guidance for the successful project process and give strength to the stakeholders to overcome problems. It helps to get cognitive awareness about problems and to improve interface management for future projects.

1.2 Aim and Objectives

This research aims to identify the causes of design-construction interface problems in construction projects according to the project stages and to determine their frequency of occurrence and degree of importance from the perspective of different construction project professionals. To achieve this aim, main objectives are:

- Identifying the design-construction interface problems in construction projects,
- Analyzing the degree of occurrence and importance of these problems based on the qustionnaire survey which will be conducted among construction sector professionals,
- Searching for if there is a significant difference between construction sector professionals.

Consequently, it is aimed to help to notice the causes of the design-construction interface problems before they occur or the effects are felt. Actually, it is known that risks and problems are not problems to be solved by ignoring or delaying.

1.3 Methodology

To meet the objectives, this study is developed into two main parts. The first part is a comprehensive literature review to find out how design-construction interface problems occur and how they impact the construction project life cycle. In the second part, a questionnaire survey is conducted with the help of the design-construction interface problems gathered from the literature. After, the data are analyzed with the application of statistical tools.

1.4 Scope

The scope of this study has limitations that are listed below:

- Construction projects will be surveyed spesifically,
- Research deals with the design, tendering, construction, and design-construction phases of projects,
- Sights will be taken from construction sector professionals but mostly consultants, contractors and designers.

1.5 Structure

This research contains five chapters. In the first chapter, called Introduction, background information about the problemstatement, aim and objectives, methodology, scope, and structure of the thesis are given. The following second chapter presents a comprehensive literature review about the subject. The third chapter, Research Methodology, describes the research method, design of the questionnaire, and data collection processes. After that, in the fourth chapter, Data Analyzes & Results and Discussion, is about the content of the survey, analysis types, data analysis and their results with discussions. The fifth and last chapter of the research, Conclusion and Recommendations, contains the results of the study, briefly summarizes the entire scope and enriches it with suggestions.

2. LITERATURE REVIEW

This chapter discusses the findings from the literature review that was conducted to understand the design-construction interface problems in construction projects. It is aimed to define these problems and interfaces encountered in the period from the beginning to the end of a project.

Construction project life-cycle, phases of the construction projects, parties in the construction projects, design management, interface management, design-construction interface and its related problems (according to project phases) are studied according to literature in this chapter.

The research was done on the keywords "design management", "interface management", "design-construction interface", "interface problems" & "construction projects". Many reliable databases have been searched and related theses, journals, conference proceedings etc. publications were scanned.

2.1 Construction Project Life Cycle

Any project goes through many phases between its development phase till the end of it. This process from beginning to finale is called the “project life cycle”. There is not any criterion about the content of this cycle, the number of phases in the cycle and their arrangement. Furthermore, in the literature, there are some considerations about the content of the project life cycle.

According to Shokri et al. (2014), as shown in Figure 2.1, the Construction Industry Institute (CII) defined the typical life cycle of the project for most construction projects as largely linear in its approach, with each phase completed before beginning the following phase (Nassar, 2018). The leading phases of this process are Feasibility study, Concept, Scope, Design and Procurement, Construction, Commissioning and Start-up, and Operation.

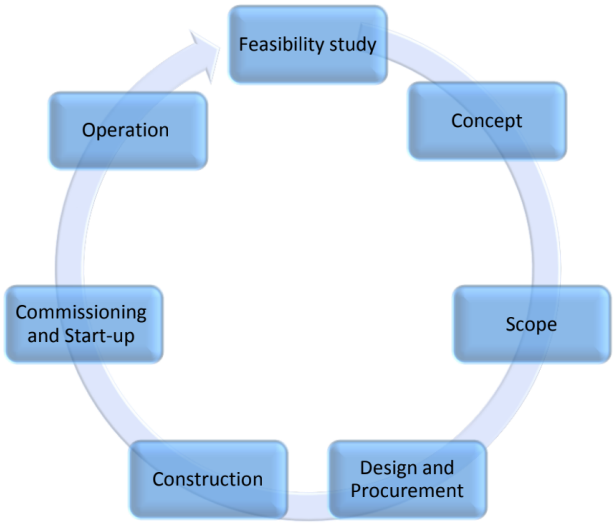

Figure 2.1 : Life Cycle of the Construction Project (Nassar, 2018).

According to Guo et al. (2010), the life cycle of a construction project consists of Planning, Design, Construction, Commissioning, Utilization, Maintenance, and Decommissioning phases (as seen in Figure 2.2) - Planning includes conceptual design, preliminary evaluation, etc.; design involves the initial design and detailed design; utilization refers to the owners' or tenants' use or operation of buildings; and decommissioning consists of demolition and recycling of buildings or material (Guo et al., 2010).

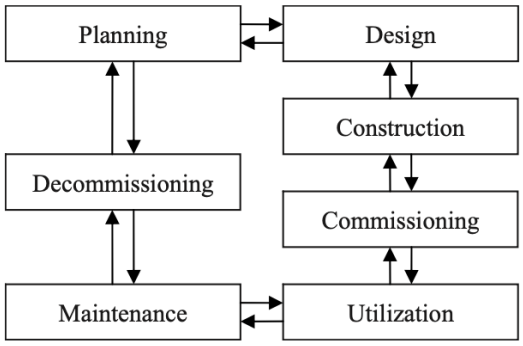

Figure 2.2 : Life Cycle of a Construction Project (Guo et al., 2010).

In another study, Arain (2002) indicated that according to the RIBA, project stages are divided into the following categories: Appraisal, Strategic brief, Outline proposals, Detailed proposals, Final proposals, Production information, Tender documentation, Tender action, Mobilization, Construction to practical completion, and After practical completion (Arain, 2002).

In the typical traditional method of construction project life cycle, each phase of the cycle is separated into independent phases and they have no direct contact or communication between participants during these phases severally. But this method harms the project's entire functions and connections. For this reason, it is necessary to construct more interrelated phases. Nevertheless, there is no typical project life cycle since the quantity of phases and the level of complexity all through each phase might vary from project to project. Furthermore, the design and construction phases are the beginning points and milestones of a project life cycle. The situation of construction phase mostly relies on the design phase and also statutes of each phase are most likely related to good relations between them (Nassar, 2018).

Throughout the project life cycle, each member of the project team is essential. Anyway, a project consists of a spacious range of members of the project team. According to Sugumaran (2013), the effectiveness of the decision-making and execution process throughout the entire project team is directly related to the information's availability, dependability, and accessibility as well as one's capacity to visualize what other parties convey. Due to the sequential nature of the design and construction processes in traditional procurement, there is little interaction between designers and contractors in the early phases of the project life cycle. Instead, contractors only become involved once the design's conceptual, artistic, and problem-solving phases are essentially finished (Male et al., 2007).

First of all, the cycle of a project should be determined so that the information flow can be arranged accordingly to this. When making a choice, the influence on predecessors or successors, as well as the entire life cycle, must be considered. Moreover, the most essential element is to identify the most likely interface issues that may arise during the project life cycle. These potential sites are the real causes that significantly stall project progress (Sugumaran, 2013). Due to this reason, it is critical to identify the possible causes of discrepancies throughout the project life cycle (Arain et al., 2006; Choudhry and Azhar, 2017).

A construction project life cycle consists of so many phases but this study will attemps to just the two main phases of the cycle: “design phase”, “construction phase”, and their interfaces. These phases are:

2.1.1 Design phase

In the design stage, the owner/client gives crucial needs to the designer. The designer establishes the project's key objectives while investigating the accessibility of methods to meet them, and creates a collection of technical drawings and other relevant documentation that represent these objevtives for proper implementation.

Mendelsohn (1997) noted that roughly 75% of the problems that emerge on the project were started during the design stage. In fact, this is not an indication that the contractors did not create any problems and that these problems did not occur during the construction phase. But, the problems which occur in the design phase, should be eliminated quickly before the starting of the construction phase. According to Chappell and Willis (1996), inconsistencies in design that are not corrected throughout the design phase will finally show themselves during the construction phase, where the consequences may be more serious.

Male et al (2007) describes the design phase as, encompassing the process of turning the client's needs into technical solutions and articulating these answers in the form of drawings and specifications.

The needs of the client are determined during the design phase, and the constructive features and quality standards are established through processes, drawings, and technical specifications (Alarcon and Mardones, 1998).

Coordination throughout the design process has to do with information flow management, which, when handled improperly, causes designers to experience information overload (Galaz-Delgado et al., 2021).

2.1.2 Tender phase

The tender stage is the last step while finalizing the design phase. All relevant information, such as the working schedule, material and workmanship requirements, bills of quantities and estimated cost, should be provided at the tender stage.

This phase has so much importance at the construction parties' level because, if the tender design is changed considerably, the contractor must react to the changes and take the appropriate action. After getting the design change requests from the contractor, unfortunately, time delays and problems occur at the project. This is a situation that is not well received by

other stakeholders. If there are any undecided parts of the project, the bidders should be informed about gray points and let them know the exact situation.

Also, the tender phase is the first step in which the designer and construction team contact and cooperate for the first time. This helps to share data throughout the project between stakeholders.

2.1.3 Construction phase

In the construction stage, the real work of the project is carried out. All the resources like materials, workmanship etc. are procured through the working schedule and construction plan. And then, when the construction is finished, the project will be delivered to the real users of it.

This part often passes in a hurry because the project time is the biggest item that can contribute to the budget. Every construction manager and the team want to finish the project earlier in time. So, every step must be ensured in an accurate and controlled manner from the beginning to the end of the project. All efforts are spent to pass this phase comfortably and to make real the project of the required quality.

2.2 Construction Project Participants

The architecture, engineering, and construction (AEC) industry is a tough and active business because there are numerous actors involved in construction projects, each with their own set of interests and relationships (Galaz-Delgado et al., 2021).

Many participants are involved in construction projects, including consultants, designers, contractors, suppliers, and subcontractors (Huang et al., 2008). But the main and major participants are the client, contractor and designer. They influence the entire project and other parties. These are the key parties for a project but all the other parties like consultants, sub-contractors etc. are noted as under these three parties' agreement, they are involved as secondary parties mostly.

The most important requirements are for parties to communicate and coordinate. According to Shokri et al. (2016), one of the problems of today's disjointed projects is managing the relationships among stakeholders.

2.2.1 The owner/client

The owner or client is the leading figure that exists from the beginning to the end of the project. The owner comes up with a project idea, defines the needs/program, organizes the scope of work, gives a brief about his/her needs and expects the necessities of the project. The owner is the most important person among the stakeholders, as the origination and development of the project depend entirely on his/her decisions.

In construction projects, the owner chooses the designers first, who then create the architectural designs and requirements, followed by the development of the building structure and other specialist designs. Typically, the owner's chosen contractor is in charge of the construction phase (Alarcon and Mardones, 1998).

2.2.2 The contractor

The contractor is the person who builds the project in the real world according to the design that comes from the owner or the designer directly. After the design phase is finished or construction document packages are available for construction, the contractor takes the stage and with his/her constructability in mind, the method of construction is specified and optimal solutions are determined for the project. The method of construction, the schedule or the whole elements of the planning phases of construction should be provided by the contractor before the construction is really started.

2.2.3 The designer

In some schemes, the designer works directly for the owner/client or the designer finds a place under the main contractor. This situation depends on the project delivery method.

As the client's primary point of contact, they are inclueded from the start and so handle the remainder of the design process as well as the interaction between the client, the design team, and the contractors throughout construction (Male et al. 2007).

In the traditional method, the designer (architect or engineer) creates designs based on the demands of the owner while keeping in mind the building rules and regulations applicable to the design premises. For this goal, the designer first reviews all available data that can be good potential for the project and then analyzes it before generating a design.

If we look at the main stakeholders and their relations with each other, it can be seen that this situation directly affects the project's success and performance. According to Al-Hammad (2000), any interface issues that arise between the relevant construction parties will have a negative affect on the execution and quality of the construction projects. Consistencies at the points where parties interact with each other may cause a project's completion date to be delayed, its quality to be compromised, or its cost to rise (Arain et al., 2006). When confronted with such scenarios, professionals can only handle the interface problems based on their own intuition rather than standards, and hence the participant cannot be supplied with a full picture of the interface difficulties (Huang et al., 2008).

In essence, construction projects necessitate the exchange of information among project participants. Doğan et al. (2015) stated that successful coordination in building design needs encouraging partners to willingly exchange knowledge and set common goals (Knotten et al. 2017).

The recent literature on project success emphasizes the significance of subjective, soft indicators such as customer satisfaction and project participant satisfaction. The soft success criteria emphasize the significance of interpersonal relationships and teamwork within the project team (Pinto and Pinto, 1991; Koutsikouri et al., 2008; Kärnä and Junnonen, 2017).

From another point of view, according to Wang (2000), disputes between stakeholders were common in projects with weak management (Choudhry and Azhar, 2017). For a project to be successful, the client and consultant must agree on the specific project's scope of work in the context of the available resources (Choudhry and Azhar, 2017). On the other hand, according to Al-Hammad (2000), project owners fail to appreciate project construction costs while demanding greater quality from contractors (Choudhry and Azhar, 2017).

The findings support prior findings that practitioners have varying perspectives of success and may emphasize different aspects of the project (Chan and Chan, 2004; Koutsikouri et al., 2008; Kärnä and Junnonen, 2017). A problem can be the first-ranked for a stakeholder but, for example, the third-ranked for another. The intensity of the interaction between the parties might have different impacts. The satisfaction of the various project participants, as well as the variances in ratings, may be impacted by each participant's function and distance from the project. For example, the contractor and the designer collaborate primarily on the site during

production, but the client and the designer collaborate over a longer period of time and are more focused at the start of the designing phase. During production, the client may already be away from the project, with little engagement with the designers (Kärnä and Junnonen, 2017). Contractors concentrate on resources, construction methods, processes, and sequences, whereas architects and designers concentrate on appearance, shape, functionality, and structural and environmental stability (Hegazy et al., 2001; Whang et al., 2007).

The designer, as the lead actor of a construction project, must have technical skills, viewing design as a flow of events based on a rationalized approach to a technical problem; cognitive skills, considering the individual designer's skills and limitations; and social skills, considering how designers communicate with other stakeholders and how this impacts collaboration and value generation (Cross and Clayburn, 1995; Tzortzopoulos and Cooper, 2007). But on a broad scale, stakeholders must understand the need of improving the integration, planning, and monitoring of their designs and production processes. To eliminate design and construction problems, owners, consultants, and contractors must work closely together (Choudhry and Azhar, 2017). Furthermore, Svalestuen et al. (2015) list twelve critical factors that affect a construction design team; research studies suggest that effective teamwork is essential to achieving high performance. In particular, factors include trust and linkages between cooperation and knowledge of the responsibilities played by the design team members (Galaz-Delgado et al., 2021).

In conclusion, it can be said that communication, collaboration, and coordination tend to predominate as the key issues that arise in the interactions of design teams; in addition to being the most common, they also exhibit a strong interconnection (Galaz-Delgado et al., 2021).

2.3 Design Management

Designers chosen based on their experience will prioritize quality, but contractors engaged through competitive bidding would prioritize efficiency and cost (Bobroff, 1991; Nam and Tatum, 1992; Barlow et al, 1997; Grilo et al. 2007). The two main stakeholders should work together as a team for the project's success but as Banwell (1964) says, there is no other key business where design duty is so separated from production duty as construction (Grilo et al. 2007). When that happens, the integration can not work properly.

The literature is very rich on the definition of “design management”. According to Sinclair (2011), design management is “the discipline of organizing, planning, and guiding the design process to successfully complete particular project goals and objectives” (Knotten et al. 2017). In another research, Deane (2008) described design management as “a function that coordinates design information into the production stage to deliver high-quality products”. Similarly, Knotten et al. (2017) have defined the BDM (Building Design Management) as the planning, organizing, and management of people, their knowledge, and the transfer of information to achieve certain project goals and objectives.

Several professionals and clients have noticed that design is a critical step that must be carefully handled (Male et al. 2007). Especially in the immediate future, design management became a serious topic in construction project management. For this reason, the total process should be handled very carefully. As a result, to produce high-quality products at the end of the cycle, Deane (2008) claims that design management is a task that aligns design knowledge into the construction phase. When the design phase is completed before the start of the construction, design management is primarily concerned with the management of designers' activities, influences, and deliverables in an architectural or engineering consultancy (Andersen et al. 2011). In this situation, the design parties and the owner just focus on the design documents. As a result of the growth of the projects and the complexity of the projects with the increase of stakeholders, new contract types have been derived to describe the relations and obligations of the stakeholders with each other. For this reason, design management has also spread over a wider area.

Design management, which emphasizes the result of design decisions (i.e., the design product) and the activity of designing (i.e., the design process), has been closely associated with a concern with systematic design processes (Cross, 1999; Press and Cooper, 2002; Lawson et al, 2003; Tzortzopoulos and Cooper, 2007).

As seen in Figure 2.3, there are so many areas in the project creation process that the designer should be aware of and consider. From the very first initials of the project, the designer is in the field to succeed in the project with the help of collaboration and communication. Here, the designer has a lot of responsibilities. The shortfall between design and management has grown as a result of changes in the construction industry, the continued specialization of professions, and the increasing use of alternative procurement methods, but they have also highlighted the

requirement for a design professional with managerial and technical skills (Smith et al. 2004). According to Hales (1993), strong design process management comes down to the efficient management of three topics: 1) design team activities, 2) design team output, and 3) design team influences (Andersen et al. 2011).

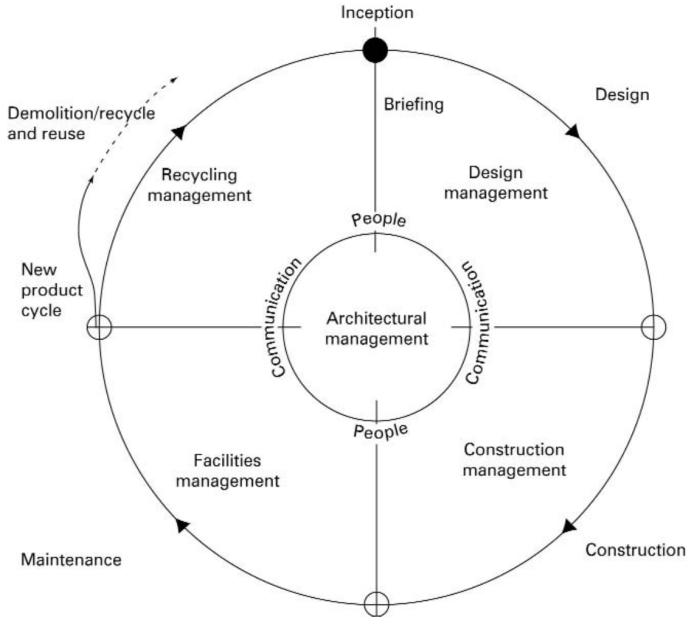

Figure 2.3 : Architectural Design Management within the Project Framework (Emmit, 2022).

According to Knotten et all. (2017), success factors (factors that lead to the success of the project) the building design management handles are client, communication, decision-making, HSE focus, interface management, knowledge management, performance evaluation, planning, risk management, and team management. In this formation process, in which the designer is the conductor of the orchestra and somehow manages and / or is involved in the whole process, the role of the designer will not be limited to design only. The design process contributes to a very little percentage of the total project cost but has a considerable impact on the characteristics and final out-of-pocket cost of any project, both in financial and life-cycle terms (Male et al. 2007).

Cooper and Press (1995) propose that design management is in charge of 1) establishing a structure for handling design, because it encompasses a variety of organizational levels and activities; and 2) Design planning entails incorporating design into organizational objectives, strategies, and policies for design, as well as putting design processes in place; 3) organizing for design, which entails having the right structure, assembling the right teams, utilizing training

and development programs, and making investments in design; 4) implementing and monitoring design, which entails implementing and monitoring design programs and projects; and 5) evaluating design, which entails evaluating design management and design projects (Andersen et al. 2011).

In addition to coordinating the design phase of the construction project, the design management also should specify the types of information that are relevant to every member of the team and establish communication channels, information flows, schedules, and formats for transferring, recording, and distributing the information (Grilo, 2007). Because the members of the project talk to each other about design documents, the common "language" is the drawings, specifications etc. therefore, everybody should understand easily and practically and be familiar with the format when they get any document from the design team. As a result, to coordinate the construction design process more effectively, present methodologies must be updated to fit the demands of the modern design manager (Bibby et al. 2019).

As with some types of agreements, the contractor should employ design management as a key tool to successfully manage resources throughout the construction phase. Contractors must build their own design management tools that are appropriate in the realistic construction phase, as well as a proper construction plan and technical assistance, to adequately use and allocate limited resources, including materials and equipment on site (Whang et al., 2007).

Overall, these studies highlight the need for effective design management in construction projects. Design management serves as a partial mediator between alliance and design performance, demonstrating that, in parallel to design management, alliance partners' complementary resources and integrated talents are important in bringing value to design outputs (Zhang et al., 2018).

It has often been proven in the literature that change requests have negative impacts on construction projects, regardless of which stakeholder. A project may experience change for a variety of reasons, including design errors, design modifications, scope expansions, or unexpected situations (Hanna et al., 2002; Marzuki et al. 2019). Sometimes the owner puts pressure on the designer to deliver the job early and start construction as soon as possible. However, as a result of giving limited time to the designer, the quality of the design document

outputs may decrease, resulting in inefficient and inadequate design solutions on the construction site.

There are several reasons for design-related concerns, design deficiencies, change orders or rework. But in the end, every time it usually results in a bad manner. These situations also provide a basis for design-construction problems.

Design-related concerns were highlighted as one of the most critical aspects in studies on the reasons for project failure. Gamil and Abdul Rahman (2020), for example, used the relative importance index (RII) to analyze the impact of 62 essential variables contributing to failure in the Yemeni construction sector and placed design-related concerns as the second most significant reason. In another research, according to Yap and Skitmore (2018), design-related errors contribute between 5% and 20% of the time and cost overruns in Malaysian building projects. All of this means that, to realize projects on time and under budget, design deficiencies (DDs) and design-related issues should be addressed from the project's beginning (Shoar and Payan, 2021). For this reason, every time a change order is made, the existing plans and specifications must be added to, removed from, or modified appropriately (Al-Hammad 2000). The target for project completion may be impacted by change orders (Arain et al., 2006).

Complexity can also be a reason for a design deficiency. The complexity of building projects grows with time. Some of the causes for this dispute include the use of new building processes, the emergence of new and distinct connections between design and construction experts, and the increased need to finish projects in less time and on a lower budget (Shoar and Payan, 2021). On the other hand, design assignments are carried out by several groups of design specialists, and insufficient team communication leads to design mistakes or derelictions as well as inadequate integration of design solutions (Skitmore et al. 2014).

Another cause-effect relationship is known as rework. Reworking a construction project entails redoing previously completed work with the primary goal of meeting the project's functional needs. Even though rework is a frequent problem in the construction industry and has a substantial impact on project performance, the causes of rework are mostly unclear, and most construction firms are unqualified to properly manage the issue. Rework, on the other hand, is defined by the Construction Industry Development Agency (1995) as "additional work generated by a discrepancy with the initial need of the project." According to Love (2002),

rework is the action or circumstance brought about by anomalies, defects, inadequate quality defects, or quality hazards, whereas Josephson et al. (2002) describe rework as needless output produced by construction defects (Skitmore et al. 2014).

Burati et al. (1992) examine the effectual elements of nine industrial projects from the Construction Industry Institute (CII) database in the United States. There are five key reasons for rework, according to them: design, construction, fabrication, transportation, and operability (Skitmore et al. 2014). In another research, Love et al. (2010) studied to find the primary factors involved in 115 Australian civil engineering projects. The results show that poor information technology utilization, excessive owner engagement in the project, a lack of strictly delineated working procedures, changes made at the owner's request, and a contractor's lack of quality improvement efforts are the main causes of rework (Skitmore et al. 2014).

As another example of the design-related deficiencies, Manavazhi (2004) states that poor design document quality is the biggest factor of rework during the design process. Similarly, Tilley et al. (1997) argued that an increase in RFIs might result in rework and coordination issues (Shoar and Payan, 2021). A definition from the opposite direction of it is, according to the study of Lopez et al. (2010), requesting change orders can lead to inaccuracies in design documents, particularly when design firm workers are behind schedule and must meet a deadline (Shoar and Payan, 2021). In both ways, we can say that this method or way of doing business causes problems.

Andi Minato (2003) states that accepting cheap design fees combined with the restricted time available to complete the task might lead to difficulties with the reliability of design documentation (Shoar and Payan, 2021). Also the study of Lopez et al. (2010) says that the quality of the design documentation has a considerable impact on both the final cost of the project and the profit of the design firm. The resulting disagreements create claims, which might cause schedule deviation and salary payment delays. As previously noted, salary payment delays caused by a decrease in employee enthusiasm and collaboration might lead to more DDs (Shoar and Payan, 2021).

Although it is argued by many that the design documents should be well prepared for the successful completion of the construction process, the method generally followed is not helpful. According to Shoar and Payan (2021), an increasing quantity of concurrent tasks can increase

workload and reduce productivity. Mohammed (2007) observed that as the number of concurrent activities increases, so does the document's vulnerability to DDs (Shoar and Payan, 2021). The more time and space allowed for the designer to complete the design documents, the better the results will be. Because the designers' contribution to the changes has been projected to take between 40 and 50 per cent of the entire project time (Koskela 1997; Alarcon and Mardones, 1998). According to Tenah (2001), what seems great on drawings or a screen is often hard to construct and designers search for consequent changes in the designs at the construction phase. These inconsistencies arise in rework, quantity modifications, delays, and construction faults (Choudhry and Azhar, 2017).

Although most of the problems in the literature and practice seem to stem from the design process, it is undeniable that many stakeholders involved in the design process have an impact on this situation. The majority of issues, on the other side, were brought on by incorrect or delayed comprehension of the owner's needs by the designers, which led to several changes throughout construction (Alarcon and Mardones, 1998).

The studies presented thus far provide evidence that design management has a significant impact on rework (Burati et al. 1992; Love et al. 2002; Hwang et al. 2009; Skitmore et al. 2014). Thus, design management should be improved to reduce rework in construction.

A trained management team can decrease disputes during the design phase, which is the initial point of contact between project partners. Management skills and behaviors can help to decrease conflict (Oladokun and Alshaikh, 2018). Assaf et al. (2018) point out, to decrease expenditures, these employees would no longer be able to work. In this case, it is quite likely that design tasks will be assigned to inexperienced designers, which will result in the delay and deletion of some key measures, such as appropriate data gathering and quality control, and will eventually result in further DDs (Shoar and Payan, 2021).

It is following the results of the Assaf et al. (2018)’s study, which found that to avoid DDs, greater focus should be given to project design management and the structure of design teams (Shoar and Payan, 2021).

In addition, Song et al. (2009) examined project performance throughout three design management application stages, from concept development to detail design. Performance simulation led to savings from 1.4 to 5.5% on overall man hours and a higher saving from 3.4

to 12% on the entire project duration, according to three levels of the contractors' design management program.

Followingly Popper (1972) and Brawne (2003, p. 33) describes the architectural design process as an iterative approach to problem identification, the creation of a tentative solution, testing that tentative solution and removing error from it, and the creation of the next possible solution, though one still containing issues that need to be addressed in the next iteration. The cycle is displayed in the Figure 2.4 below (Mitchell et al. 2011).

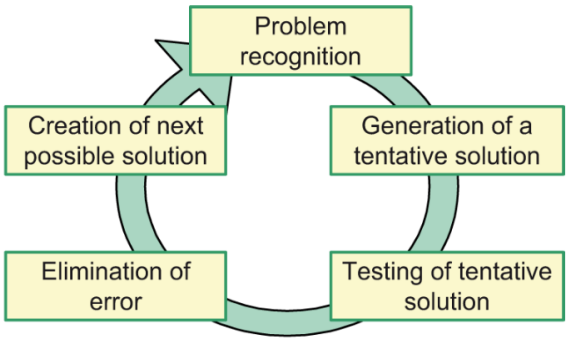

Figure 2.4 : The Design Process as an Iterative Cycle (Mitchell et al., 2011).

Still, each building construction project begins with the goal of finishing it in line with the contractual requirements (Choudhry and Azhar, 2017) but, all design process theories and models agree that decisions are taken all through the design process based on the data available at the time (Mitchell et al. 2011).

2.4 Interface Management

As the projects started to become larger and more complex, the specializations required for each project began to differ, and the number of stakeholders required for these specializations began to increase. There is a need to create interfaces between these stakeholders and the disciplines they are interested in, and to manage this interface network.

As Sinclair (2011) stated, the interfaces of the various disciplines are linked in various ways throughout the design process. All of these interdependencies exist in the building design stages and must be coordinated. One of the most difficult aspects of BDM (Building Design Management) is the coordination of these multidisciplinary linkages (Knotten et al., 2015a; Knotten, 2017). It takes assembling different interdisciplinary teams from many organizations

and having them operate in a fast-paced atmosphere for a set period of time to accomplish the goals of a construction project. This operation creates several interfaces or interactions for the moment (Daniels, Farnsworth and Weidman, 2014; Marzuki et al. 2019).

First of all, it is important to define the concept of “interface”. “Interface” is defined by Healy (1997) as; “a boundary where an interdependency exists across that boundary and where responsibility for the interdependency changes across that boundary” (Quoted by Yeganeh, 2019). Interfaces are the contact points for every work package and it’s related to stakeholders or stage/phase. Poorly managed interface management leads to poor productivity, poor quality, and increased cost which affects overall project performance negatively. Alarcon (1998) asserts that to successfully complete this step and improve the design-construction interface, it is crucial to distinguish between tasks that contribute "value" and those that generate "waste" throughout the design and building processes. According to Ku (2000), the interface is the layer between two organizations that affects each other (AL Mousli and El-Sayegh, 2016). The interface can be stated as the needed physical and functional coordination of two or even more disciplines (Huang et al., 2008; AL Mousli and El-Sayegh, 2016).

Many problems occurred in construction projects, especially in interfaces. But there are no universally accepted definitions of Interface Management and its constituent parts. However, often, interfaces are seen as the divisions between autonomous, yet interdependent systems, project phases and scope packs, building materials, and stakeholders (Shokri, 2016). Lin (1997) states that there may be an interaction between activities, structures, situations, equipments, and components (AL Mousli and El-Sayegh, 2016).

The idea behind project management is interface management, which provides a "bird's eye perspective" and assists in avoiding time overruns, lowering cost overruns, minimizing reworks in construction, and also gaining quantifiable advantages like increased customer satisfaction (Manoj, 2010). To minimize their potential to have a detrimental influence on the project, interface issues inside the project's organization must be properly addressed. Wideman (2002) made two definitions of Interface Management: (1) “The management of communication, coordination, and responsibility across a common boundary between two organizations, phases, or physical entities which are interdependent”; and (2) “managing the problems that often occur among people, departments, and disciplines rather than within the project team itself” (Quoted by Chen, 2008). As explained, Interface Management involves every part of the project in the

built environment such as the project life cycle process, different phases of the life cycle, resources, schedules, systems, contracts, etc. Therefore, Interface Management cannot be considered separately from project management activities.

Adopting appropriate interface management considerably enhances building performance and outcome predictability (Manoj, 2010). By controlling the border conditions between or among project elements including people/organizations, physical elements/components, systems, equipment, phases, or concepts, interface management addresses a variety of interface difficulties (Chen 2009; Tian, 2013).

Effective interface management in a construction project requires thorough integration of all technical and managerial issues among the participating parties, with a focus on collaboration and cooperation. Otherwise, counteractions will arise in the interface, causing harm to all project members (Huang et al., 2008). Recently, industry leaders and academics have been researching the adoption of interface management systems, which are used to recognize and communicate the "interfaces existing between project stakeholders and construction components" (Shokri et al., 2012; Daniels et al., 2014).

Contrarily, it is challenging to create alternative management models (lean construction and agile project management), in the context of significant and complicated construction projects. Because of this, interface management is still being investigated as a way to increase construction efficiency (Daniels et al., 2014).

An essential first step in the examination of the project's interface management affecting elements is identifying and classifying interfaces (Tian, 2013). It is crucial to identify the major causes of errors and discrepancies and either eradicate them or lessen their negative effects to pinpoint problematic areas in the design-construction interface and create proposals for workable solutions.

In the majority of conventional non-design-build project delivery methods, architects often coordinate interface design difficulties while project managers or supervisors focus on field interface conflicts. Then, interface design is carried out without much, if any, constructability input from contractors and designers are rarely involved in the planning and building phases. Both sides are forced to carry out duties according to their own expertise and experience due to the broken design-construction interaction. Field conflicts and various interface-related design

problems result from this (Chen et al. 2008). As Arian (2002) stated that interface issues between the owner, designer, and contractors might be a cause of challenges for design and construction management (Oladokun and Alshaikh, 2018).

In this thesis study, the author focused on the problems which affected the design and construction phases especially. These two main processes are closely interconnected and the shortcomings in the design directly redound on the construction process. Therefore, the problems in the design phase should be identified first, and then their potential impacts on constructability will be discussed.

2.4.1 Design-construction interfaces

The standars of a construction work is frequently a reflection of the data produced throughout the planning and design phases, and particularly of the level of construction input to the design process, therefore the design-construction interface is particularly crucial (Sugumaran, 2013). Problems with the design-construction interface vary in how they are categorized. The main attitude should be to trace and control them. For this reason, it is important to be aware of these problems at every phase and to foresee what causes these problems and what consequences these problems will have.

Bogus et al. (2003) stated that any attempts to reduce the overall project delivery time can be thwarted if design and construction are viewed as independent entities, often with little to no cooperation between them. Such a reduction is possible by moving toward an integrated design-construction interface (Quoted by Yeganeh, 2019). However, sometimes the stakeholders, which have their own goals, face different challenges during any phase of the project. Therefore, understanding the reasons and how they are connected, which are connected to all project phases, can aid practitioners in taking them into account and avoiding their unfavourable effects in future projects, improving interface integration, and making better judgements that may improve project performance (Yeganeh, 2019). Understanding and controlling design-construction interface issues is seen as fundamental for the success of any project. Disregarding these ongoing problems results in project failure or, at most, poor results (AL Mousli and El-Sayegh, 2016).

Construction is seen as being linear and sequential (Koskela, 2000, p. 257), while the design is often seen as iterative and cyclical (Austin et al., 1999a; Brawne, 2003, p. 33; Mitchell et al.

2011). The crucial interface between the design phase and the construction process is challenging to manage because of these contradicting cyclical and linear qualities (Mitchell et al. 2011). As seen in Figure 2.5, the characteristics of these two phases, construction and design are totally different. Therefore, the interface between the two phases must be well established so that the project can be successful.

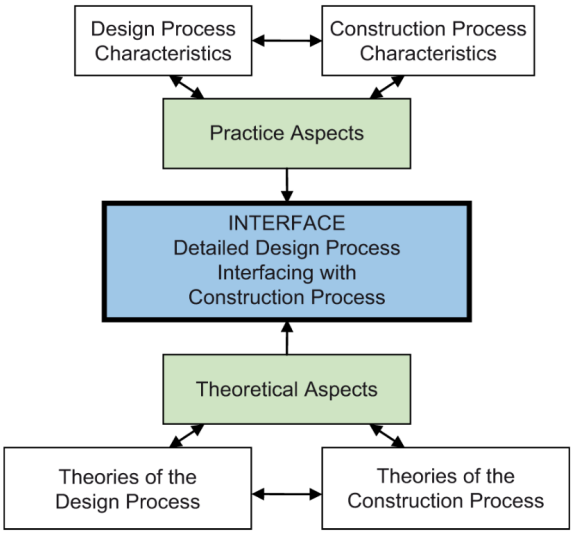

Figure 2.5 : Conceptualisation of the Practical and Theoretical Aspects at the Interface Between Design and Construction (Mitchell et al., 2011).

Another issue is, the most comprehensive and difficult step of the design process is the detailed design stage, which is also when the construction process first interacts with the design process (Mitchell et al. 2011). Even when design and construction are well connected, it can be challenging to get the appropriate information to the right person at the right time in the right format (McCarthy et al. 2000). At this point, design management became a catalyst because it has a positive impact on project performance and benefits.

On the other hand, as Chan and Chan (2000) said, the chosen procurement method can affect project performance and the collaboration of design and construction teams. The procurement methods used should take into account factors such as project type, building complexity, design and construction timeline and budget, and client structure and knowledge (Grilo et al., 2007).

Every construction project has several phases, which leads to various ways in which the designer and contractor collaborate. The designer and a couple of prospective contractors firstly interface. Here, it's important to make sure that each contractor has access to enough

information (McCarthy et al. 2000). But in actuality, this is rarely a smooth process, especially when designers and contractors have differing perspectives on the project. For instance, the contractors see a facility from the aspect of the process and the problems (such as cost, schedule, and techniques) that arise from the assembly of these components, whereas the designers view a facility from the viewpoint of the components of the end product (Vanegas and Opdenbosch, 1994).

As stated by McCarthy et al. (2000), the contractor participates in some role in the planning and design phases of the project and should continue to be involved throughout its commissioning, operation, and maintenance.

The previous literature studies make it obvious that there is a clear gap in the design-construction interface. (Alarcon and Mardones, 1998). Due to these oversights, discrepancies, errors, and defects can emerge during the construction and design phases of projects. To discover inconsistencies and extend project service life, it is critical to identify and remove major causes of mistakes and inconsistencies, or to mitigate their negative impact (Choudhry and Azhar, 2017). Recognizing and addressing design-construction interface issues is considered critical for project success. Ignoring these issues resulting in project failure or, at most, limited success (Al Mousli and El-Sayegh, 2016).

2.4.2 Design-construction interface problems

Design-construction interface problems have the biggest influence on the effective delivery of construction projects. These problems can affect just one measure like cost, time, quality, resource etc. but usually, it affects the overall project performance. If one is serious about reducing problems on the construction site, one obvious place to start is by focusing on how the project team will proceed to minimize these problems during the design process (Arain and Assaf, 2007). The design process is not always just the business of the designer. Concerning interfaces, Fredrickson (1998) stated that each project, client, and team of design and contractor has different design requirements. There is no a solution that fits all for determining the best design approach for a specific project (Arain and Assaf, 2007).

Problems, their causes and also impact on the project performance are studied by many researchers. These problems have a bigger impact than expected. In the end, inadequate project process causes poor project performance. Management issues may result from a lack of

adherence to protocols by the owner, consultant, and contractors (Arain et al., 2006). According to Wang (2000), conflicts between the stakeholders were more common in projects with inadequate management (Arain and Assaf, 2007). As a solution to this problem, early contractor engagement results in advantages such as a better schedule, lower cost, more safety, and higher-quality performance (Gil et al., 2004; Emmitt, 2010).

It is impossible to provide action plans to improve the performance of the design teams without having a clear understanding of the issues and difficulties that might affect the interactions (Galaz-Delgado et al., 2021). Focusing on what the project team can do to avoid difficulties during the design process is a logical place to start if one were to really investigate approaches to lessen problems on site (Arain et al., 2006).

The methods used in earlier studies to categorize the problems at the design-construction interface varied. (Al Mousli and El-Sayegh, 2016) For example, Pavitt and Gibb (2003) subdivided them into organizational, contractual and physical problems; Tian (2013) categorized the interfaces as time, relational, information and environmental interfaces; some researchers studied the problems between two or more stakeholders like between designers and contractors (Al-Hammad & Assaf, 1992; Al-Mansouri, 1988); contractors and owners (Al-Hammad, 1990), contractors and subcontractors (Al-Hammad, 1993), and between construction parties (Al-Hammad, 2000).

The study of Chen et al. (2008) examines the causes of interface problems from six interconnected perspectives: people/participants, methods/processes, resources, documentation, project management, and environment. According to Al-Hammad (2000), 19 design-construction interface problems have been categorized objectively into four broad categories: financial, contract and specifications, environmental, and other common interface problems.

Apart from that, Arain et al. (2006), AL Mousli and El-Sayegh (2016) and Arainet al. (2007) studied categorization by using construction project phases. This classifying strategy was also used in this study since it covers the major phases of the construction process.

In this study, based on an extensive review of the literature, all of the interface problems encountered were summarized and ninety-one (91) main interface problems were identified. These problems are frequently encountered by professionals in the construction business

environment. These ninety-one (91) interface problems were classified according to which phases of the project timeline they encountered. Finally, four main categories are defined and as design phase, tendering phase, construction phase and design-construction phase.

Design phase problems

The thirty-six (36) interface problems that exist throughout the design phase of a construction project like the initial times of the project and/or development of design are collected under this heading.

Problems encountered at this phase are mostly related to data, briefs, the designer's awareness, time, and scope. And also, relations between stakeholders, especially bilateral relations between owner-designer and contractor-designer. At this phase, if these stakeholders have not been together in the same project before, they are contacting the project and each other for the first time at this stage. That's exactly why the designer takes the greatest pressure and all the problems are built around her/him.

Involvement of the contractor, lack of proper coordination, incomplete or incorrect data transmission, time limitation, designer's awareness about sources, unclear definition about the scope of the works, unclear design documents or delay in preparation and many other problems like this are identified.

The problems, which professionals face during the design phase in construction projects, are listed at Table 2.1.

Table 2.1 : Design-construction interface problems that determined at design phase.

Nu.	Phases / Problems	References
1	Involvement of the contractor in design conceptual phase	Arain (2002), Arain and Assaf (2007)
2	Involvement of the contractor in design development phase	Arain (2002), Arain and Assaf (2007)
3	Lack of stipulated data	Arain (2002), Arain and Assaf (2007), Nassar (2018)
4	Delay in construction documents preparation	Arain (2002), AL Mousli and El-Sayegh (2016), Arain and Assaf (2007)
5	Lack of human resources for design firm	Arain (2002), AL Mousli and El-Sayegh (2016), Arain and Assaf (2007), Choudhry et al. (2017), Nassar (2018), Abu-Reishah and Hiyassat (2021)
6	Time limitation in design phase	Arain (2002), AL Mousli and El-Sayegh (2016), Arain and Assaf (2007)
7	Lack of contractor involvement during the design phase	AL Mousli and El-Sayegh (2016)
8	Lack of proper coordination between various disciplines of design team	AL Mousli and El-Sayegh (2016), Nassar (2018), Abu-Reishah and Hiyassat (2021)
9	Unstable owner requirements	AL Mousli and El-Sayegh (2016), Nassar (2018), Abu-Reishah and Hiyassat (2021)
10	Contractor is not involved in the conceptual phase of design	Choudhry et al. (2017)

Table 2.1 (continued): Design-construction interface problems that determined at design phase.

Nu.	Phases / Problems	References
11	Contractor is not involved in the development phase of design	Choudhry et al. (2017)
12	Data provided to designer are incomplete	Choudhry et al. (2017)
13	Data provided to designer are incorrect	Choudhry et al. (2017)
14	Data is provided late to designer	Choudhry et al. (2017)
15	Designer busy in too many assignments	Choudhry et al. (2017)
16	Lack of awareness about governmental regulations, municipality requirements, statues and their modifications	Choudhry et al. (2017)
17	Designer's knowledge is lacking in constructability of design	Choudhry et al. (2017)
18	Lack of awareness about the availability of construction materials and equipment in the local market	Choudhry et al. (2017), Nassar (2018), Abu-Reishah and Hiyassat (2021)
19	Designer's knowledge is lacking on engineering design technique and software	Choudhry et al. (2017)
20	Frequent replacement of designer by the owner	Choudhry et al. (2017)
21	Personal and social problems of designer	Choudhry et al. (2017)
22	Lack of reward, delayed payment or less payment to designer by owner	Choudhry et al. (2017), Abu-Reishah and Hiyassat (2021), Nassar (2018)
23	Too little time is given to designer for completion of the design documents	Choudhry et al. (2017), Nassar (2018)
24	Lack of project planning and analysis by owner at the project start	Choudhry et al. (2017)
25	Frequent changes in the design due to owner dis-satisfaction	Choudhry et al. (2017)
26	Approving authorities do not check carefully that the structure is designed according to the building bye-laws, codes and government rules	Choudhry et al. (2017)
27	Lack of awareness about the construction knowledge and ongoing site operations	Nassar (2018)
28	Inaccurate estimation of project element costs and quantities	Nassar (2018), Marzuki et al. (2019), Abu-Reishah and Hiyassat (2021)
29	Lack of design quality assurance practices	Nassar (2018)
30	Unclear definition for scope of work	Nassar (2018), Abu-Reishah and Hiyassat (2021), Yeganeh et al (2019)
31	Mistakes and discrepancies in design documents	Nassar (2018), Abu-Reishah and Hiyassat (2021)
32	Insufficient or inaccurate geotechnical investigation	Abu-Reishah and Hiyassat (2021)
33	Outsourcing of design services	Nassar (2018)
34	Involvement of the designer as a consultant	Nassar (2018), Abu-Reishah and Hiyassat (2021)
35	Delays in design approval by owner	Yeganeh et al (2019)
36	Delays in preparing designs by design team	Yeganeh et al (2019)

Tender phase problems

The nine (9) interface problems that exist throughout the tendering phase of a construction project are collected under this heading.

The tender phase often does not manifest itself as a separate phase. Near or after the completion of the design phase, pre-construction tender documents are collected and the phase is carried out. Staying between the two main stages, the design and construction phases, causes problems in this interface.

The problems, which professionals face during tendering phase in construction projects, are listed at Table 2.2.

Table 2.2 : Design-construction interface problems that determined at tender phase.

Nu.	Phases / Problems	References
1	Incomplete or inaccurate design documents unintentionally provided with bidding documents	Choudhry et al. (2017)
2	Incomplete or inaccurate design documents intentionally provided with bidding documents	Choudhry et al. (2017)
3	Type of construction contract in use	Choudhry et al. (2017)
4	Contractor did not consider that the design is exotic, complex or not have the required expertise	Choudhry et al. (2017)
5	Awarding the contract to the lower bidder price regardless of the quality of service	Choudhry et al. (2017), Abu-Reishah and Hiyassat (2021), Nassar (2018)
6	Absence of third party validation during defect liability period	Choudhry et al. (2017)
7	Inappropriate work packaging and subcontracting	Nassar (2018), Chen et al. (2008)
8	Restricting the contractor classification and a specific experience for the subcontractors in the contract form by the client	Nassar (2018)
9	Inadequate study for tender document to observe discrepancies before tender awarding	Nassar (2018)

Construction phase problems

The fourty-seven (47) interface problems that exist throughout the construction phase of a construction project are collected under this heading. It is expected that the largest number of problems will be detected at this stage because it is the stage that the constructability of the design is checked and the design documents are actually used.

Mostly, changes in design or requirements of the owner and unforeseen problems in site or design documents are the bases of the other problems. Insufficient or ambiguous working drawing documents and details, design errors and changes, procurement delays and difficulties, owner's changes, qualifications of the contractor and many other problems like this are identified.

The problems, which professionals face during the construction phase in construction projects, are listed at Table 2.3.

Table 2.3 : Design-construction interface problems that determined at construction phase.

Nu.	Phases / Problems	References
1	Lack of designer knowledge of available material and equipments	Arain (2002), Nassar (2018), Arain and Assaf (2007)
2	Complete & adequate plans and specs	Arain (2002)

Table 2.3 (continued): Design-construction interface problems that determined at construction phase.

Nu.	Phases / Problems	References
3	Insufficient working drawing details	Arain (2002), AL Mousli and El-Sayegh (2016), Al-Hammad (2000), Huang et al. (2008), Nasssar (2018)
4	Exotic design & technology	Arain (2002), Arain and Assaf (2007), AL Mousli and El-Sayegh (2016), Abu-Reishah and Hiyassat (2021)
5	Ambigious design details	Arain (2002), Arain and Assaf (2007)
6	Lack of specialized construction manager	Arain (2002), AL Mousli and El-Sayegh (2016), Arain and Assaf (2007), Abu-Reishah and Hiyassat (2021)
7	Material changes in types & specs during construction phase	Arain (2002), Arain and Assaf (2007), AL Mousli and El-Sayegh (2016)
8	Design errors	Arain (2002)
9	Construction errors and defective work at the construction site	Arain (2002), AL Mousli and El-Sayegh (2016), Arain and Assaf (2007), Nasssar (2018), Abu-Reishah and Hiyassat (2021)
10	Lack of skilled or specialized human resources	Arain (2002), Nasssar (2018), Abu-Reishah and Hiyassat (2021)
11	Designer's lack of awareness about on-going construction process	Arain (2002), Arain and Assaf (2007), Choudhry et al. (2017)
12	Contractor's lack of comprehension of drawings details and specs	Arain (2002), Choudhry et al. (2017), Arain and Assaf (2007)
13	Involvement of designer as design consultant	Arain (2002), AL Mousli and El-Sayegh (2016), Arain and Assaf (2007)
14	Contractor's lack of sufficient knowledge about new technology	Arain (2002), Arain and Assaf (2007)
15	Incomplete drawings and specification	AL Mousli and El-Sayegh (2016), Arain and Assaf (2007), Abu-Reishah and Hiyassat (2021), Arain and Assaf (2007)
16	Delay in material approval (submittals)	AL Mousli and El-Sayegh (2016), Arain and Assaf (2007), Arain (2002)
17	Owner proposes changes because he had planned to make changes during construction	Choudhry et al. (2017)
18	Owner proposes changes during construction due to sudden changes in his reqiurements / expactations	Choudhry et al. (2017)
19	Owner proposes changes during construction due to change in ownership	Choudhry et al. (2017)
20	Owner proposes changes to assert his authority and make undue interference in construction	Choudhry et al. (2017)
21	Owner proposes changes due to financial problems	Choudhry et al. (2017)
22	Slowness in decision making process by owner	Choudhry et al. (2017), Abu-Reishah and Hiyassat (2021), Nasssar (2018)
23	Changes in building codes, bye-laws and government rules	Choudhry et al. (2017)
24	Delayed revision of drawings by designer	Choudhry et al. (2017)
25	Drawings not properly stamped or certifies by designer	Choudhry et al. (2017)
26	Custody and supply of drawings at site	Choudhry et al. (2017)
27	Delayed approval of drawings by owner or consultant	Choudhry et al. (2017), Abu-Reishah and Hiyassat (2021)
28	Material changes due to shortage of particular material in the market	Choudhry et al. (2017), Arain (2002), Arain and Assaf (2007), Nasssar (2018)
29	Material changes due to procurement delays by contractor	Choudhry et al. (2017), Arain (2002), Arain and Assaf (2007)
30	Contractor does not follow recommended construction methods and reluctant to use proper construction equipment	Choudhry et al. (2017)
31	Contractor lacks in coordination and management during construction	Choudhry et al. (2017)
32	Contractor’s staff facing shortage of tools and or equipment for measurement, alignment and or for adjustment at corners	Choudhry et al. (2017)
33	Contractor and his staff focusing on other projects	Choudhry et al. (2017), Nasssar (2018), Abu-Reishah and Hiyassat (2021)
34	Unanticipated weather conditions	Choudhry et al. (2017)
35	Unforeseen problems and differing site conditions	Choudhry et al. (2017)
36	Timing of proposed changes, i.e. whether at the start or at the end of construction	Choudhry et al. (2017)

Table 2.3 (continued): Design-construction interface problems that determined at construction phase.

Nu.	Phases / Problems	References
37	Approving authorities do not check carefully that the structure is constructed according to the approved building plans	Choudhry et al. (2017)
38	Communication Gap between Constructor and Designer	Arain and Assaf (2007), Arain (2002)
39	Lack of Mutual Respect between Constructor and Designer	Arain and Assaf (2007), Arain (2002)
40	Lack of communication & coordination among all parties	Arain and Assaf (2007), Arain (2002), AL Mousli and El-Sayegh (2016), Abu-Reishah and Hiyassat (2021)
41	Lack of Skilled Manpower	Arain and Assaf (2007), Choudhry et al. (2017)
42	Interference of client during implementation	Nasssar (2018)
43	Bad decision making	Abu-Reishah and Hiyassat (2021)
44	Lack of specialized quality control team	Abu-Reishah and Hiyassat (2021)
45	Frequent changes of subcontractors	Nasssar (2018)
46	Financial and technical status of the contractor	Nasssar (2018)
47	Lateness in preparing construction documents (such as schedule, detailed drawings)	Abu-Reishah and Hiyassat (2021)

Design-construction phase problems

The thirty-five (35) interface problems that exist throughout the interface of the design-construction phases of a construction project are collected under this heading.

Actually, this is not an exact phase of a construction project. It is an interface point of these two main phases, the design and construction phases. Because of this, the problems that are encountered at this stage are mostly about the management system of the project or official processes.

The problems, that professionals face during both the design and construction phases in construction projects, are listed at Table 2.4.

Table 2.4 : Design-construction interface problems that determined at design-construction phase.

Nu.	Phases / Problems	References
1	Building codes	Arain (2002), Arain and Assaf (2007)
2	Governmental regulations	Arain (2002), Arain and Assaf (2007)
3	Lack of professional experience & judgement	Arain (2002), Abu-Reishah and Hiyassat (2021)
4	Obstinate nature of participants	Arain (2002), Arain and Assaf (2007)
5	Participant's honest wrong beliefs	Arain (2002), Arain and Assaf (2007)
6	Unforeseen problems	Arain (2002), Arain and Assaf (2007)
7	Design omission	Arain (2002), Arain and Assaf (2007)
8	Type of contract with the owner	Arain (2002)
9	Involvement of contractor as consultant	Arain (2002), Arain and Assaf (2007)

Table 2.4 (continued): Design-construction interface problems that determined at design-construction phase.

Nu.	Phases / Problems	References
10	Lack of buildability (constructability) studies	AL Mousli and El-Sayegh (2016), Arain and Assaf (2007), Arain (2002)
11	Delay in approvals by government authorities	AL Mousli and El-Sayegh (2016)
12	Conflicts due to cultural differences	AL Mousli and El-Sayegh (2016), Arain (2002)
13	Poorly written contract & vague contract details	AL Mousli and El-Sayegh (2016), Abu-Reishah and Hiyassat (2021), Nasssar (2018), Al-Hammad (2000), Huang et al. (2008)
14	Design Complexity	Arain and Assaf (2007), Arain (2002)
15	Lack of Professionals Experience and Judgement	Arain and Assaf (2007), AL Mousli and El-Sayegh (2016)
16	Economic Situation	Arain and Assaf (2007), Arain (2002)
17	Fast Track Construction	Arain and Assaf (2007), Arain (2002)
18	Weather Conditions	Arain and Assaf (2007), Arain (2002)
19	Nationalities of Participants	Arain and Assaf (2007)
20	Poor exchange of information leads to rework and change order	Arain and Assaf (2007), Arain (2002), AL Mousli and El-Sayegh (2016), Abu-Reishah and Hiyassat (2021)
21	Preparation and Approval of Shop Drawings	Arain and Assaf (2007), Arain (2002)
22	Personal Conflicts of Professionals	Arain and Assaf (2007), Arain (2002)
23	Incompetence of professional project management as individual service	Arain and Assaf (2007), Arain (2002), AL Mousli and El-Sayegh (2016), Abu-Reishah and Hiyassat (2021)
24	Inadequate choice of project contract type (Lump sum, unit price, etc.)	Abu-Reishah and Hiyassat (2021), Nasssar (2018)
25	Inadequate choice of project delivery system (deign-bid-build, etc.)	Abu-Reishah and Hiyassat (2021), Arain and Assaf (2007), Arain (2002), Nasssar (2018)
26	Delay in shop drawings, change orders and permits acceptance and inquiries	Abu-Reishah and Hiyassat (2021)
27	Unrealistic client expectations regarding project time, cost and quality	Nasssar (2018), Abu-Reishah and Hiyassat (2021)
28	Poor project management	Chen et al. (2008)
29	Poorly done planning and scheduling	Chen et al. (2008), Abu-Reishah and Hiyassat (2021)
30	Poor interface management	Chen et al. (2008)
31	Conflict resolution	Marzuki et al. (2019)
32	Incapability to predict and resolve project's problems related to new technological techniques	Nasssar (2018)
33	Violating conditions of the contract	Al-Hammad (2000)
34	Inconsistent planning	Huang et al. (2008)
35	Quality of design/contract documents	Marzuki et al. (2019)

According to Shokri et al. (2016), managing the interactions between stakeholders is one of the problems confronting today's fragmented projects (AL Mousli and El-Sayegh, 2016). According to Elmualim and Gilder (2014), the fragmentation and lack of coordination among contractual parties are the primary causes of the challenges facing the construction sector (AL Mousli and El-Sayegh, 2016).

The lack of data was the main issue with the design. The construction sector and other stakeholders in the design phase were not given adequate information on time by the designers.

This instance demonstrated how the designers' own work was not planned with the information needs of their internal clients in mind (Alarcon and Mardones, 1998). The results also demonstrated that many of these elements are connected to already-existing project management practices, such as resource allocation, schedule control, and quality management (Chen et al. 2008).

As it has been studied and analyzed many times in the literature, the most important design-construction interface problems and the least important ones are examined through studies.

In the study of Arain and Assaf (2007), the following references of problems are founded as the most important ones: “contractor’s lack of comprehension of drawing details and specifications”, “involvement of the contractor as a consultant”, “time limitation in the design phase”, “design complexity and participants’ honest wrong beliefs”. According to Choudhry and Azhar (2017), the top three significant causes of discrepancies are the “provision of incomplete data to designers”, “lack of interest by approving authorities to carefully check the design”, and “owner-proposed changes due to financial problems”. In another study, “the involvement of the designer as a consultant”, “communication gap between constructor and designer”, “insufficient working drawing details”, “lack of coordination between parties”, “lack of human resources in design firm”, “lack of designer’s knowledge of available materials and equipment”, and “incomplete plans and specifications” were seen as the primary reasons of the inconsistent project design and construction interface (Arain et al., 2006).

In the study of Arain and Assaf (2007), the following sources of problems are founded as the least important ones: “project management as individual professional service”, “weather conditions”, “unforeseen problems”, “involvement of the contractor in the conceptual design phase”, “involvement of the contractor in the design development phase”. Some of the least major recognized sources of discrepancies include the “nationality of participants”, “the appointment of the designer as a consultant”, and “the appointment of the contractor as a designer” (Choudhry and Azhar, 2017). According to Arain et al. (2006), “project management as a professional service”, “weather conditions”, “nationalities of participants”, “involvement of the contractor in design conceptual phase”, “unforeseen problems”, “involvement of the contractor in design development phase”, and “government regulations” found as the least important problems.

3. RESEARCH METHODOLOGY

This chapter describes the research methodology, questionnaire design and data collection. The comprehensive literature review established the foundation for the questionnaire design, which served as the research tool. Data were collected by distributing the questionnaire to the design and construction professionals who work as a client, consultant, and/or contractor. The responses were statistically analyzed and presented.

3.1 Research Design

The purpose of this research is to investigate the causes and impacts of design-construction interface problems in construction projects and recommend strategies to eliminate them. General framework of the research can be seen in below Figure 3.1.

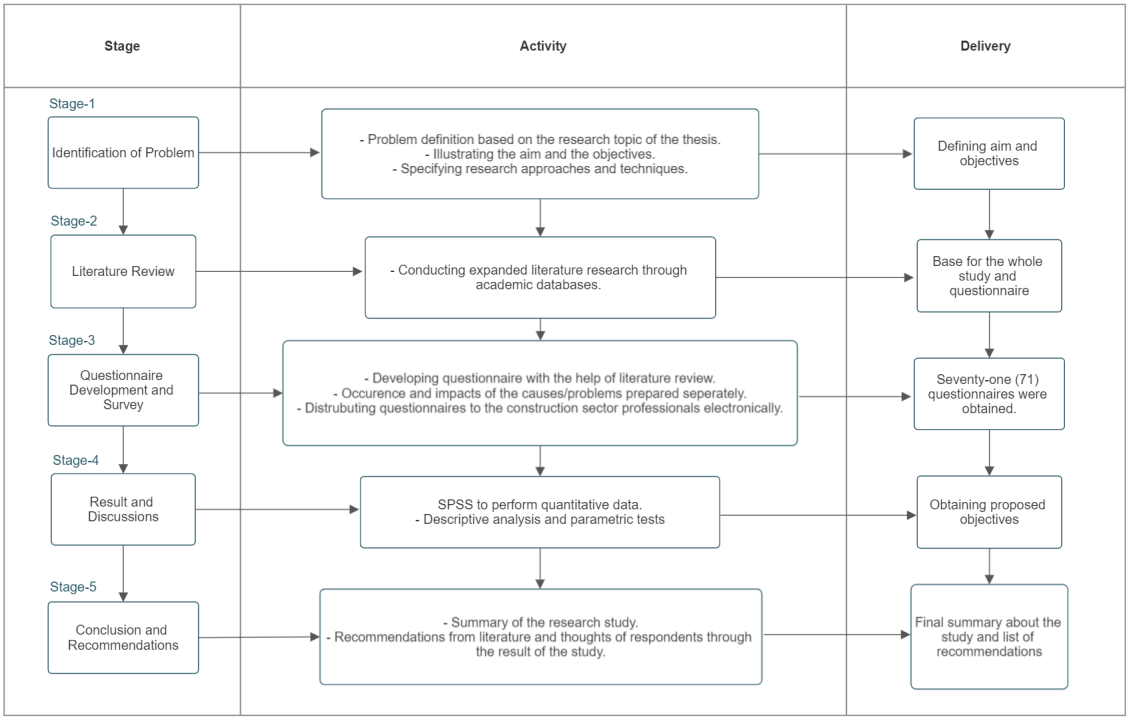

Figure 3.1 : Research Methodology Framework.

3.1.1 First stage: Identification of problem

A problem definition has been made in a way that shows the research topic of the thesis. Then, the aim and main objectives were identified. Adopted research methodology was chosen.

3.1.2 Second stage: Literature review

Previous studies were studied through a comprehensive literature review. Ninety-one (91) causes of design-construction interface problems were collected from the reviewed literature. This part was detailed in the relevant section.

3.1.3 Third stage: Questionnaire design

In the context of the literature review, relevant data were gathered and analyzed to get the final usable data for the questionnaire survey. As a result, the questionnaire was designed by considering the collected design-interface problems from the literature. The occurrence and impacts of the design-interface problems were questioned separately. The questionnaire was sent to design and construction professionals who work as a client, consultant, and/or contractor. In total, seventy-one (71) responses were obtained.

In this study, the client is the operator, owner, or employer of the project. The contractor is the project's constructor with whom the owner has had a construction contract. The consultant is the project's designer or engineer, with whom the owner has contracted to provide professional services.

3.1.4 Fourth stage: Results and discussions

The statistical package for the Social Sciences (SPSS) was employed to analyse the data gathered from the questionnaire. The mentioned statistical instruments were used in this study:

1. Cronbach's Alpha for Reliability Statistics.
2. Frequency and Descriptive Analysis.
3. Relative Importance Index (RII).
4. Test of Normality (Skewness-Kurtosis Normality Test).
5. One-way ANOVA.

6. Levene's Test for Homogeneity.

7. Post-Hoc Analysis (Tukey and Gabriel Tests and Games-Howell Test).

3.1.5 Fifth stage: Conclusion and recommendations

In this step of the research, conclusions and recommendations were given. It presented the outcomes with related objectives, identified problem areas from the results, and recommended appropriate strategies.

3.2 Data Sources / Data Collection

The data collection methods used in this study are described in this section.

3.2.1 Literature study

A comprehensive literature review was conducted through academic research portals, databases, and relevant data were gathered from the journal papers, websites, publishings, dissertations, and conference proceedings.

3.2.2 Questionnaire

The literature review provided guidance for the questionnaire design. More than 250 problems were found in the literature. Some of them were combined according to their similarity. The most common and most occurred problems were included in the final version of the questionnaire.

The final version of the questionnaire was shared with the design and construction professionals. To reach both national and international professionals, the questionnaire was prepared in both Turkish and English languages. Questions were prepared by using a 5-point Likert scale. An open-ended question was also included to learn the perspectives of professionals on minimizing the impact of the design-construction interface problems.

The questionnaire was arranged into four (4) sections as listed below:

Section 1: General information of the professionals

Section 2: Factors causing the design - construction interface problems (the degree of occurrence)

Section 3: Factors causing the design - construction interface problems (the importance)

Section 4: Recommendations, Suggestions, Comments

The first section includes multiple-choice questions. It searches company type, respondent's position in the company and year of experience. In the second and third sections of the questionnaire, the occurrence and impacts of the design-construction interface problems were investigated. These sections were divided into four sections under the titles of: design phase problems, tendering phase problems, construction phase problems and design-construction phase problems. In these two sections, the questionnaire used a 5-point Likert-type scale to facilitate statistical analysis (5 = extremely important, 4 = very important, 3 = moderately important, 2 = slightly important, and 1 = not important). And finally, in the fourth section of the questionnaire, the question was prepared as an open-ended one and asked for professional's recommendations and comments on the solutions for the aforementioned problems. One hundred ninety (190) questionnaires were distributed and seventy-one (71) responses were returned. Thus, the participation rate was %37,5.

3.3 Data Analysis

All of the analyzes that were used in this research are shown in Figure 3.2 below and explained under the following headings.

3.3.1 Reliability analysis

The Cronbach's Alpha Method is a popular indication of reliability analysis. Cronbach's Alpha is being used to calculate questionnaire reliability within each field and across all areas of the questionnaire. The Cronbach's Coefficient Alpha Value should be between 0.0 and +1.0. According to Pallant (2013), higher values indicate a better level of reliability. The Cronbach's Alpha for the entire questionnaire is 0.99, indicating that it is quite reliable.

3.3.2 Frequency and descriptive analysis

It is usual practice to summarize data frequency or central tendency measures using descriptive statistics (mean, median and mode). A descriptive statistics technique called frequency analysis displays the frequency of each response that respondents

selected. To aid users in analyzing the data and drawing conclusions, SPSS Statistics may additionally compute the mean, median, and mode when frequency analysis is used.

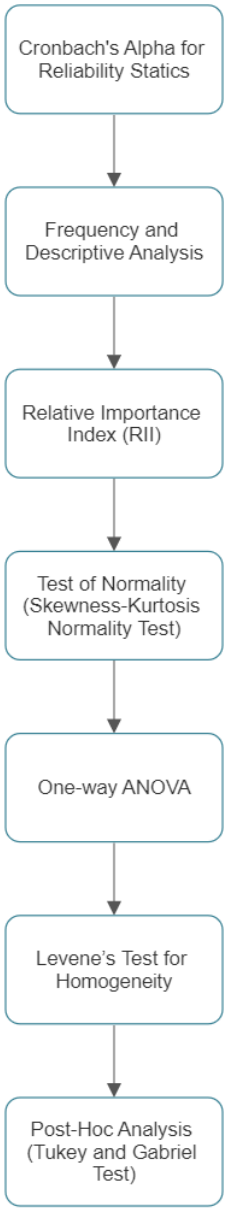

Figure 3.2 : Analysis Structure.

3.3.3 Relative importance index (RII)

All factors' rankings are calculated using the RII, or relative weight, which was determined in the formula 3.1 below (Field, 2009).

$$\text{Relative importance index method (RII)} = \frac{\sum w}{AN} = \frac{5n_5+4n_4+3n_3+2n_2+1n_1}{5N} \quad (3.1)$$

W is for the respondent's weighting of each component, which ranged from 1 to 5. (n1 is the number of responses “very low” and n5 is for “very high”.)

N is the total number of participants.

The RII value ranged from 0 to 1, and the higher the value, the more significant the feature.

3.3.4 Test of normality (Skewness-Kurtosis normality test)

The Skewness-Kurtosis normality distribution test was used to determine whether the data were normally distributed. According to Tabachnick and Fidell (2013), kurtosis-skewness values should be between +1.5 and -1.5 in a normal distribution.

If the variables were normally distributed, the use of parametric tests therefore becomes possible. At this point, One-way ANOVA test is chosen.

3.3.5 One-way ANOVA

If it is desired to compare more than two independent groups, the One-way ANOVA test can be applied. Interval scale variables would be approximately normally distributed if the parametric restrictions were met.

3.3.6 Levene’s test for homogeneity

Post-hoc analyses were carried out to determine which groups were responsible for the difference after ANOVA testing revealed a statistically significant difference between groups with p-values under 0.05. Measuring the homogeneity of variances is important to determine which post-hoc test can be applied.

3.3.7 Post-Hoc analysis

After finding a statistically significant result, further post-hoc analysis can be used to show where the differences came from. The Gabriel's and Tukey tests and Games-Howell test were used in this research.

4. DATA ANALYSIS, RESULTS AND DISCUSSIONS

4.1 Data Analysis

This section analyzes the results that were gained from the survey of seventy-one (71) questionnaires. The questionnaires were analyzed using Statistical package for the Social Sciences (SPSS).

4.1.1 General information

This section gives general information about respondents in terms of the type of their organization / company, their position and their years of experience.

As shown in Table 4.1, %16,9 of the respondents are working in a Consulting organization/company, %64,8 of them are in a Contractor company and %18,3 of them are in a Designer company.

Table 4.1 : Respondent's general information.

General Information	Frequency (No.)	Percentage (%)
Type of Organization, Company		
Consulting	12	16,9
Contractor	46	64,8
Designer	13	18,3
Position in the Organization, Company		
Architect	23	32,4
Engineer, Project Engineer	17	23,9
Project Manager, Deputy	15	21,1
Site, Office Engineer	5	7,0
Others	11	15,5
Years of Experience		
Less than 5 years	13	18,3
From 5 years to less than 10 years	18	25,4
From 10 years to less than 15 years	10	14,1
15 years and over	30	42,3

It is clear from Table 4.1, %32,4 of the respondents are working as Architects, %23,9 of them are Engineers or Project Engineers, %21,1 of them are Project Managers or Deputies, %7,0 of them are Site or Office Engineers, and %15,5 of them are collected in the Other group which have less than 5 responses. Other group includes Internal Audit, Real Estate Developer etc.

Also, Table 4.1 shows that %18,3 of the respondents have less than 5 years of experience, %25,4 of them have years of an experience from 5 years to 10 years, %14,1 of them have years of an experience from 10 years to 15 years, and %42,3 of the respondents have experience more than 15 years.

4.1.2 Analysis of factors causing the design-construction interface problems

It is aimed to analyze the participants' perceptions of the design-construction interface problems according to their causes. The occurrence and importance of the causes were analyzed as separate variables. To manage this, several statistical analyzes were carried out.

After the reliability analysis of the questionnaire is validated, some frequency and descriptive analyses were performed. While looking at the values of variables, the Skewness-Kurtosis normality test also was applied to check out whether the data were normally distributed.

Table 4.2 shows mean scores, standard deviations, and Skewness-Kurtosis values of design phase problems according to occurrence factor.

Table 4.2 : Descriptive analysis of design phase problems (occurrence).

Causes	Mean	Std. Deviation	Skewness	Kurtosis
PD1 - Involvement of the contractor in design conceptual phase	2,76	1,048	0,271	-0,470
PD2 - Involvement of the contractor in design development phase	3,06	1,027	0,211	-0,483
PD3 - Lack of stipulated data	3,68	0,841	-0,356	-0,327
PD4 - Delay in construction documents preparation	3,59	0,919	-0,221	-0,720
PD5 - Lack of human resources for design firm	3,32	0,982	-0,420	-0,613
PD6 - Time limitation in design phase	3,96	0,948	-0,639	-0,431
PD7 - Lack of contractor involvement during the design phase	2,97	1,146	0,115	-0,888
PD8 - Lack of proper coordination between various disciplines of design team	3,68	1,053	-0,293	-1,087
PD9 - Unstable owner requirements	3,86	0,883	-0,613	0,483

Table 4.2 (continued): Descriptive analysis of design phase problems (occurrence).

Causes	Mean	Std. Deviation	Skewness	Kurtosis
PD10 - Contractor is not involved in the conceptual phase of design	3,07	1,033	-0,304	-0,407
PD11 - Contractor is not involved in the development phase of design	3,20	1,009	-0,497	-0,238
PD12 - Data provided to designer are incomplete	3,34	1,082	-0,090	-0,864
PD13 - Data provided to designer are incorrect	3,15	1,091	0,159	-0,712
PD14 - Data is provided late to designer	3,39	1,021	-0,120	-0,842
PD15 - Designer busy in too many assignments	3,65	0,927	-0,006	-0,888
PD16 - Lack of awareness about governmental regulations, municipality requirements, statues and their modifications	3,41	0,904	0,042	-0,744
PD17 - Designer's knowledge is lacking in constructability of design	3,11	1,090	0,111	-0,866
PD18 - Lack of awareness about the availability of construction materials and equipment in the local market	3,13	0,955	-0,260	-0,540
PD19 - Designer's knowledge is lacking on engineering design technique and software	3,06	1,013	0,140	-0,877
PD20 - Frequent replacement of designer by the owner	2,85	1,154	0,369	-0,632
PD21 - Personal and social problems of designer	2,30	1,047	0,678	0,171
PD22 - Lack of reward, delayed payment or less payment to designer by owner	3,28	1,058	0,077	-0,708
PD23 - Too little time is given to designer for completion of the design documents	3,68	1,025	-0,452	-0,214
PD24 - Lack of project planning and analysis by owner at the project start	3,70	1,034	-0,729	0,308
PD25 - Frequent changes in the design due to owner dis-satisfaction	3,52	0,892	-0,376	-0,067
PD26 - Approving authorities do not check carefully that the structure is designed according to the building bye-laws, codes and government rules	2,94	1,145	0,465	-0,698
PD27 - Lack of awareness about the construction knowledge and ongoing site operations	3,04	0,963	0,112	-0,249
PD28 - Inaccurate estimation of project element costs and quantities	3,45	0,938	-0,281	-0,429
PD29 - Lack of design quality assurance practices	3,34	0,970	-0,154	-0,308
PD30 - Unclear definition for scope of work	3,10	1,002	-0,115	-0,387
PD31 - Mistakes and discrepancies in design documents	3,34	0,985	-0,086	-0,351
PD32 - Insufficient or inaccurate geotechnical investigation	2,96	1,061	0,234	-0,664
PD33 - Outsourcing of design services	2,82	0,990	-0,074	-0,516
PD34 - Involvement of the designer as a consultant	2,99	0,902	-0,332	0,155
PD35 - Delays in design approval by owner	3,17	0,971	-0,157	-0,342
PD36 - Delays in preparing designs by design team	3,32	1,039	0,015	-0,926

Table 4.3 shows mean scores, standard deviations, and Skewness-Kurtosis values of tender phase problems according to occurrence factor.

Table 4.3 : Descriptive analysis of tender phase problems (occurrence).

Causes	Mean	Std. Deviation	Skewness	Kurtosis
PT1 - Incomplete or inaccurate design documents unintentionally provided with bidding documents	3,24	0,992	0,038	-0,458
PT2 - Incomplete or inaccurate design documents intentionally provided with bidding documents	2,63	1,149	0,591	-0,281
PT3 - Type of construction contract in use	2,90	0,897	0,076	0,215
PT4 - Contractor did not consider that the design is exotic, complex or not have the required expertise	3,06	1,132	-0,113	-0,911
PT5 - Awarding the contract to the lower bidder price regardless of the quality of service	3,93	1,087	-0,682	-0,545
PT6 - Absence of third party validation during defect liability period	3,42	1,065	-0,486	-0,221
PT7 - Inappropriate work packaging and subcontracting	3,66	1,082	-0,537	-0,467
PT8 - Restricting the contractor classification and a specific experience for the subcontractors in the contract form by the client	3,00	0,956	0,000	-0,154
PT9 - Inadequate study for tender document to observe discrepancies before tender awarding	3,39	1,127	-0,529	-0,467

Table 4.4 shows mean scores, standard deviations, and Skewness-Kurtosis values of construction phase problems according to occurrence factor.

Table 4.4 : Descriptive analysis of construction phase problems (occurrence).

Causes	Mean	Std. Deviation	Skewness	Kurtosis
PC1 - Lack of designer knowledge of available material and equipments	3,18	0,990	-0,290	-0,620
PC2 - Complete & adequate plans and specs	3,55	1,025	-0,382	-0,697
PC3 - Insufficient working drawing details	3,76	0,978	-0,628	-0,111
PC4 - Exotic design & technology	2,80	0,821	-0,093	0,151
PC5 - Ambigious design details	3,52	0,984	-0,570	-0,133
PC6 - Lack of specialized construction manager	3,41	1,008	-0,216	-0,808
PC7 - Material changes in types & specs during construction phase	3,52	0,939	-0,276	-0,338
PC8 - Design errors	3,56	0,937	-0,189	-0,799
PC9 - Construction errors and defective work at the construction site	3,77	0,929	-0,630	0,180
PC10 - Lack of skilled or specialized human resources	3,87	0,940	-0,377	-0,777
PC11 - Designer's lack of awareness about on-going construction process	3,52	0,908	-0,536	-0,143
PC12 - Contractor's lack of comprehension of drawings details and specs	3,23	1,085	0,155	-0,835
PC13 - Involvement of designer as design consultant	2,72	0,988	0,051	-0,444
PC14 - Contractor's lack of sufficient knowledge about new technology	3,07	1,100	0,056	-0,865
PC15 - Incomplete drawings and specification	3,69	1,022	-0,411	-0,567
PC16 - Delay in material approval (submittals)	3,58	0,873	-0,377	-0,510
PC17 - Owner proposes changes because he had planned to make changes during construction	3,61	0,933	-0,208	-0,768

Table 4.4 (continued): Descriptive analysis of construction phase problems (occurrence).

Causes	Mean	Std. Deviation	Skewness	Kurtosis
PC18 - Owner proposes changes during construction due to sudden changes in his reqiurements / expactations	3,61	0,918	-0,036	-0,801
PC19 - Owner proposes changes during construction due to change in ownership	2,80	1,077	0,407	-0,403
PC20 - Owner proposes changes to assert his authority and make undue interference in construction	2,80	1,142	0,282	-0,503
PC21 - Owner proposes changes due to financial problems	3,38	1,047	-0,287	-0,114
PC22 - Slowness in decision making process by owner	3,68	0,875	-0,627	0,418
PC23 - Changes in building codes, bye-laws and government rules	2,51	0,998	0,423	0,091
PC24 - Delayed revision of drawings by designer	3,51	0,860	0,047	-0,588
PC25 - Drawings not properly stamped or certifies by designer	2,94	1,094	-0,021	-0,416
PC26 - Custody and supply of drawings at site	2,80	1,064	0,115	-0,524
PC27 - Delayed approval of drawings by owner or consultant	3,34	0,955	0,075	-0,943
PC28 - Material changes due to shortage of particular material in the market	3,01	0,933	0,080	-0,166
PC29 - Material changes due to procurement delays by contractor	3,08	0,890	0,331	-0,155
PC30 - Contractor does not follow recommended construction methods and reluctant to use proper construction equipment	3,00	0,941	0,106	-0,236
PC31 - Contractor lacks in coordination and management during construction	3,20	0,950	0,206	-0,966
PC32 - Contractor's staff facing shortage of tools and or equipment for measurement, alignment and or for adjustment at corners	2,90	1,110	0,071	-0,793
PC33 - Contractor and his staff focusing on other projects	2,93	1,060	0,292	-0,330
PC34 - Unanticipated weather conditions	2,76	0,836	-0,123	-0,608
PC35 - Unforeseen problems and differing site conditions	2,99	0,819	-0,134	-0,277
PC36 - Timing of proposed changes, i.e. whether at the start or at the end of construction	3,28	0,814	0,252	-0,328
PC37 - Approving authorities do not check carefully that the structure is constructed according to the approved building plans	3,03	0,971	0,135	-0,314
PC38 - Communication Gap between Constructor and Designer	3,37	1,111	0,123	-1,091
PC39 - Lack of Mutual Respect between Constructor and Designer	2,89	1,115	0,419	-0,568
PC40 - Lack of communication & coordination among all parties	3,42	1,215	-0,085	-1,272
PC41 - Lack of Skilled Manpower	3,69	1,090	-0,370	-0,873
PC42 - Interference of client during implementation	3,39	1,007	-0,350	-0,521
PC43 - Bad decision making	3,34	0,970	0,232	-0,878
PC44 - Lack of specialized quality control team	3,41	0,965	-0,027	-0,536
PC45 - Frequent changes of subcontractors	3,30	0,932	-0,087	-0,570
PC46 - Financial and technical status of the contractor	3,37	0,914	0,236	-0,687
PC47 - Lateness in preparing construction documents (such as schedule, detailed drawings)	3,49	0,908	0,021	-0,744

Table 4.5 shows mean scores, standard deviations, and Skewness-Kurtosis values of design-construction phase problems according to occurrence factor.

Table 4.5 : Descriptive analysis of design-construction phase problems (occurrence).

Causes	Mean	Std. Deviation	Skewness	Kurtosis
PDC1 - Building codes	2,76	0,801	0,979	1,632
PDC2 - Governmental regulations	2,90	0,864	0,467	-0,177
PDC3 - Lack of professional experience & judgement	3,24	0,902	-0,017	-1,015
PDC4 - Obstinate nature of participants	3,28	1,044	0,102	-0,932
PDC5 - Participant's honest wrong beliefs	3,20	0,965	0,276	-0,492
PDC6 - Unforeseen problems	3,38	0,900	0,128	-0,133
PDC7 - Design omission	3,17	1,028	0,137	-1,009
PDC8 - Type of contract with the owner	2,96	0,963	-0,309	0,149
PDC9 - Involvement of contractor as consultant	2,79	0,970	-0,139	-0,670
PDC10 - Lack of buildability (constructability) studies	3,20	1,090	0,070	-0,474
PDC11 - Delay in approvals by government authorities	3,23	1,058	0,350	-1,091
PDC12 - Conflicts due to cultural differences	2,49	0,969	0,408	-0,078
PDC13 - Poorly written contract & vague contract details	3,24	1,007	-0,071	0,067
PDC14 - Design Complexity	3,25	1,092	0,219	-0,768
PDC15 - Lack of Professionals Experience and Judgement	3,39	0,978	-0,025	-0,611
PDC16 - Economic Situation	3,80	0,950	-0,206	-0,966
PDC17 - Fast Track Construction	3,97	0,925	-0,500	-0,656
PDC18 - Weather Conditions	2,76	0,902	0,017	0,115
PDC19 - Nationalities of Participants	2,03	0,910	0,529	0,017
PDC20 - Poor exchange of information leads to rework and change order	3,34	1,068	-0,069	-0,790
PDC21 - Preparation and Approval of Shop Drawings	3,23	0,848	-0,021	-0,152
PDC22 - Personal Conflicts of Professionals	3,15	0,951	0,091	-0,305
PDC23 - Incompetence of professional project management as individual service	3,30	0,916	-0,172	-0,568
PDC24 - Inadequate choice of project contract type (Lump sum, unit price, etc.)	3,24	0,963	-0,504	-0,026
PDC25 - Inadequate choice of project delivery system (deign-bid-build, etc.)	3,23	0,959	-0,172	-0,089
PDC26 - Delay in shop drawings, change orders and permits acceptance and inquiries	3,37	0,960	-0,005	-0,541
PDC27 - Unrealistic client expectations regarding project time, cost and quality	3,70	0,932	-0,240	-0,762
PDC28 - Poor project management	3,63	1,018	-0,124	-1,080
PDC29 - Poorly done planning and scheduling	3,69	0,965	-0,217	-0,884
PDC30 - Poor interface management	3,38	0,868	-0,024	-0,023
PDC31 - Conflict resolution	3,20	0,950	0,001	-0,328

Table 4.5 (continued): Descriptive analysis of design-construction phase problems (occurrence).

Causes	Mean	Std. Deviation	Skewness	Kurtosis
PDC32 - Incapability to predict and resolve project's problems related to new technological techniques	3,18	0,915	0,199	0,186
PDC33 - Violating conditions of the contract	3,03	0,971	0,135	-0,314
PDC34 - Inconsistent planning	3,61	0,978	-0,447	0,013
PDC35 - Quality of design/contract documents	3,28	0,959	-0,200	0,041

Table 4.6 shows mean scores, standard deviations, and Skewness-Kurtosis values of design phase problems according to importance factor.

Table 4.6 : Descriptive analysis of design phase problems (importance).

Causes	Mean	Std. Deviation	Skewness	Kurtosis
PD1 - Involvement of the contractor in design conceptual phase	3,06	1,229	-0,110	-0,930
PD2 - Involvement of the contractor in design development phase	3,37	1,233	-0,411	-0,887
PD3 - Lack of stipulated data	3,87	1,120	-1,186	1,007
PD4 - Delay in construction documents preparation	3,89	0,887	-0,785	0,761
PD5 - Lack of human resources for design firm	3,62	1,087	-0,695	0,069
PD6 - Time limitation in design phase	3,96	0,977	-0,953	0,483
PD7 - Lack of contractor involvement during the design phase	3,25	1,092	-0,255	-0,696
PD8 - Lack of proper coordination between various disciplines of design team	4,11	0,964	-1,215	1,590
PD9 - Unstable owner requirements	3,76	1,075	-0,921	0,294
PD10 - Contractor is not involved in the conceptual phase of design	3,28	1,161	-0,351	-0,661
PD11 - Contractor is not involved in the development phase of design	3,38	1,074	-0,463	-0,386
PD12 - Data provided to designer are incomplete	3,90	1,110	-0,831	-0,149
PD13 - Data provided to designer are incorrect	4,04	1,188	-0,977	-0,256
PD14 - Data is provided late to designer	3,80	1,090	-0,955	0,302
PD15 - Designer busy in too many assignments	3,82	0,976	-0,759	0,104
PD16 - Lack of awareness about governmental regulations, municipality requirements, statues and their modifications	3,61	1,089	-0,655	0,016
PD17 - Designer's knowledge is lacking in constructability of design	3,93	1,060	-0,893	0,224
PD18 - Lack of awareness about the availability of construction materials and equipment in the local market	3,61	1,021	-0,626	0,172
PD19 - Designer's knowledge is lacking on engineering design technique and software	3,85	1,117	-0,825	0,029
PD20 - Frequent replacement of designer by the owner	3,69	1,249	-0,652	-0,565
PD21 - Personal and social problems of designer	2,89	1,141	0,227	-0,713
PD22 - Lack of reward, delayed payment or less payment to designer by owner	3,75	1,052	-0,985	0,794

Table 4.6 (continued): Descriptive analysis of design phase problems (importance).

Causes	Mean	Std. Deviation	Skewness	Kurtosis
PD23 - Too little time is given to designer for completion of the design documents	3,92	1,092	-0,979	0,445
PD24 - Lack of project planning and analysis by owner at the project start	3,80	0,995	-0,844	0,481
PD25 - Frequent changes in the design due to owner dis-satisfaction	3,79	0,970	-0,816	0,606
PD26 - Approving authorities do not check carefully that the structure is designed according to the building bye-laws, codes and government rules	3,75	1,079	-0,737	0,070
PD27 - Lack of awareness about the construction knowledge and ongoing site operations	3,80	0,995	-0,934	0,978
PD28 - Inaccurate estimation of project element costs and quantities	3,99	0,964	-0,859	0,370
PD29 - Lack of design quality assurance practices	3,59	1,050	-0,707	0,287
PD30 - Unclear definition for scope of work	3,87	0,970	-0,899	0,812
PD31 - Mistakes and discrepancies in design documents	4,06	1,081	-1,232	1,067
PD32 - Insufficient or inaccurate geotechnical investigation	3,68	1,193	-0,640	-0,487
PD33 - Outsourcing of design services	3,17	1,069	-0,203	-0,180
PD34 - Involvement of the designer as a consultant	3,41	1,129	-0,379	-0,385
PD35 - Delays in design approval by owner	3,65	0,987	-0,701	0,550
PD36 - Delays in preparing designs by design team	3,68	0,953	-0,728	0,469

Table 4.7 shows mean scores, standard deviations, and Skewness-Kurtosis values of tender phase problems according to importance factor.

Table 4.7 : Descriptive analysis of tender phase problems (importance).

Causes	Mean	Std. Deviation	Skewness	Kurtosis
PT1 - Incomplete or inaccurate design documents unintentionally provided with bidding documents	3,77	1,072	-0,750	0,155
PT2 - Incomplete or inaccurate design documents intentionally provided with bidding documents	3,96	1,152	-1,070	0,485
PT3 - Type of construction contract in use	3,44	0,982	-0,610	0,450
PT4 - Contractor did not consider that the design is exotic, complex or not have the required expertise	3,58	1,051	-0,590	-0,096
PT5 - Awarding the contract to the lower bidder price regardless of the quality of service	4,13	1,068	-1,200	0,786
PT6 - Absence of third party validation during defect liability period	3,68	0,982	-0,604	0,164
PT7 - Inappropriate work packaging and subcontracting	3,94	1,027	-1,026	0,672
PT8 - Restricting the contractor classification and a specific experience for the subcontractors in the contract form by the client	3,65	1,001	-0,728	0,452
PT9 - Inadequate study for tender document to observe discrepancies before tender awarding	3,92	0,952	-0,951	1,074

Table 4.8 shows mean scores, standard deviations, and Skewness-Kurtosis values of construction phase problems according to importance factor.

Table 4.8 : Descriptive analysis of construction phase problems (importance).

Causes	Mean	Std. Deviation	Skewness	Kurtosis
PC1 - Lack of designer knowledge of available material and equipments	3,89	0,887	-1,037	1,831
PC2 - Complete & adequate plans and specs	4,00	1,028	-1,298	1,909
PC3 - Insufficient working drawing details	4,17	0,862	-1,165	1,817
PC4 - Exotic design & technology	3,31	1,022	-0,497	0,085
PC5 - Ambigious design details	4,03	0,878	-0,968	1,238
PC6 - Lack of specialized construction manager	3,87	0,999	-0,889	0,581
PC7 - Material changes in types & specs during construction phase	3,62	0,868	-0,381	0,213
PC8 - Design errors	4,17	0,956	-1,561	3,086
PC9 - Construction errors and defective work at the construction site	4,10	0,973	-1,254	1,622
PC10 - Lack of skilled or specialized human resources	4,04	1,020	-1,083	0,851
PC11 - Designer's lack of awareness about on-going construction process	3,77	1,031	-0,817	0,509
PC12 - Contractor's lack of comprehension of drawings details and specs	3,96	1,139	-1,108	0,628
PC13 - Involvement of designer as design consultant	3,51	1,081	-0,787	0,135
PC14 - Contractor's lack of sufficient knowledge about new technology	3,63	1,059	-0,771	0,338
PC15 - Incomplete drawings and specification	4,08	1,025	-1,075	0,446
PC16 - Delay in material approval (submittals)	3,87	1,027	-1,041	0,962
PC17 - Owner proposes changes because he had planned to make changes during construction	3,77	1,003	-0,752	0,282
PC18 - Owner proposes changes during construction due to sudden changes in his reqiurements / expactations	3,75	1,024	-0,698	0,059
PC19 - Owner proposes changes during construction due to change in ownership	3,70	1,061	-0,557	-0,313
PC20 - Owner proposes changes to assert his authority and make undue interference in construction	3,86	1,112	-0,868	0,121
PC21 - Owner proposes changes due to financial problems	3,87	1,081	-0,927	0,403
PC22 - Slowness in decision making process by owner	3,87	0,940	-1,014	1,251
PC23 - Changes in building codes, bye-laws and government rules	3,59	1,178	-0,603	-0,353
PC24 - Delayed revision of drawings by designer	3,85	0,936	-1,081	1,349
PC25 - Drawings not properly stamped or certifies by designer	3,62	1,113	-0,790	0,187
PC26 - Custody and supply of drawings at site	3,35	1,243	-0,477	-0,688
PC27 - Delayed approval of drawings by owner or consultant	3,76	1,007	-0,880	0,382
PC28 - Material changes due to shortage of particular material in the market	3,38	1,005	-0,399	-0,204
PC29 - Material changes due to procurement delays by contractor	3,52	0,984	-0,478	-0,142
PC30 - Contractor does not follow recommended construction methods and reluctant to use proper construction equipment	3,77	0,988	-0,715	0,334
PC31 - Contractor lacks in coordination and management during construction	3,94	1,132	-0,980	0,221
PC32 - Contractor’s staff facing shortage of tools and or equipment for measurement, alignment and or for adjustment at corners	3,68	1,156	-0,815	0,024

Table 4.8 (continued): Descriptive analysis of construction phase problems (importance).

Causes	Mean	Std. Deviation	Skewness	Kurtosis
PC33 - Contractor and his staff focusing on other projects	3,56	1,156	-0,673	-0,251
PC34 - Unanticipated weather conditions	3,14	1,099	-0,420	-0,306
PC35 - Unforeseen problems and differing site conditions	3,45	0,983	-0,463	0,116
PC36 - Timing of proposed changes, i.e. whether at the start or at the end of construction	3,76	1,021	-0,741	0,141
PC37 - Approving authorities do not check carefully that the structure is constructed according to the approved building plans	3,77	1,111	-0,759	0,174
PC38 - Communication Gap between Constructor and Designer	3,89	1,022	-0,843	0,362
PC39 - Lack of Mutual Respect between Constructor and Designer	3,75	1,192	-0,584	-0,656
PC40 - Lack of communication & coordination among all parties	4,14	0,946	-1,020	0,713
PC41 - Lack of Skilled Manpower	4,11	0,934	-0,987	0,749
PC42 - Interference of client during implementation	3,68	0,968	-0,761	0,385
PC43 - Bad decision making	3,93	1,087	-0,888	0,336
PC44 - Lack of specialized quality control team	3,82	1,004	-0,751	0,305
PC45 - Frequent changes of subcontractors	3,87	1,041	-1,069	0,897
PC46 - Financial and technical status of the contractor	3,93	0,961	-1,049	1,196
PC47 - Lateness in preparing construction documents (such as schedule, detailed drawings)	3,85	0,980	-0,896	0,701

Table 4.9 shows mean scores, standard deviations, and Skewness-Kurtosis values of design-construction phase problems according to importance factor.

Table 4.9 : Descriptive analysis of design-construction phase problems (importance).

Causes	Mean	Std. Deviation	Skewness	Kurtosis
PDC1 - Building codes	3,31	1,090	-0,311	-0,582
PDC2 - Governmental regulations	3,48	1,080	-0,364	-0,465
PDC3 - Lack of professional experience & judgement	3,92	0,996	-0,986	0,793
PDC4 - Obstinate nature of participants	3,41	1,090	-0,474	-0,155
PDC5 - Participant's honest wrong beliefs	3,41	1,022	-0,571	0,025
PDC6 - Unforeseen problems	3,65	0,927	-0,780	0,646
PDC7 - Design omission	3,93	1,060	-1,041	0,774
PDC8 - Type of contract with the owner	3,54	1,106	-0,613	-0,246
PDC9 - Involvement of contractor as consultant	3,37	1,085	-0,645	-0,055
PDC10 - Lack of buildability (constructability) studies	3,72	1,003	-0,714	0,177
PDC11 - Delay in approvals by government authorities	3,56	1,038	-0,607	-0,035
PDC12 - Conflicts due to cultural differences	2,96	1,188	-0,022	-0,874
PDC13 - Poorly written contract & vague contract details	3,75	0,996	-0,893	0,822
PDC14 - Design Complexity	3,72	1,071	-0,627	-0,297

Table 4.9 (continued): Descriptive analysis of design-construction phase problems (importance).

Causes	Mean	Std. Deviation	Skewness	Kurtosis
PDC15 - Lack of Professionals Experience and Judgement	3,90	0,973	-1,041	1,054
PDC16 - Economic Situation	4,01	0,978	-1,159	1,338
PDC17 - Fast Track Construction	3,94	1,054	-0,864	0,208
PDC18 - Weather Conditions	3,08	1,038	-0,488	-0,385
PDC19 - Nationalities of Participants	2,48	1,119	0,086	-0,874
PDC20 - Poor exchange of information leads to rework and change order	3,86	0,867	-0,803	0,939
PDC21 - Preparation and Approval of Shop Drawings	3,76	1,035	-0,932	0,586
PDC22 - Personal Conflicts of Professionals	3,38	1,087	-0,266	-0,646
PDC23 - Incompetence of professional project management as individual service	3,92	1,025	-1,057	1,057
PDC24 - Inadequate choice of project contract type (Lump sum, unit price, etc.)	3,75	0,996	-0,893	0,822
PDC25 - Inadequate choice of project delivery system (deign-bid-build, etc.)	3,70	0,977	-0,787	0,395
PDC26 - Delay in shop drawings, change orders and permits acceptance and inquiries	3,79	0,999	-0,975	0,970
PDC27 - Unrealistic client expectations regarding project time, cost and quality	3,94	0,954	-1,204	2,019
PDC28 - Poor project management	4,11	1,115	-1,308	1,019
PDC29 - Poorly done planning and scheduling	4,04	1,114	-1,170	0,714
PDC30 - Poor interface management	3,77	1,072	-1,037	0,750
PDC31 - Conflict resolution	3,77	1,085	-1,053	0,667
PDC32 - Incapability to predict and resolve project's problems related to new technological techniques	3,82	0,976	-0,665	0,386
PDC33 - Violating conditions of the contract	3,87	1,041	-0,990	0,778
PDC34 - Inconsistent planning	4,03	1,028	-1,114	0,869
PDC35 - Quality of design/contract documents	3,80	1,050	-0,809	0,083

The Skewness-Kurtosis values should be between +1.5 and -1.5 (Tabachnick and Fidell, 2013). For all the variables the Skewness-Kurtosis statistics are within the given range, it can be said that the data have a normal distribution. Starting from here, parametric tests can be applied for further analysis.

Before the Normality test, the Relative Importance Index (RII) was used to rank all the variables. This analysis showed that the higher the value, the more important it is. The "rank" column displays the hierarchical ordering determined by the highest mean and RII.

From Table 4.10, Table 4.11, Table 4.12, Table 4.13, Table 4.14, Table 4.15 mean scores showed that the shared design-construction interface problems in all phases are

important and frequently observed by all professional stakeholders. To see the rankings of the variables separately according to the company role as consultant, designer and contractor; RII values are investigated.

According to consultants; the mean scores of the occurrence of causes can be seen from Table 4.10 that; at design phase, “PD6-Time limitation in the design phase” becomes in the first rank and has a mean score of 4,083 and followed by “PD8-Lack of proper coordination between various disciplines of the design team” secondly with 4,00. At tendering phase, “PT5-Awarding the contract to the lower bidder price regardless of the quality of service” is in the first place with 4,250 mean score and in the second line “PT7-Inappropriate work packaging and subcontracting” comes with 4,083 mean score. At the construction phase, “PC15-Incomplete drawings and specification” and “PC9-Construction errors and defective work at the construction site” have 4,333 mean score and in the first place together, “PC22-Slowness in decision making process by owner” comes in the second line with the 4,250 mean score. At the design-construction phase, “PDC16-Economic Situation” is found in the first line and has 4,667 mean score. After that, “PDC17-Fast Track Construction” and “PDC28-Poor project management” come together with 4,33 mean score as the second.

Table 4.10 : Comparison of the significance based on company role: Consultant (occurrence).

No	Category	Design-Construction Interface Problems	RII	Rank
1	Design phase	PD6 - Time limitation in design phase	0,817	1
2		PD8 - Lack of proper coordination between various disciplines of design team	0,800	2
3		PD23 - Too little time is given to designer for completion of the design documents	0,767	3
4		PD25 - Frequent changes in the design due to owner dis-satisfaction	0,750	4
5		PD3 - Lack of stipulated data	0,750	4
6		PD16 - Lack of awareness about governmental regulations, municipality requirements, statues and their modifications	0,733	5
7		PD20 - Frequent replacement of designer by the owner	0,733	5
8		PD24 - Lack of project planning and analysis by owner at the project start	0,733	5
9	Tendering phase	PT5 - Awarding the contract to the lower bidder price regardless of the quality of service	0,850	1
10		PT7 - Inappropriate work packaging and subcontracting	0,817	2
11		PT9 - Inadequate study for tender document to observe discrepancies before tender awarding	0,800	3
12		PT4 - Contractor did not consider that the design is exotic, complex or not have the required expertise	0,767	4

Table 4.10 (continued): Comparison of the significance based on company role: Consultant (occurrence).

No	Category	Design-Construction Interface Problems	RII	Rank
13	Construction phase	PT1 - Incomplete or inaccurate design documents unintentionally provided with bidding documents	0,733	5
14		PC15 - Incomplete drawings and specification	0,867	1
15		PC9 - Construction errors and defective work at the construction site	0,867	1
16		PC22 - Slowness in decision making process by owner	0,850	2
17		PC47 - Lateness in preparing construction documents (such as schedule, detailed drawings)	0,833	3
18		PC16 - Delay in material approval (submittals)	0,817	4
19		PC3 - Insufficient working drawing details	0,817	4
20		PC38 - Communication Gap between Constructor and Designer	0,817	4
21		PC2 - Complete & adequate plans and specs	0,800	5
22		PC24 - Delayed revision of drawings by designer	0,800	5
23		PC43 - Bad decision making	0,800	5
24		PC8 - Design errors	0,800	5
25	Design-Construction phase	PDC16 - Economic Situation	0,933	1
26		PDC17 - Fast Track Construction	0,867	2
27		PDC28 - Poor project management	0,867	2
28		PDC29 - Poorly done planning and scheduling	0,850	3
29		PDC30 - Poor interface management	0,833	4
30		PDC20 - Poor exchange of information leads to rework and change order	0,817	5

Considering the importance of the variables at the design phase, values can be seen at Table 4.11, “PD8-Lack of proper coordination between various disciplines of the design team” becomes in the first rank with 4,417 mean score and after that, as the second “PD15-Designer busy in too many assignments” comes with 4,250 mean score. At tendering phase, “PT5-Awarding the contract to the lower bidder price regardless of the quality of service” and “PT9-Inadequate study for the tender document to observe discrepancies before tender awarding” are in the first place together with 4,500 mean score and in the second line “PT2-Incomplete or inaccurate design documents intentionally provided with bidding documents” comes with 4,250 mean score. At the construction phase, “PC9-Construction errors and defective work at the construction site” has 4,583 mean score in the first line and after that, “PC24-Delayed revision of drawings by designer” comes in the second line with the 4,417 mean score. At the design-construction phase, “PDC16-Economic Situation” is found in the first line with 4,583 mean score and “PDC28-Poor project management”, “PDC29-Poorly done planning and scheduling” and “PDC34-Inconsistent planning” come after that with 4,417 mean score as the second.

Table 4.11 : Comparison of the significance based on company role: Consultant (importance).

No	Category	Design-Construction Interface Problems	RII	Rank
1	Design phase	PD8 - Lack of proper coordination between various disciplines of design team	0,883	1
2		PD15 - Designer busy in too many assignments	0,850	2
3		PD23 - Too little time is given to designer for completion of the design documents	0,850	2
4		PD12 - Data provided to designer are incomplete	0,833	3
5		PD24 - Lack of project planning and analysis by owner at the project start	0,833	3
6		PD3 - Lack of stipulated data	0,833	3
7		PD31 - Mistakes and discrepancies in design documents	0,833	3
8		PD13 - Data provided to designer are incorrect	0,817	4
9		PD14 - Data is provided late to designer	0,817	4
10		PD4 - Delay in construction documents preparation	0,817	4
11		PD9 - Unstable owner requirements	0,817	4
12		PD17 - Designer's knowledge is lacking in constructability of design	0,800	5
13		PD22 - Lack of reward, delayed payment or less payment to designer by owner	0,800	5
14		PD27 - Lack of awareness about the construction knowledge and ongoing site operations	0,800	5
15		PD28 - Inaccurate estimation of project element costs and quantities	0,800	5
16		PD30 - Unclear definition for scope of work	0,800	5
17		PD6 - Time limitation in design phase	0,800	5
18	Tendering phase	PT5 - Awarding the contract to the lower bidder price regardless of the quality of service	0,900	1
19		PT9 - Inadequate study for tender document to observe discrepancies before tender awarding	0,900	1
20		PT2 - Incomplete or inaccurate design documents intentionally provided with bidding documents	0,850	2
21		PT1 - Incomplete or inaccurate design documents unintentionally provided with bidding documents	0,800	3
22		PT4 - Contractor did not consider that the design is exotic, complex or not have the required expertise	0,800	3
23		PT8 - Restricting the contractor classification and a specific experience for the subcontractors in the contract form by the client	0,800	3
24		PT7 - Inappropriate work packaging and subcontracting	0,783	4
25		PT6 - Absence of third party validation during defect liability period	0,767	5
26	Construction phase	PC9 - Construction errors and defective work at the construction site	0,917	1
27		PC24 - Delayed revision of drawings by designer	0,883	2
28		PC8 - Design errors	0,883	2
29		PC16 - Delay in material approval (submittals)	0,867	3
30		PC3 - Insufficient working drawing details	0,867	3
31		PC40 - Lack of communication & coordination among all parties	0,867	3
32		PC47 - Lateness in preparing construction documents (such as schedule, detailed drawings)	0,867	3
33		PC15 - Incomplete drawings and specification	0,850	4
34		PC2 - Complete & adequate plans and specs	0,850	4
35		PC22 - Slowness in decision making process by owner	0,850	4
36		PC10 - Lack of skilled or specialized human resources	0,833	5
37		PC12 - Contractor's lack of comprehension of drawings details and specs	0,833	5

Table 4.11 (continued): Comparison of the significance based on company role: Consultant (importance).

No	Category	Design-Construction Interface Problems	RII	Rank
38	Design-Construction phase	PC38 - Communication Gap between Constructor and Designer	0,833	5
39		PDC16 - Economic Situation	0,917	1
40		PDC28 - Poor project management	0,883	2
41		PDC29 - Poorly done planning and scheduling	0,883	2
42		PDC34 - Inconsistent planning	0,883	2
43		PDC15 - Lack of Professionals Experience and Judgement	0,833	3
44		PDC20 - Poor exchange of information leads to rework and change order	0,833	3
45		PDC27 - Unrealistic client expectations regarding project time, cost and quality	0,833	3
46		PDC7 - Design omission	0,833	3
47		PDC23 - Incompetence of professional project management as individual service	0,817	4
48		PDC25 - Inadequate choice of project delivery system (deign-bid-build, etc.)	0,817	4
49		PDC30 - Poor interface management	0,817	4
50		PDC33 - Violating conditions of the contract	0,817	4
51		PDC10 - Lack of buildability (constructability) studies	0,800	5
52		PDC13 - Poorly written contract & vague contract details	0,800	5
53		PDC21 - Preparation and Approval of Shop Drawings	0,800	5
54		PDC26 - Delay in shop drawings, change orders and permits acceptance and inquiries	0,800	5
55		PDC31 - Conflict resolution	0,800	5
56		PDC35 - Quality of design/contract documents	0,800	5

According to contractors; the mean scores of the occurrence of causes can be seen at Table 4.12, at the design phase, “PD6-Time limitation in the design phase” becomes in the first rank and has a mean score of 3,870 and followed by “PD9-Unstable owner requirements” secondly with 3,848. At tendering phase, “PT5-Awarding the contract to the lower bidder price regardless of the quality of service” is in the first place with 3,783 mean score and in the second line “PT7-Inappropriate work packaging and subcontracting” comes with 3,500 mean score. At the construction phase, “PC10-Lack of skilled or specialized human resources” is in the first place with 3,696 mean score and in the second line “PC5-Ambigious design details” and “PC9-Construction errors and defective work at the construction site” are together with 3,630 mean score. At the design-construction phase, “PDC17-Fast Track Construction” becomes in the first rank and has a mean score of 3,957 and followed by “PDC27-Unrealistic client expectations regarding project time, cost and quality” secondly with 3,587.

Table 4.12 : Comparison of the significance based on company role: Contractor (occurence).

No	Category	Design-Construction Interface Problems	RII	Rank
1	Design phase	PD6 - Time limitation in design phase	0,774	1
2		PD9 - Unstable owner requirements	0,770	2
3		PD8 - Lack of proper coordination between various disciplines of design team	0,739	3
4		PD24 - Lack of project planning and analysis by owner at the project start	0,730	4
5		PD4 - Delay in construction documents preparation	0,726	5
6	Tendering phase	PT5 - Awarding the contract to the lower bidder price regardless of the quality of service	0,757	1
7		PT7 - Inappropriate work packaging and subcontracting	0,700	2
8		PT6 - Absence of third party validation during defect liability period	0,665	3
9		PT9 - Inadequate study for tender document to observe discrepancies before tender awarding	0,643	4
10		PT1 - Incomplete or inaccurate design documents unintentionally provided with bidding documents	0,622	5
11	Construction phase	PC10 - Lack of skilled or specialized human resources	0,739	1
12		PC3 - Insufficient working drawing details	0,726	2
13		PC41 - Lack of Skilled Manpower	0,726	2
14		PC9 - Construction errors and defective work at the construction site	0,704	3
15		PC17 - Owner proposes changes because he had planned to make changes during construction	0,704	3
16		PC18 - Owner proposes changes during construction due to sudden changes in his reqiurements / expactations	0,704	3
17		PC15 - Incomplete drawings and specification	0,700	4
18		PC22 - Slowness in decision making process by owner	0,696	5
19	Design-Construction phase	PDC17 - Fast Track Construction	0,791	1
20		PDC27 - Unrealistic client expectations regarding project time, cost and quality	0,717	2
21		PDC16 - Economic Situation	0,709	3
22		PDC29 - Poorly done planning and scheduling	0,700	4
23		PDC34 - Inconsistent planning	0,687	5

Considering the importance of the variables, values can be seen at Table 4.13, at the design phase, “PD8-Lack of proper coordination between various disciplines of the design team” becomes in the first rank with 3,957 mean score and after that, as the second “PD31-Mistakes and discrepancies in design documents” comes with 3,848 mean score. At tendering phase, “PT5-Awarding the contract to the lower bidder price regardless of the quality of service” and “PT7-Inappropriate work packaging and subcontracting” are in the first place together with 3,891 mean score and in the second line “PT2-Incomplete or inaccurate design documents intentionally provided with bidding documents” comes with 3,717 mean score. At the construction phase, “PC41-Lack of Skilled Manpower” is in the first place with 4,065 mean score and in the

second line “PC3-Insufficient working drawing details” and “PC40-Lack of communication & coordination among all parties” are together with 4,022 mean score. At the design-construction phase, “PDC17-Fast Track Construction” becomes in the first rank and has a mean score of 3,891 and followed by “PDC28-Poor project management” secondly with 3,870.

Table 4.13 : Comparison of the significance based on company role: Contractor (importance).

No	Category	Design-Construction Interface Problems	RII	Rank
1	Design phase	PD8 - Lack of proper coordination between various disciplines of design team	0,791	1
2		PD31 - Mistakes and discrepancies in design documents	0,770	2
3		PD13 - Data provided to designer are incorrect	0,765	3
4		PD28 - Inaccurate estimation of project element costs and quantities	0,765	3
5		PD4 - Delay in construction documents preparation	0,761	4
6		PD6 - Time limitation in design phase	0,761	4
7		PD17 - Designer’s knowledge is lacking in constructability of design	0,761	4
8		PD23 - Too little time is given to designer for completion of the design documents	0,743	5
9		PD30 - Unclear definition for scope of work	0,743	5
10	Tendering phase	PT5 - Awarding the contract to the lower bidder price regardless of the quality of service	0,778	1
11		PT7 - Inappropriate work packaging and subcontracting	0,778	1
12		PT2 - Incomplete or inaccurate design documents intentionally provided with bidding documents	0,743	2
13		PT1 - Incomplete or inaccurate design documents unintentionally provided with bidding documents	0,730	3
14		PT9 - Inadequate study for tender document to observe discrepancies before tender awarding	0,722	4
15		PT6 - Absence of third party validation during defect liability period	0,709	5
16	Construction phase	PC41 - Lack of Skilled Manpower	0,813	1
17		PC3 - Insufficient working drawing details	0,804	2
18		PC40 - Lack of communication & coordination among all parties	0,804	2
19		PC8 - Design errors	0,796	3
20		PC10 - Lack of skilled or specialized human resources	0,787	4
21		PC15 - Incomplete drawings and specification	0,787	4
22		PC9 - Construction errors and defective work at the construction site	0,778	5
23	Design-Construction phase	PDC17 - Fast Track Construction	0,778	1
24		PDC28 - Poor project management	0,774	2
25		PDC34 - Inconsistent planning	0,765	3
26		PDC3 - Lack of professional experience & judgement	0,761	4
27		PDC16 - Economic Situation	0,761	4
28		PDC29 - Poorly done planning and scheduling	0,761	4
29		PDC23 - Incompetence of professional project management as individual service	0,757	5
30		PDC27 - Unrealistic client expectations regarding project time, cost and quality	0,757	5

Lastly, according to designers; the mean scores of the occurence of causes can be seen at Table 4.14, at the design phase, “PD6-Time limitation in the design phase”, “PD9-Unstable owner requirements”, “PD15-Designer busy in too many assignments” are in the first place together with 4,154 mean score and after that, “PD3-Lack of stipulated data”, “PD22-Lack of reward, delayed payment or less payment to the designer by owner”, “PD24-Lack of project planning and analysis by owner at the project start” are come together as second with 3,923 means core. At tendering phase, “PT5” is in the first place with 4,154 mean score and in the second line “PT6” and “PT7” are together with 3,846 mean score. At the construction phase, “PC10” becomes in the first rank and has a mean score of 4,538 and followed by “PC9” secondly with 4,154 mean score. At the design-construction phase, “PDC34” is in the first place with 4,000 mean score and in the second line “PDC16” and “PDC28” are together with 3,923 mean score.

Table 4.14 : Comparison of the significance based on company role: Designer (occurence).

No	Category	Design-Construction Interface Problems	RII	Rank
1	Design phase	PD6 - Time limitation in design phase	0,831	1
2		PD9 - Unstable owner requirements	0,831	1
3		PD15 - Designer busy in too many assignments	0,831	1
4		PD3 - Lack of stipulated data	0,785	2
5		PD22 - Lack of reward, delayed payment or less payment to designer by owner	0,785	2
6		PD24 - Lack of project planning and analysis by owner at the project start	0,785	2
7		PD23 - Too little time is given to designer for completion of the design documents	0,769	3
8		PD25 - Frequent changes in the design due to owner dis-satisfaction	0,754	4
9		PD16 - Lack of awareness about governmental regulations, municipality requirements, statues and their modifications	0,738	5
10		PD28 - Inaccurate estimation of project element costs and quantities	0,738	5
11		PD29 - Lack of design quality assurance practices	0,738	5
12	Tendering phase	PT5 - Awarding the contract to the lower bidder price regardless of the quality of service	0,831	1
13		PT6 - Absence of third party validation during defect liability period	0,769	2
14		PT7 - Inappropriate work packaging and subcontracting	0,769	2
15		PT9 - Inadequate study for tender document to observe discrepancies before tender awarding	0,692	3
16		PT1 - Incomplete or inaccurate design documents unintentionally provided with bidding documents	0,662	4
17		PT3 - Type of construction contract in use	0,631	5

Table 4.14 (continued): Comparison of the significance based on company role: Designer (occurence).

No	Category	Design-Construction Interface Problems	RII	Rank
18	Construction phase	PC10 - Lack of skilled or specialized human resources	0,908	1
19		PC9 - Construction errors and defective work at the construction site	0,831	2
20		PC41 - Lack of Skilled Manpower	0,815	3
21		PC7 - Material changes in types & specs during construction phase	0,800	4
22		PC42 - Interference of client during implementation	0,800	4
23		PC3 - Insufficient working drawing details	0,785	5
24	Design-Construction phase	PDC34 - Inconsistent planning	0,800	1
25		PDC16 - Economic Situation	0,785	2
26		PDC28 - Poor project management	0,785	2
27		PDC15 - Lack of Professionals Experience and Judgement	0,769	3
28		PDC27 - Unrealistic client expectations regarding project time, cost and quality	0,769	3
29		PDC29 - Poorly done planning and scheduling	0,769	3
30		PDC6 - Unforeseen problems	0,754	4
31		PDC11 - Delay in approvals by government authorities	0,754	4
32		PDC20 - Poor exchange of information leads to rework and change order	0,754	4
33		PDC17 - Fast Track Construction	0,738	5
34		PDC24 - Inadequate choice of project contract type (Lump sum, unit price, etc.)	0,738	5

Considering the importance of the variables, values can be seen at Table 4.15, at the design phase, “PD13” becomes in the first rank and has a mean score of 4,769 and followed by “PD31” secondly with 4,692 mean score. At tendering phase, “PT5-Awarding the contract to the lower bidder price regardless of the quality of service” is in the first place with 4,615 mean score and in the second line “PT2-Incomplete or inaccurate design documents intentionally provided with bidding documents” comes with 4,538 mean score. At the construction phase, “PC8-Design errors” is in the first place with 4,615 mean score and in the second line “PC3-Insufficient working drawing details” and “PC5-Ambigious design details” are together with 4,538 mean score. At the design-construction phase, “PDC28-Poor project management” becomes in the first rank and has a mean score of 4,692 and is followed by “PDC29-Poorly done planning and scheduling” secondly with 4,538.

Table 4.15 : Comparison of the significance based on company role: Designer (importance).

No	Category	Design-Construction Interface Problems	RII	Rank
1	Design phase	PD13 - Data provided to designer are incorrect	0,954	1
2		PD31 - Mistakes and discrepancies in design documents	0,938	2
3		PD19 - Designer's knowledge is lacking on engineering design technique and software	0,923	3
4		PD28 - Inaccurate estimation of project element costs and quantities	0,908	4
5		PD3 - Lack of stipulated data	0,892	5
6		PD6 - Time limitation in design phase	0,892	5
7		PD12 - Data provided to designer are incomplete	0,892	5
8	Tendering phase	PT5 - Awarding the contract to the lower bidder price regardless of the quality of service	0,923	1
9		PT2 - Incomplete or inaccurate design documents intentionally provided with bidding documents	0,908	2
10		PT9 - Inadequate study for tender document to observe discrepancies before tender awarding	0,892	3
11		PT4 - Contractor did not consider that the design is exotic, complex or not have the required expertise	0,831	4
12		PT7 - Inappropriate work packaging and subcontracting	0,831	4
13		PT1 - Incomplete or inaccurate design documents unintentionally provided with bidding documents	0,800	5
14		PT6 - Absence of third party validation during defect liability period	0,800	5
15	Construction phase	PC8 - Design errors	0,923	1
16		PC3 - Insufficient working drawing details	0,908	2
17		PC5 - Ambigious design details	0,908	2
18		PC12 - Contractor's lack of comprehension of drawings details and specs	0,892	3
19		PC15 - Incomplete drawings and specification	0,892	3
20		PC31 - Contractor lacks in coordination and management during construction	0,892	3
21		PC41 - Lack of Skilled Manpower	0,892	3
22		PC1 - Lack of designer knowledge of available material and equipments	0,877	4
23		PC2 - Complete & adequate plans and specs	0,877	4
24		PC6 - Lack of specialized construction manager	0,877	4
25		PC9 - Construction errors and defective work at the construction site	0,877	4
26		PC40 - Lack of communication & coordination among all parties	0,877	4
27		PC43 - Bad decision making	0,877	4
28		PC10 - Lack of skilled or specialized human resources	0,862	5
29		PC20 - Owner proposes changes to assert his authority and make undue interference in construction	0,862	5
30		PC38 - Communication Gap between Constructor and Designer	0,862	5
31		PC44 - Lack of specialized quality control team	0,862	5
32	Design-Construction phase	PDC28 - Poor project management	0,938	1
33		PDC29 - Poorly done planning and scheduling	0,908	2
34		PDC34 - Inconsistent planning	0,877	3
35		PDC3 - Lack of professional experience & judgement	0,862	4
36		PDC7 - Design omission	0,862	4

Table 4.15 (continued): Comparison of the significance based on company role: Designer (importance).

No	Category	Design-Construction Interface Problems	RII	Rank
37		PDC14 - Design Complexity	0,862	4
38		PDC15 - Lack of Professionals Experience and Judgement	0,862	4
39		PDC27 - Unrealistic client expectations regarding project time, cost and quality	0,862	4
40		PDC33 - Violating conditions of the contract	0,862	4
41		PDC35 - Quality of design/contract documents	0,862	4
42		PDC16 - Economic Situation	0,846	5
43		PDC17 - Fast Track Construction	0,846	5
44		PDC23 - Incompetence of professional project management as individual service	0,846	5
45		PDC32 - Incapability to predict and resolve project's problems related to new technological techniques	0,846	5

From the results according to the occurrence of causes at the design phase, it can be concluded and seen from Table 4.16 that, “PD6-Time limitation in the design phase” is ranked as first in all company roles, highest RII score belongs to designers. At tendering phase, “PT5-Awarding the contract to the lower bidder price regardless of the quality of service” comes in the first line in all company roles, in this variable consultants have the highest RII score. Therefore, “PT7-Inappropriate work packaging and subcontracting” is in the second line in all company roles, also with the highest RII score in consultants.

Table 4.16 : Comparison of the significance based on company role: Overall (occurence).

No	Category	Design-Construction Interface Problems	RII	Rank	RII	Rank	RII	Rank
			Consultant		Contractor		Designer	
1	Design phase	PD6 - Time limitation in design phase	0,817	1	0,774	1	0,831	1
2		PD8 - Lack of proper coordination between various disciplines of design team	0,800	2	0,739	3		
3		PD23 - Too little time is given to designer for completion of the design documents	0,767	3				
4		PD25 - Frequent changes in the design due to owner dis-satisfaction	0,750	4			0,754	4
5		PD3 - Lack of stipulated data	0,750	4			0,785	2
6		PD16 - Lack of awareness about governmental regulations, municipality requirements, statues and their modifications	0,733	5			0,738	5
7		PD20 - Frequent replacement of designer by the owner	0,733	5				
8		PD24 - Lack of project planning and analysis by owner at the project start	0,733	5	0,730	4	0,785	2
9		PD9 - Unstable owner requirements			0,770	2	0,831	1

Table 4.16 (continued): Comparison of the significance based on company role: Overall (occurence).

No	Category	Design-Construction Interface Problems	RII	Rank	RII	Rank	RII	Rank
			Consultant		Contractor		Designer	
10		PD4 - Delay in construction documents preparation			0,726	5		
11		PD15 - Designer busy in too many assignments					0,831	1
12		PD22 - Lack of reward, delayed payment or less payment to designer by owner					0,785	2
13		PD28 - Inaccurate estimation of project element costs and quantities					0,738	5
14		PD29 - Lack of design quality assurance practices					0,738	5
15	Tendering phase	PT5 - Awarding the contract to the lower bidder price regardless of the quality of service	0,850	1	0,757	1	0,831	1
16		PT7 - Inappropriate work packaging and subcontracting	0,817	2	0,700	2	0,769	2
17		PT9 - Inadequate study for tender document to observe discrepancies before tender awarding	0,800	3	0,643	4	0,692	3
18		PT4 - Contractor did not consider that the design is exotic, complex or not have the required expertise	0,767	4				
19		PT1 - Incomplete or inaccurate design documents unintentionally provided with bidding documents	0,733	5	0,622	5	0,662	4
20		PT6 - Absence of third party validation during defect liability period			0,665	3		
21		PT3 - Type of construction contract in use					0,631	5
22	Construction phase	PC15 - Incomplete drawings and specification	0,867	1	0,700	4		
23		PC9 - Construction errors and defective work at the construction site	0,867	1	0,704	3	0,831	2
24		PC22 - Slowness in decision making process by owner	0,850	2	0,696	5		
25		PC47 - Lateness in preparing construction documents (such as schedule, detailed drawings)	0,833	3				
26		PC16 - Delay in material approval (submittals)	0,817	4				
27		PC3 - Insufficient working drawing details	0,817	4	0,726	2	0,785	5
28		PC38 - Communication Gap between Constructor and Designer	0,817	4				
29		PC2 - Complete & adequate plans and specs	0,800	5				
30		PC24 - Delayed revision of drawings by designer	0,800	5				
31		PC43 - Bad decision making	0,800	5				
32		PC8 - Design errors	0,800	5				
33		PC10 - Lack of skilled or specialized human resources			0,739	1	0,908	1
34		PC41 - Lack of Skilled Manpower			0,726	2	0,815	3
35		PC17 - Owner proposes changes because he had planned to make changes during construction			0,704	3		
36		PC18 - Owner proposes changes during construction due to sudden changes in his reqiurements / expactations			0,704	3		
37		PC7 - Material changes in types & specs during construction phase					0,800	4
38		PC42 - Interference of client during implementation					0,800	4

Table 4.16 (continued): Comparison of the significance based on company role: Overall (occurence).

No	Category	Design-Construction Interface Problems	RII	Rank	RII	Rank	RII	Rank
			Consultant		Contractor		Designer	
39	Design-Construction phase	PDC16 - Economic Situation	0,933	1	0,709	3	0,785	2
40		PDC17 - Fast Track Construction	0,867	2	0,791	1	0,738	5
41		PDC28 - Poor project management	0,867	2			0,785	2
42		PDC29 - Poorly done planning and scheduling	0,850	3	0,700	4	0,769	3
43		PDC30 - Poor interface management	0,833	4				
44		PDC20 - Poor exchange of information leads to rework and change order	0,817	5			0,754	4
45		PDC27 - Unrealistic client expectations regarding project time, cost and quality			0,717	2		
46		PDC34 - Inconsistent planning			0,687	5	0,800	1
47		PDC6 - Unforeseen problems					0,754	4
48		PDC11 - Delay in approvals by government authorities					0,754	4
49		PDC24 - Inadequate choice of project contract type (Lump sum, unit price, etc.)					0,738	5

Looking at the ranking values according to their importance, it can be concluded and seen from Table 4.17 that, at the design phase, construction phase and design-construction phase there is no same rankings in variables according to company roles. At tendering phase, “PT5-Awarding the contract to the lower bidder price regardless of the quality of service” comes in the first line in all company roles, in this variable designers have the highest RII score. And also, “PT2-Incomplete or inaccurate design documents intentionally provided with bidding documents” comes in as the second cause in all company roles, with the highest RII score in designers. Lastly, “PT6-Absence of third party validation during defect liability period” has the fifth ranking in all company roles, in this variable designers have the highest RII score.

Table 4.17 : Comparison of the significance based on company role: Overall (importance).

No	Category	Design-Construction Interface Problems	RII	Rank	RII	Rank	RII	Rank
			Consultant		Contractor		Designer	
1	Design phase	PD8 - Lack of proper coordination between various disciplines of design team	0,883	1	0,791	1		
2		PD15 - Designer busy in too many assignments	0,850	2				
3		PD23 - Too little time is given to designer for completion of the design documents	0,850	2	0,743	5		
4		PD12 - Data provided to designer are incomplete	0,833	3				

Table 4.17 (continued): Comparison of the significance based on company role: Overall (importance).

No	Category	Design-Construction Interface Problems	RII	Rank	RII	Rank	RII	Rank
			Consultant		Contractor		Designer	
5		PD24 - Lack of project planning and analysis by owner at the project start	0,833	3				
6		PD3 - Lack of stipulated data	0,833	3			0,892	5
7		PD31 - Mistakes and discrepancies in design documents	0,833	3	0,770	2	0,938	2
8		PD13 - Data provided to designer are incorrect	0,817	4	0,765	3	0,954	1
9		PD14 - Data is provided late to designer	0,817	4				
10		PD4 - Delay in construction documents preparation	0,817	4	0,761	4		
11		PD9 - Unstable owner requirements	0,817	4				
12		PD17 - Designer's knowledge is lacking in constructability of design	0,800	5	0,761	4		
13		PD22 - Lack of reward, delayed payment or less payment to designer by owner	0,800	5				
14		PD27 - Lack of awareness about the construction knowledge and ongoing site operations	0,800	5				
15		PD28 - Inaccurate estimation of project element costs and quantities	0,800	5	0,765	3	0,908	4
16		PD30 - Unclear definition for scope of work	0,800	5	0,743	5		
17		PD6 - Time limitation in design phase	0,800	5	0,761	4	0,892	5
18		PD19 - Designer's knowledge is lacking on engineering design technique and software					0,923	3
19		PD12 - Data provided to designer are incomplete					0,892	5
20	Tendering phase	PT5 - Awarding the contract to the lower bidder price regardless of the quality of service	0,900	1	0,778	1	0,923	1
21		PT9 - Inadequate study for tender document to observe discrepancies before tender awarding	0,900	1	0,722	4	0,892	3
22		PT2 - Incomplete or inaccurate design documents intentionally provided with bidding documents	0,850	2	0,743	2	0,908	2
23		PT1 - Incomplete or inaccurate design documents unintentionally provided with bidding documents	0,800	3	0,730	3	0,800	5
24		PT4 - Contractor did not consider that the design is exotic, complex or not have the required expertise	0,800	3			0,831	4
25		PT8 - Restricting the contractor classification and a specific experience for the subcontractors in the contract form by the client	0,800	3				
26		PT7 - Inappropriate work packaging and subcontracting	0,783	4	0,778	1	0,831	4
27		PT6 - Absence of third party validation during defect liability period	0,767	5	0,709	5	0,800	5
28	Construction phase	PC9 - Construction errors and defective work at the construction site	0,917	1	0,778	5	0,877	4
29		PC24 - Delayed revision of drawings by designer	0,883	2				
30		PC8 - Design errors	0,883	2	0,796	3	0,923	1
31		PC16 - Delay in material approval (submittals)	0,867	3				
32		PC3 - Insufficient working drawing details	0,867	3	0,804	2	0,908	2

Table 4.17 (continued): Comparison of the significance based on company role: Overall (importance).

No	Category	Design-Construction Interface Problems	RII	Rank	RII	Rank	RII	Rank
			Consultant		Contractor		Designer	
33		PC40 - Lack of communication & coordination among all parties	0,867	3	0,804	2	0,877	4
34		PC47 - Lateness in preparing construction documents (such as schedule, detailed drawings)	0,867	3				
35		PC15 - Incomplete drawings and specification	0,850	4	0,787	4	0,892	3
36		PC2 - Complete & adequate plans and specs	0,850	4			0,877	4
37		PC22 - Slowness in decision making process by owner	0,850	4				
38		PC10 - Lack of skilled or specialized human resources	0,833	5	0,787	4	0,862	5
39		PC12 - Contractor's lack of comprehension of drawings details and specs	0,833	5			0,892	3
40		PC38 - Communication Gap between Constructor and Designer	0,833	5			0,862	5
41		PC41 - Lack of Skilled Manpower			0,813	1	0,892	3
42		PC5 - Ambigious design details					0,908	2
43		PC31 - Contractor lacks in coordination and management during construction					0,892	3
44		PC1 - Lack of designer knowledge of available material and equipments					0,877	4
45		PC6 - Lack of specialized construction manager					0,877	4
46		PC43 - Bad decision making					0,877	4
47		PC20 - Owner proposes changes to assert his authority and make undue interference in construction					0,862	5
48		PC44 - Lack of specialized quality control team					0,862	5
49	Design-Construction phase	PDC16 - Economic Situation	0,917	1	0,761	4	0,846	5
50		PDC28 - Poor project management	0,883	2	0,774	2	0,938	1
51		PDC29 - Poorly done planning and scheduling	0,883	2	0,761	4	0,908	2
52		PDC34 - Inconsistent planning	0,883	2	0,765	3	0,877	3
53		PDC15 - Lack of Professionals Experience and Judgement	0,833	3				
54		PDC20 - Poor exchange of information leads to rework and change order	0,833	3				
55		PDC27 - Unrealistic client expectations regarding project time, cost and quality	0,833	3	0,757	5	0,862	4
56		PDC7 - Design omission	0,833	3			0,862	4
57		PDC23 - Incompetence of professional project management as individual service	0,817	4	0,757	5	0,846	5
58		PDC25 - Inadequate choice of project delivery system (deign-bid-build, etc.)	0,817	4				
59		PDC30 - Poor interface management	0,817	4				
60		PDC33 - Violating conditions of the contract	0,817	4			0,862	4
61		PDC10 - Lack of buildability (constructability) studies	0,800	5				
62		PDC13 - Poorly written contract & vague contract details	0,800	5				

Table 4.17 (continued): Comparison of the significance based on company role: Overall (importance).

No	Category	Design-Construction Interface Problems	RII	Rank	RII	Rank	RII	Rank
			Consultant		Contractor		Designer	
63		PDC21 - Preparation and Approval of Shop Drawings	0,800	5				
64		PDC26 - Delay in shop drawings, change orders and permits acceptance and inquiries	0,800	5				
65		PDC31 - Conflict resolution	0,800	5				
66		PDC35 - Quality of design/contract documents	0,800	5			0,862	4
67		PDC17 - Fast Track Construction			0,778	1	0,846	5
68		PDC3 - Lack of professional experience & judgement			0,761	4	0,862	4
69		PDC14 - Design Complexity					0,862	4
70		PDC15 - Lack of Professionals Experience and Judgement					0,862	4
71		PDC32 - Incapability to predict and resolve project's problems related to new technological techniques					0,846	5

For further analysis, one-way analysis of variance (ANOVA) test was applied since, it is aimed to visualize and see if there is a statistically significant difference between stakeholders: Consultants, Designers, and Contractors. If the variable has a p-value less than “0,05”, it can be said that there is a statistically significant difference between groups. Therefore, the variables which have this value are pinned and furtherly analyzed to see the differences that came from which groups.

According to the occurrence of causes in the design phase, it was found that there is a statistically significant difference between groups in the variables of “PD2-Involvement of the contractor in design development phase”, “PD20-Frequent replacement of designer by the owner”, and “PD22-Lack of reward, delayed payment or less payment to the designer by owner”. As mentioned before, to say that there is a statistically significant difference between groups in these variables, the p-value of the variables should not be greater than 0,05. Looking at the p-values of these variables at Table 4.18, are respectively: 0,05, 0,023, and 0,020.

Table 4.18 : One-way ANOVA test for design phase problems (occurence).

Variables		Sum of Squares	df	Mean Square	F	Sig.
PD2 - Involvement of the contractor in design development phase	Between Groups	6,213	2	3,106	3,127	0,050*
	Within Groups	67,562	68	0,994		
	Total	73,775	70			

Table 4.18 (continued): One-way ANOVA test for design phase problems (occurence).

Variables		Sum of Squares	df	Mean Square	F	Sig.
PD20 - Frequent replacement of designer by the owner	Between Groups	9,751	2	4,876	3,968	0,023*
	Within Groups	83,545	68	1,229		
	Total	93,296	70			
PD22 - Lack of reward, delayed payment or less payment to designer by owner	Between Groups	8,530	2	4,265	4,153	0,020*
	Within Groups	69,836	68	1,027		
	Total	78,366	70			

In the tendering phase, the only statistically significant difference was found in “PT4-Contractor did not consider that the design is exotic, complex or not have the required expertise” with a p-value of 0,031, can be seen at Table 4.19.

Table 4.19 : One-way ANOVA test for tender phase problems (occurence).

Variables		Sum of Squares	df	Mean Square	F	Sig.
PT4 - Contractor did not consider that the design is exotic, complex or not have the required expertise	Between Groups	8,728	2	4,364	3,662	0,031*
	Within Groups	81,046	68	1,192		
	Total	89,775	70			

In the construction phase, “PC9-Construction errors and defective work at the construction site”, “PC10-Lack of skilled or specialized human resources”, “PC12-Contractor's lack of comprehension of drawings details and specs”, “PC15-Incomplete drawings and specification”, “PC22-Slowness in decision-making process by owner”, “PC31-Contractor lacks in coordination and management during construction”, “PC32-Contractor’s staff facing shortage of tools and or equipment for measurement, alignment and or for adjustment at corners”, “PC33-Contractor and his staff focusing on other projects”, “PC38-Communication Gap between Constructor and Designer”, “PC43-Bad decision making”, and “PC47-Lateness in preparing construction documents (such as schedule, detailed drawings)” were found as statistically different with p-values respectively: 0,006, 0,015, 0,008, 0,038, 0,016, 0,00, 0,004, 0,005, 0,023, 0,028, and 0,015; can be seen at Table 4.20.

Table 4.20 : One-way ANOVA test for construction phase problems (occurence).

Variables		Sum of Squares	df	Mean Square	F	Sig.
PC9 - Construction errors and defective work at the construction site	Between Groups	8,557	2	4,279	5,613	0,006*
	Within Groups	51,837	68	0,762		
	Total	60,394	70			
PC10 - Lack of skilled or specialized human resources	Between Groups	7,223	2	3,611	4,495	0,015*
	Within Groups	54,637	68	0,803		
	Total	61,859	70			
PC12 - Contractor's lack of comprehension of drawings details and specs	Between Groups	11,032	2	5,516	5,256	0,008*
	Within Groups	71,362	68	1,049		
	Total	82,394	70			
PC15 - Incomplete drawings and specification	Between Groups	6,709	2	3,354	3,431	0,038*
	Within Groups	66,474	68	0,978		
	Total	73,183	70			
PC22 - Slowness in decision making process by owner	Between Groups	6,129	2	3,064	4,394	0,016*
	Within Groups	47,421	68	0,697		
	Total	53,549	70			
PC31 - Contractor lacks in coordination and management during construction	Between Groups	12,789	2	6,395	8,619	0,000*
	Within Groups	50,450	68	0,742		
	Total	63,239	70			
PC32 - Contractor’s staff facing shortage of tools and or equipment for measurement, alignment and or for adjustment at corners	Between Groups	13,164	2	6,582	6,119	0,004*
	Within Groups	73,146	68	1,076		
	Total	86,310	70			
PC33 - Contractor and his staff focusing on other projects	Between Groups	11,239	2	5,619	5,669	0,005*
	Within Groups	67,409	68	0,991		
	Total	78,648	70			
PC38 - Communication Gap between Constructor and Designer	Between Groups	9,114	2	4,557	4,005	0,023*
	Within Groups	77,365	68	1,138		
	Total	86,479	70			
PC43 - Bad decision making	Between Groups	6,595	2	3,297	3,782	0,028*
	Within Groups	59,293	68	0,872		
	Total	65,887	70			
PC47 - Lateness in preparing construction documents (such as schedule, detailed drawings)	Between Groups	6,740	2	3,370	4,493	0,015*
	Within Groups	51,006	68	0,750		
	Total	57,746	70			

In the design-construction phase, the statistically significant difference were found in: “PDC7-Design omission”, “PDC8-Type of the contract with the owner”, “PDC10-Lack of buildability (constructability) studies”, “PDC11-Delay in approvals by government authorities”, “PDC13-Poorly written contract & vague contract details”, “PDC16-Economic Situation”, “PDC20-Poor exchange of information leads to rework and change order”, “PDC23-Incompetence of professional project management as

individual service", "PDC24-Inadequate choice of project contract type (Lump sum, unit price, etc.)", "PDC25-Inadequate choice of project delivery system (deign-bid-build, etc.)", "PDC26-Delay in shop drawings, change orders and permits acceptance and inquiries", "PDC28-Poor project management", "PDC29-Poorly done planning and scheduling", "PDC30-Poor interface management", "PDC33-Violating conditions of the contract", and "PDC35-Quality of design/contract documents". The p-values of these variables are as follows and seen at Table 4.21.: 0,002, 0,00, 0,019, 0,012, 0,044, 0,001, 0,002, 0,033, 0,001, 0,001, 0,006, 0,006, 0,044, 0,002, 0,022, and 0,013.

Table 4.21 : One-way ANOVA test for design-construction phase problems (occurence).

Variables		Sum of Squares	df	Mean Square	F	Sig.
PDC7 - Design omission	Between Groups	12,011	2	6,005	6,591	0,002*
	Within Groups	61,961	68	0,911		
	Total	73,972	70			
PDC8 - Type of contract with the owner	Between Groups	15,923	2	7,962	11,060	0,000*
	Within Groups	48,950	68	0,720		
	Total	64,873	70			
PDC10 - Lack of buildability (constructability) studies	Between Groups	9,108	2	4,554	4,177	0,019*
	Within Groups	74,131	68	1,090		
	Total	83,239	70			
PDC11 - Delay in approvals by government authorities	Between Groups	9,507	2	4,753	4,692	0,012*
	Within Groups	68,887	68	1,013		
	Total	78,394	70			
PDC13 - Poorly written contract & vague contract details	Between Groups	6,208	2	3,104	3,261	0,044*
	Within Groups	64,722	68	0,952		
	Total	70,930	70			
PDC16 - Economic Situation	Between Groups	12,237	2	6,118	8,157	0,001*
	Within Groups	51,003	68	0,750		
	Total	63,239	70			
PDC20 - Poor exchange of information leads to rework and change order	Between Groups	13,685	2	6,842	7,028	0,002*
	Within Groups	66,203	68	0,974		
	Total	79,887	70			
PDC23 - Incompetence of professional project management as individual service	Between Groups	5,630	2	2,815	3,601	0,033*
	Within Groups	53,159	68	0,782		
	Total	58,789	70			
PDC24 - Inadequate choice of project contract type (Lump sum, unit price, etc.)	Between Groups	12,439	2	6,220	8,057	0,001*
	Within Groups	52,490	68	0,772		
	Total	64,930	70			

Table 4.21 (continued): One-way ANOVA test for design-construction phase problems (occurence).

Variables		Sum of Squares	df	Mean Square	F	Sig.
PDC25 - Inadequate choice of project delivery system (deign-bid-build, etc.)	Between Groups	12,359	2	6,180	8,076	0,001*
	Within Groups	52,035	68	0,765		
	Total	64,394	70			
PDC26 - Delay in shop drawings, change orders and permits acceptance and inquiries	Between Groups	9,114	2	4,557	5,597	0,006*
	Within Groups	55,365	68	0,814		
	Total	64,479	70			
PDC28 - Poor project management	Between Groups	10,172	2	5,086	5,551	0,006*
	Within Groups	62,307	68	0,916		
	Total	72,479	70			
PDC29 - Poorly done planning and scheduling	Between Groups	5,741	2	2,870	3,284	0,044*
	Within Groups	59,442	68	0,874		
	Total	65,183	70			
PDC30 - Poor interface management	Between Groups	8,932	2	4,466	6,933	0,002*
	Within Groups	43,800	68	0,644		
	Total	52,732	70			
PDC33 - Violating conditions of the contract	Between Groups	7,019	2	3,509	4,050	0,022*
	Within Groups	58,925	68	0,867		
	Total	65,944	70			
PDC35 - Quality of design/contract documents	Between Groups	7,710	2	3,855	4,627	0,013*
	Within Groups	56,657	68	0,833		
	Total	64,366	70			

According to the importance of causes in the design phase, it was found that there is a statistically significant difference between groups in these variables: “PD3-Lack of stipulated data”, “PD12-Data provided to the designer are incomplete”, “PD13-Data provided to designer are incorrect”, “PD19-Designer’s knowledge is lacking on engineering design technique and software”, “PD31-Mistakes and discrepancies in design documents”, and “PD34-Involvement of the designer as a consultant”. P-values of these variables are as follows and can be seen at Table 4.22.: 0,035, 0,049, 0,038, 0,020, 0,040, and 0,011.

Table 4.22 : One-way ANOVA test for design phase problems (importance).

Variables		Sum of Squares	df	Mean Square	F	Sig.
PD3 - Lack of stipulated data	Between Groups	8,244	2	4,122	3,521	0,035*
	Within Groups	79,615	68	1,171		

Table 4.22 (continued): One-way ANOVA test for design phase problems (importance).

Variables		Sum of Squares	df	Mean Square	F	Sig.
	Total	87,859	70			
PD12 - Data provided to designer are incomplete	Between Groups	7,304	2	3,652	3,143	0,049*
	Within Groups	79,006	68	1,162		
	Total	86,310	70			
PD13 - Data provided to designer are incorrect	Between Groups	9,040	2	4,520	3,422	0,038*
	Within Groups	89,833	68	1,321		
	Total	98,873	70			
PD19 - Designer's knowledge is lacking on engineering design technique and software	Between Groups	9,534	2	4,767	4,169	0,020*
	Within Groups	77,762	68	1,144		
	Total	87,296	70			
PD31 - Mistakes and discrepancies in design documents	Between Groups	7,404	2	3,702	3,385	0,040*
	Within Groups	74,371	68	1,094		
	Total	81,775	70			
PD34 - Involvement of the designer as a consultant	Between Groups	11,061	2	5,531	4,816	0,011*
	Within Groups	78,094	68	1,148		
	Total	89,155	70			

In the tendering phase, "PT2-Incomplete or inaccurate design documents intentionally provided with bidding documents", "PT4-Contractor did not consider that the design is exotic, complex or not have the required expertise", "PT5-Awarding the contract to the lower bidder price regardless of the quality of service", and "PT9-Inadequate study for the tender document to observe discrepancies before tender awarding" were found as statistically different among groups, can be seen at Table 4.23. The p-values of these variables are respectively: 0,046, 0,010, 0,038, and 0,001.

Table 4.23 : One-way ANOVA test for tender phase problems (importance).

Variables		Sum of Squares	df	Mean Square	F	Sig.
PT2 - Incomplete or inaccurate design documents intentionally provided with bidding documents	Between Groups	8,066	2	4,033	3,234	0,046*
	Within Groups	84,807	68	1,247		
	Total	92,873	70			
PT4 - Contractor did not consider that the design is exotic, complex or not have the required expertise	Between Groups	9,893	2	4,946	4,988	0,010*
	Within Groups	67,431	68	0,992		
	Total	77,324	70			
PT5 - Awarding the contract to the lower bidder price regardless of the quality of service	Between Groups	7,326	2	3,663	3,434	0,038*
	Within Groups	72,533	68	1,067		

Table 4.23 (continued): One-way ANOVA test for tender phase problems (importance).

Variables		Sum of Squares	df	Mean Square	F	Sig.
	Total	79,859	70			
PT9 - Inadequate study for tender document to observe discrepancies before tender awarding	Between Groups	12,306	2	6,153	8,174	0,001*
	Within Groups	51,187	68	0,753		
	Total	63,493	70			

In the construction phase, “PC5-Ambigious design details”, “PC9-Construction errors and defective work at the construction site”, and “PC24-Delayed revision of drawings by designer”. The P-values of these variables are 0,049, 0,043, and 0,045; can be seen at Table 4.24.

Table 4.24 : One-way ANOVA test for construction phase problems (importance).

Variables		Sum of Squares	df	Mean Square	F	Sig.
PC5 - Ambigious design details	Between Groups	4,579	2	2,289	3,154	0,049*
	Within Groups	49,365	68	0,726		
	Total	53,944	70			
PC9 - Construction errors and defective work at the construction site	Between Groups	5,860	2	2,930	3,296	0,043*
	Within Groups	60,450	68	0,889		
	Total	66,310	70			
PC24 - Delayed revision of drawings by designer	Between Groups	5,347	2	2,674	3,250	0,045*
	Within Groups	55,948	68	0,823		
	Total	61,296	70			

In the design-construction phase, these variables are found: “PDC14-Design Complexity”, “PDC16-Economic Situation”, “PDC28-Poor project management”, and “PDC29-Poorly done planning and scheduling” with p-values of 0,041, 0,031, 0,035, and 0,047 can be seen at Table 4.25.

Table 4.25 : One-way ANOVA test for design-construction phase problems (importance).

Variables		Sum of Squares	df	Mean Square	F	Sig.
PDC14 - Design Complexity	Between Groups	7,180	2	3,590	3,336	0,041*
	Within Groups	73,186	68	1,076		
	Total	80,366	70			

Table 4.25 (continued): One-way ANOVA test for design-construction phase problems (importance).

Variables		Sum of Squares	df	Mean Square	F	Sig.
PDC16 - Economic Situation	Between Groups	6,522	2	3,261	3,668	0,031*
	Within Groups	60,463	68	0,889		
	Total	66,986	70			
PDC28 - Poor project management	Between Groups	8,195	2	4,098	3,531	0,035*
	Within Groups	78,903	68	1,160		
	Total	87,099	70			
PDC29 - Poorly done planning and scheduling	Between Groups	7,487	2	3,743	3,206	0,047*
	Within Groups	79,387	68	1,167		
	Total	86,873	70			

With the help of one-way ANOVA test, the variables which show a statistically significant difference between Consultants, Designers, and Contractors were identified. Then, further post-hoc analysis was carried out to determine which groups caused this difference. To decide which post-hoc test is applicable, it is necessary to measure the homogeneity of variances. Levene's test was applied to the variables which were pinned in the ANOVA test and their homogeneity results are given in tables. These values allowed us to decide which test to apply to the variables. Where the significance level (p-value) is lower than 0,05, it is a non-homogeneously distributed variance and the Games-Howell post-hoc test should be applied. On the contrary, where the significance level (p-value) is greater than 0,05, it is a homogeneously distributed variance and the Tukey and Gabriel post-hoc tests should be applied.

Levene's test was applied to the variables detected through the ANOVA test. All the values for the occurrence in the design phase causes are greater than 0,005; can be seen at Table 4.26. So, Gabriel and Tukey's post-hoc tests were applied to these variables. It can be said that for "PD2-Involvement of the contractor in design development phase" and "PD20-Frequent replacement of designer by the owner", there is a significant difference between Consultants and Contractors. For "PD22-Lack of reward, delayed payment or less payment to the designer by owner", it can be said that the difference occurred between Contractors and Designers. These relations can be seen at Table 4.27.

Table 4.26 : Homogeneity of design phase problems (occurence).

Causes	Levene Statistic	Sig.
PD2 - Involvement of the contractor in design development phase	1,602	0,209
PD20 - Frequent replacement of designer by the owner	0,528	0,592
PD22 - Lack of reward, delayed payment or less payment to designer by owner	0,992	0,376

Table 4.27 : Tukey and Gabriel Post-Hoc analysis of design phase problems (occurence).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
PD2 - Involvement of the contractor in design development phase	Tukey HSD	Consultant	Contractor	-0,761	0,323	0,055
			Designer	-0,346	0,399	0,663
		Contractor	Consultant	0,761	0,323	0,055
			Designer	0,415	0,313	0,387
		Designer	Consultant	0,346	0,399	0,663
			Contractor	-0,415	0,313	0,387
	Gabriel	Consultant	Contractor	-.761*	0,323	0,046*
			Designer	-0,346	0,399	0,768
		Contractor	Consultant	.761*	0,323	0,046*
			Designer	0,415	0,313	0,426
		Designer	Consultant	0,346	0,399	0,768
			Contractor	-0,415	0,313	0,426
PD20 - Frequent replacement of designer by the owner	Tukey HSD	Consultant	Contractor	.993*	0,359	0,020*
			Designer	0,974	0,444	0,079
		Contractor	Consultant	-.993*	0,359	0,020*
			Designer	-0,018	0,348	0,998
		Designer	Consultant	-0,974	0,444	0,079
			Contractor	0,018	0,348	0,998
	Gabriel	Consultant	Contractor	.993*	0,359	0,015*
			Designer	0,974	0,444	0,091
		Contractor	Consultant	-.993*	0,359	0,015*
			Designer	-0,018	0,348	1,000
		Designer	Consultant	-0,974	0,444	0,091

Table 4.27 (continued): Tukey and Gabriel Post-Hoc analysis of design phase problems (occurence).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
PD22 - Lack of reward, delayed payment or less payment to designer by owner	Tukey HSD	Consultant	Contractor	0,018	0,348	1,000
			Contractor	0,457	0,328	0,352
			Designer	-0,423	0,406	0,553
		Contractor	Consultant	-0,457	0,328	0,352
			Designer	-.880*	0,318	0,020*
		Designer	Consultant	0,423	0,406	0,553
			Contractor	.880*	0,318	0,020*
	Gabriel	Consultant	Contractor	0,457	0,328	0,380
			Designer	-0,423	0,406	0,654
		Contractor	Consultant	-0,457	0,328	0,380
			Designer	-.880*	0,318	0,015*
		Designer	Consultant	0,423	0,406	0,654
			Contractor	.880*	0,318	0,015*

*. The mean difference is significant at the 0.05 level.

In the tendering phase, for "PT4-Contractor did not consider that the design is exotic, complex or not have the required expertise" the p-value is greater than 0,05, and Gabriel and Tukey tests were applied. Its result can be seen at Table 4.28. According to these post-hoc tests, there is a significant difference between Consultants and Contractors at Table 4.29.

Table 4.28 : Homogeneity of tender phase problems (occurence).

Causes	Levene Statistic	Sig.
PT4 - Contractor did not consider that the design is exotic, complex or not have the required expertise	0,787	0,459

Table 4.29 : Tukey and Gabriel Post-Hoc analysis of tender phase problems (occurence).

(I) Company Role	(J) Company Role		Mean Difference (I-J)	Std. Error	Sig.
Dependent Variable:	PT4 - Contractor did not consider that the design is exotic, complex or not have the required expertise				
Tukey HSD	Consultant	Conractor	.942*	0,354	0,026*
		Designer	0,910	0,437	0,101
	Conractor	Consultant	-.942*	0,354	0,026*
		Designer	-0,032	0,343	0,995
	Designer	Consultant	-0,910	0,437	0,101
		Conractor	0,032	0,343	0,995
Gabriel	Consultant	Conractor	.942*	0,354	0,020*
		Designer	0,910	0,437	0,117
	Conractor	Consultant	-.942*	0,354	0,020*
		Designer	-0,032	0,343	1,000
	Designer	Consultant	-0,910	0,437	0,117
		Conractor	0,032	0,343	1,000

*. The mean difference is significant at the 0.05 level.

In the construction phase, the p-values of all variables except "PC9-Construction errors and defective work at the construction site" are greater than 0,05; its results can be seen at Table 4.30. After applying Games-Howell post-hoc test for PC9, it can be said from the Table 4.31 that there is a significant difference between Consultants-Contractors and Contractors-Designers.

Table 4.30 : Homogeneity of construction phase problems (occurence).

Causes	Levene Statistic	Sig.
PC9 - Construction errors and defective work at the construction site	5,030	0,009
PC10 - Lack of skilled or specialized human resources	1,138	0,327
PC12 - Contractor's lack of comprehension of drawings details and specs	1,633	0,203
PC15 - Incomplete drawings and specification	0,823	0,443
PC22 - Slowness in decision making process by owner	0,749	0,477
PC31 - Contractor lacks in coordination and management during construction	0,392	0,678

Table 4.30 (continued): Homogeneity of construction phase problems (occurence).

Causes	Levene Statistic	Sig.
PC32 - Contractor's staff facing shortage of tools and or equipment for measurement, alignment and or for adjustment at corners	0,718	0,492
PC33 - Contractor and his staff focusing on other projects	0,185	0,832
PC38 - Communication Gap between Constructor and Designer	0,782	0,462
PC43 - Bad decision making	1,376	0,259
PC47 - Lateness in preparing construction documents (such as schedule, detailed drawings)	0,071	0,931

Table 4.31 : Games-Howell Post-Hoc analysis of construction phase problems (occurence).

(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
Games-Howell	Dependent Variable: PC9 - Construction errors and defective work at the construction site			
Consultant	Contractor	.812*	0,237	0,006*
	Designer	0,179	0,243	0,743
Contractor	Consultant	-.812*	0,237	0,006*
	Designer	-.632*	0,211	0,014*
Designer	Consultant	-0,179	0,243	0,743
	Contractor	.632*	0,211	0,014*

*. The mean difference is significant at the 0.05 level.

For the other variables that were applied Gabriel and Tukey tests, can be seen at Table 4.32, the groups that have difference were respectively: for "PC10-Lack of skilled or specialized human resources", between Designers and Contractors; for "PC12-Contractor's lack of comprehension of drawings details and specs", between Consultants-Contractors and Contractors-Designers; for "PC15-Incomplete drawings and specification", between Designers and Contractors; for "PC22-Slowness in decision making process by owner", between Designers and Contractors; for "PC31-Contractor lacks in coordination and management during construction", between Consultants-Contractors and Contractors-Designers; for "PC32-Contractor's staff

facing shortage of tools and or equipment for measurement, alignment and or for adjustment at corners", between Consultants-Contractors and Contractors-Designers; for "PC33-Contractor and his staff focusing on other projects", between Consultants and Contractors; for "PC38-Communication Gap between Constructor and Designer", between Consultants and Contractors; for "PC43-Bad decision making", between Consultants-Contractors and Consultants-Designers; and lastly "PC47-Lateness in preparing construction documents (such as schedule, detailed drawings)", between Consultants and Contractors. These results can be seen at Table 4.32.

Table 4.32 : Tukey and Gabriel Post-Hoc analysis of construction phase problems (occurence).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
PC10 - Lack of skilled or specialized human resources	Tukey HSD	Consultant	Contractor	0,138	0,291	0,884
			Designer	-0,705	0,359	0,129
		Contractor	Consultant	-0,138	0,291	0,884
			Designer	-.843*	0,282	0,011*
		Designer	Consultant	0,705	0,359	0,129
			Contractor	.843*	0,282	0,011*
	Gabriel	Consultant	Contractor	0,138	0,291	0,944
			Designer	-0,705	0,359	0,151
		Contractor	Consultant	-0,138	0,291	0,944
			Designer	-.843*	0,282	0,008*
		Designer	Consultant	0,705	0,359	0,151
			Contractor	.843*	0,282	0,008*
PC12 - Contractor's lack of comprehension of drawings details and specs	Tukey HSD	Consultant	Contractor	.815*	0,332	0,043*
			Designer	-0,019	0,410	0,999
		Contractor	Consultant	-.815*	0,332	0,043*
			Designer	-.834*	0,322	0,031*
		Designer	Consultant	0,019	0,410	0,999
			Contractor	.834*	0,322	0,031*
	Gabriel	Consultant	Contractor	.815*	0,332	0,035*
			Designer	-0,019	0,410	1,000
		Contractor	Consultant	-.815*	0,332	0,035*
			Designer	-.834*	0,322	0,025*
		Designer	Consultant	0,019	0,410	1,000
			Contractor	.834*	0,322	0,025*
PC15 - Incomplete drawings and specification	Tukey HSD	Consultant	Contractor	.833*	0,320	0,030*
			Designer	0,564	0,396	0,334

Table 4.32 (continued): Tukey and Gabriel Post-Hoc analysis of construction phase problems (occurence).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
		Contractor	Consultant	-.833*	0,320	0,030*
			Designer	-0,269	0,311	0,663
		Designer	Consultant	-0,564	0,396	0,334
			Contractor	0,269	0,311	0,663
	Gabriel	Consultant	Contractor	.833*	0,320	0,024*
			Designer	0,564	0,396	0,401
		Contractor	Consultant	-.833*	0,320	0,024*
			Designer	-0,269	0,311	0,744
		Designer	Consultant	-0,564	0,396	0,401
			Contractor	0,269	0,311	0,744
PC22 - Slowness in decision making process by owner	Tukey HSD	Consultant	Contractor	.772*	0,271	0,016*
			Designer	0,404	0,334	0,453
		Contractor	Consultant	-.772*	0,271	0,016*
			Designer	-0,368	0,262	0,345
		Designer	Consultant	-0,404	0,334	0,453
			Contractor	0,368	0,262	0,345
	Gabriel	Consultant	Contractor	.772*	0,271	0,011*
			Designer	0,404	0,334	0,542
		Contractor	Consultant	-.772*	0,271	0,011*
			Designer	-0,368	0,262	0,376
		Designer	Consultant	-0,404	0,334	0,542
			Contractor	0,368	0,262	0,376
PC31 - Contractor lacks in coordination and management during construction	Tukey HSD	Consultant	Contractor	1.025*	0,279	0,001*
			Designer	0,301	0,345	0,659
		Contractor	Consultant	-1.025*	0,279	0,001*
			Designer	-.724*	0,271	0,025*
		Designer	Consultant	-0,301	0,345	0,659
			Contractor	.724*	0,271	0,025*
	Gabriel	Consultant	Contractor	1.025*	0,279	0,001*
			Designer	0,301	0,345	0,765
		Contractor	Consultant	-1.025*	0,279	0,001*
			Designer	-.724*	0,271	0,020*
		Designer	Consultant	-0,301	0,345	0,765
			Contractor	.724*	0,271	0,020*

Table 4.32 (continued): Tukey and Gabriel Post-Hoc analysis of construction phase problems (occurence).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
		Designer	Consultant	-0,199	0,415	0,882
			Contractor	.798*	0,326	0,044*
	Gabriel	Consultant	Contractor	.996*	0,336	0,008*
			Designer	0,199	0,415	0,950
		Contractor	Consultant	-.996*	0,336	0,008*
			Designer	-.798*	0,326	0,037*
		Designer	Consultant	-0,199	0,415	0,950
			Contractor	.798*	0,326	0,037*
PC33 - Contractor and his staff focusing on other projects	Tukey HSD	Consultant	Contractor	1.014*	0,323	0,007*
			Designer	0,436	0,399	0,521
		Contractor	Consultant	-1.014*	0,323	0,007*
			Designer	-0,579	0,313	0,161
		Designer	Consultant	-0,436	0,399	0,521
			Contractor	0,579	0,313	0,161
	Gabriel	Consultant	Contractor	1.014*	0,323	0,005*
			Designer	0,436	0,399	0,620
		Contractor	Consultant	-1.014*	0,323	0,005*
			Designer	-0,579	0,313	0,161
		Designer	Consultant	-0,436	0,399	0,620
			Contractor	0,579	0,313	0,161
PC38 - Communication Gap between Constructor and Designer	Tukey HSD	Consultant	Contractor	.953*	0,346	0,020*
			Designer	0,545	0,427	0,413
		Contractor	Consultant	-.953*	0,346	0,020*
			Designer	-0,408	0,335	0,447
		Designer	Consultant	-0,545	0,427	0,413
			Contractor	0,408	0,335	0,447
	Gabriel	Consultant	Contractor	.953*	0,346	0,015*
			Designer	0,545	0,427	0,496
		Contractor	Consultant	-.953*	0,346	0,015*
			Designer	-0,408	0,335	0,498
		Designer	Consultant	-0,545	0,427	0,496
			Contractor	0,408	0,335	0,498
PC43 - Bad decision making	Tukey HSD	Consultant	Contractor	.761*	0,303	0,038*
			Designer	.923*	0,374	0,042*
		Contractor	Consultant	-.761*	0,303	0,038*
			Designer	0,162	0,293	0,845
		Designer	Consultant	-.923*	0,374	0,042*

Table 4.32 (continued): Tukey and Gabriel Post-Hoc analysis of construction phase problems (occurence).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
			Contractor	-0,162	0,293	0,845
	Gabriel	Consultant	Contractor	.761*	0,303	0,030*
			Designer	.923*	0,374	0,047*
		Contractor	Consultant	-.761*	0,303	0,030*
			Designer	0,162	0,293	0,916
		Designer	Consultant	-.923*	0,374	0,047*
			Contractor	-0,162	0,293	0,916
PC47 - Lateness in preparing construction documents (such as schedule, detailed drawings)	Tukey HSD	Consultant	Contractor	.841*	0,281	0,011*
			Designer	0,705	0,347	0,112
		Contractor	Consultant	-.841*	0,281	0,011*
			Designer	-0,135	0,272	0,873
		Designer	Consultant	-0,705	0,347	0,112
			Contractor	0,135	0,272	0,873
	Gabriel	Consultant	Contractor	.841*	0,281	0,007*
			Designer	0,705	0,347	0,130
		Contractor	Consultant	-.841*	0,281	0,007*
			Designer	-0,135	0,272	0,937
		Designer	Consultant	-0,705	0,347	0,130
			Contractor	0,135	0,272	0,937

*. The mean difference is significant at the 0.05 level.

In the design-construction phase, p-values of all variables are greater than 0,05; can be seen at Table 4.33. Therefore, Gabriel and Tukey tests were applied.

Table 4.33 : Homogeneity of design-construction phase problems (occurence).

Causes	Levene Statistic	Sig.
PDC7 - Design omission	1,764	0,179
PDC8 - Type of contract with the owner	0,945	0,394
PDC10 - Lack of buildability (constructability) studies	0,869	0,424
PDC11 - Delay in approvals by government authorities	2,024	0,140
PDC13 - Poorly written contract & vague contract details	0,897	0,412

Table 4.33 (continued): Homogeneity of design-construction phase problems (occurence).

Causes	Levene Statistic	Sig.
PDC16 - Economic Situation	2,906	0,062
PDC20 - Poor exchange of information leads to rework and change order	0,428	0,654
PDC23 - Incompetence of professional project management as individual service	0,617	0,543
PDC24 - Inadequate choice of project contract type (Lump sum, unit price, etc.)	2,902	0,062
PDC25 - Inadequate choice of project delivery system (deign-bid-build, etc.)	2,848	0,065
PDC26 - Delay in shop drawings, change orders and permits acceptance and inquiries	0,179	0,837
PDC28 - Poor project management	1,968	0,148
PDC29 - Poorly done planning and scheduling	1,389	0,256
PDC30 - Poor interface management	0,980	0,381
PDC33 - Violating conditions of the contract	0,852	0,431
PDC35 - Quality of design/contract documents	0,944	0,394

According to the results, (can be seen at Appendix B), for “PDC7-Design omission” and “PDC8-Type of the contract with the owner”, the difference between Consultants-Contractors and Contractors-Designers are statistically significant. For “PD10-Lack of buildability (constructability) studies”, between Consultants-Contractors; for “PDC11-Delay in approvals by government authorities”, between Contractors and Designers; for “PDC16-Economic Situation”, between Consultants and Contractors; for “PDC20-Poor exchange of information leads to rework and change order”, between Consultants-Contractors and Contractors-Designers; for “PDC23-Incompetence of professional project management as individual service”, between Consultants and Contractors; for “PDC24-Inadequate choice of project contract type (Lump sum, unit price, etc.)”, between Consultants-Contractors and Contractors-Designers; for “PDC25-Inadequate choice of project delivery system (deign-bid-build, etc.)”, between Consultants and Contractors; for “PDC26-Delay in shop drawings, change orders and permits acceptance and inquiries”, between Consultants and Contractors; for “PDC28-Poor project management”, between Consultants and Contractors; for “PDC29-Poorly done planning and scheduling”, between Consultants and Contractors; for “PDC30-Poor interface management”, between Consultants-Contractors and

Consultants-Designers; for “PDC33-Violating conditions of the contract”, between Consultants and Contractors; for “PDC35-Quality of design/contract documents”, between Consultants and Contractors.

For the variables related to the importance of the causes, similar statistical tests were applied, as can be seen at Table 4.34 for design phase problems.

Table 4.34 : Homogeneity of design phase problems (importance).

Causes	Levene Statistic	Sig.
PD3 - Lack of stipulated data	4,816	0,011
PD12 - Data provided to designer are incomplete	4,317	0,017
PD13 - Data provided to designer are incorrect	7,873	0,001
PD19 - Designer’s knowledge is lacking on engineering design technique and software	5,464	0,006
PD31 - Mistakes and discrepancies in design documents	2,406	0,098
PD34 - Involvement of the designer as a consultant	0,978	0,381

In the design phase, as seen at Table 4.35, the Games-Howell test was applied to “PD3-Lack of stipulated data”, “PD12-Data provided to the designer are incomplete”, “PD13-Data provided to the designer is incorrect”, and “PD19-Designer’s knowledge is lacking on engineering design technique and software” variables.

Table 4.35 : Games-Howell Post-Hoc analysis of design phase problems (importance).

Dependent Variable	(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
PD3 - Lack of stipulated data	Consultant	Contractor	0,536	0,278	0,147
		Designer	-0,295	0,252	0,485
	Contractor	Consultant	-0,536	0,278	0,147
		Designer	-.831*	0,234	0,002*
	Designer	Consultant	0,295	0,252	0,485
		Contractor	.831*	0,234	0,002*
PD12 - Data provided to designer are incomplete	Consultant	Contractor	0,493	0,345	0,347

Table 4.35 (continued): Games-Howell Post-Hoc analysis of design phase problems (importance).

Dependent Variable	(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
		Designer	-0,295	0,330	0,652
	Contractor	Consultant	-0,493	0,345	0,347
		Designer	-.788*	0,227	0,003*
	Designer	Consultant	0,295	0,330	0,652
		Contractor	.788*	0,227	0,003*
PD13 - Data provided to designer are incorrect	Consultant	Contractor	0,257	0,385	0,784
		Designer	-0,686	0,357	0,170
	Contractor	Consultant	-0,257	0,385	0,784
		Designer	-.943*	0,223	0,000*
	Designer	Consultant	0,686	0,357	0,170
		Contractor	.943*	0,223	0,000*
PD19 - Designer's knowledge is lacking on engineering design technique and software	Consultant	Contractor	0,098	0,308	0,946
		Designer	-.865*	0,287	0,020*
	Contractor	Consultant	-0,098	0,308	0,946
		Designer	-.963*	0,228	0,000*
	Designer	Consultant	.865*	0,287	0,020*
		Contractor	.963*	0,228	0,000*

*. The mean difference is significant at the 0.05 level.

For "PD31-Mistakes and discrepancies in design documents" and "PD34-Involvement of the designer as a consultant", as seen at Table 4.36, Tukey and Gabriel tests were applied. After the results of the Games-Howell test, except "PD19-Designer's knowledge is lacking on engineering design technique and software" variable, the three other variables have statistically significant differences between Contractors and Designers. In PD19, there is a difference between all three groups. As for the results of Tukey and Gabriel tests, it can be said that there is a difference between Contractors and Designers in "PD31-Mistakes and discrepancies in design documents". But for "PD34-Involvement of the designer as a consultant", there is a difference between all three groups.

Table 4.36 : Tukey and Gabriel Post-Hoc analysis of design phase problems (importance).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
PD31 - Mistakes and discrepancies in design documents	Tukey HSD	Consultant	Contractor	0,319	0,339	0,617
			Designer	-0,526	0,419	0,425
		Contractor	Consultant	-0,319	0,339	0,617
			Designer	-.844*	0,328	0,033*
		Designer	Consultant	0,526	0,419	0,425
			Contractor	.844*	0,328	0,033*
	Gabriel	Consultant	Contractor	0,319	0,339	0,691
			Designer	-0,526	0,419	0,510
		Contractor	Consultant	-0,319	0,339	0,691
			Designer	-.844*	0,328	0,027*
		Designer	Consultant	0,526	0,419	0,510
			Contractor	.844*	0,328	0,027*
PD34 - Involvement of the designer as a consultant	Tukey HSD	Consultant	Contractor	-0,178	0,347	0,866
			Designer	-1.147*	0,429	0,025*
		Contractor	Consultant	0,178	0,347	0,866
			Designer	-.970*	0,337	0,014*
		Designer	Consultant	1.147*	0,429	0,025*
			Contractor	.970*	0,337	0,014*
	Gabriel	Consultant	Contractor	-0,178	0,347	0,931
			Designer	-1.147*	0,429	0,028*
		Contractor	Consultant	0,178	0,347	0,931
			Designer	-.970*	0,337	0,011*
		Designer	Consultant	1.147*	0,429	0,028*
			Contractor	.970*	0,337	0,011*

*. The mean difference is significant at the 0.05 level.

In the tendering phase, the p-values of the variables can be seen at Table 4.37. While the Games-Howell test was applied to “PT2-Incomplete or inaccurate design documents intentionally provided with bidding documents” and “PT4-Contractor did not consider that the design is exotic, complex or not have the required expertise” variables, the Tukey and Gabriel tests are applied to “PT5-Awarding the contract to the lower bidder price regardless of the quality of service” and “PT9-Inadequate study for the tender document to observe discrepancies before tender awarding”. After the results of the Games-Howell test, both “PT2-Incomplete or inaccurate design documents intentionally provided with bidding documents” and “PT4-Contractor did not consider that the design is exotic, complex or not have the required expertise”

variables have differences between Contractors and Designers, can be seen at Table 4.38.

Table 4.37 : Homogeneity of tender phase problems (importance).

Causes	Levene Statistic	Sig.
PT2 - Incomplete or inaccurate design documents intentionally provided with bidding documents	4,891	0,010
PT4 - Contractor did not consider that the design is exotic, complex or not have the required expertise	3,982	0,023
PT5 - Awarding the contract to the lower bidder price regardless of the quality of service	1,232	0,298
PT9 - Inadequate study for tender document to observe discrepancies before tender awarding	2,138	0,126

Table 4.38 : Games-Howell Post-Hoc analysis of tender phase problems (importance).

Dependent Variable	(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
PT2 - Incomplete or inaccurate design documents intentionally provided with bidding documents	Consultant	Contractor	0,533	0,313	0,224
		Designer	-0,288	0,288	0,586
	Contractor	Consultant	-0,533	0,313	0,224
		Designer	-.821*	0,237	0,003*
	Designer	Consultant	0,288	0,288	0,586
		Contractor	.821*	0,237	0,003*
PT4 - Contractor did not consider that the design is exotic, complex or not have the required expertise	Consultant	Contractor	0,696	0,340	0,131
		Designer	-0,154	0,338	0,893
	Contractor	Consultant	-0,696	0,340	0,131
		Designer	-.849*	0,221	0,001*
	Designer	Consultant	0,154	0,338	0,893
		Contractor	.849*	0,221	0,001*

*. The mean difference is significant at the 0.05 level.

From the Tukey and Gabriel test results, for “PT9-Inadequate study for the tender document to observe discrepancies before tender awarding”, there is a difference between all three groups; can be seen at Table 4.39.

Table 4.39 : Tukey and Gabriel Post-Hoc analysis of tender phase problems (importance).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
PT5 - Awarding the contract to the lower bidder price regardless of the quality of service	Tukey HSD	Consultant	Contractor	0,609	0,335	0,171
			Designer	-0,115	0,413	0,958
		Contractor	Consultant	-0,609	0,335	0,171
			Designer	-0,724	0,324	0,073
		Designer	Consultant	0,115	0,413	0,958
			Contractor	0,724	0,324	0,073
	Gabriel	Consultant	Contractor	0,609	0,335	0,169
			Designer	-0,115	0,413	0,989
		Contractor	Consultant	-0,609	0,335	0,169
			Designer	-0,724	0,324	0,066
		Designer	Consultant	0,115	0,413	0,989
			Contractor	0,724	0,324	0,066
PT9 - Inadequate study for tender document to observe discrepancies before tender awarding	Tukey HSD	Consultant	Contractor	.891*	0,281	0,006*
			Designer	0,038	0,347	0,993
		Contractor	Consultant	-.891*	0,281	0,006*
			Designer	-.853*	0,273	0,007*
		Designer	Consultant	-0,038	0,347	0,993
			Contractor	.853*	0,273	0,007*
	Gabriel	Consultant	Contractor	.891*	0,281	0,004*
			Designer	0,038	0,347	0,999
		Contractor	Consultant	-.891*	0,281	0,004*
			Designer	-.853*	0,273	0,005*
		Designer	Consultant	-0,038	0,347	0,999
			Contractor	.853*	0,273	0,005*

*. The mean difference is significant at the 0.05 level.

In the construction phase, the p-values of the variables can be seen at Table 4.40. For “PC24-Delayed revision of drawings by designer”, the Games-Howell test was applied and for “PC5-Ambiguous design details” and “PC9-Construction errors and defective work at the construction site”, as seen at Table 4.41, Tukey and Gabriel tests were applied.

Table 4.40 : Homogeneity of construction phase problems (importance).

Causes	Levene Statistic	Sig.
PC5 - Ambigious design details	0,497	0,611
PC9 - Construction errors and defective work at the construction site	0,936	0,397
PC24 - Delayed revision of drawings by designer	3,391	0,039

After applying tests, for “PC5-Ambiguous design details”, between the Contractor and Designer.

Table 4.41 : Tukey and Gabriel Post-Hoc analysis of construction phase problems (importance).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
PC5 - Ambigious design details	Tukey HSD	Consultant	Contractor	0,214	0,276	0,720
			Designer	-0,455	0,341	0,381
		Contractor	Consultant	-0,214	0,276	0,720
			Designer	-.669*	0,268	0,039*
		Designer	Consultant	0,455	0,341	0,381
			Contractor	.669*	0,268	0,039*
	Gabriel	Consultant	Contractor	0,214	0,276	0,801
			Designer	-0,455	0,341	0,458
		Contractor	Consultant	-0,214	0,276	0,801
			Designer	-.669*	0,268	0,033*
		Designer	Consultant	0,455	0,341	0,458
			Contractor	.669*	0,268	0,033*
PC9 - Construction errors and defective work at the construction site	Tukey HSD	Consultant	Contractor	0,692	0,306	0,068
			Designer	0,199	0,377	0,859
		Contractor	Consultant	-0,692	0,306	0,068
			Designer	-0,493	0,296	0,226
		Designer	Consultant	-0,199	0,377	0,859
			Contractor	0,493	0,296	0,226
	Gabriel	Consultant	Contractor	0,692	0,306	0,059
			Designer	0,199	0,377	0,935
		Contractor	Consultant	-0,692	0,306	0,059
			Designer	-0,493	0,296	0,235
		Designer	Consultant	-0,199	0,377	0,935
			Contractor	0,493	0,296	0,235

*. The mean difference is significant at the 0.05 level.

For the last phase as design-construction phase, according to the results of Levene's tests, except "PDC28-Poor project management" variable, for the other three variables as "PDC14-Design Complexity", "PDC16-Economic Situation" and "PDC29-Poorly done planning and scheduling" the Tukey and Gabriel tests were applied, can be seen at Table 4.43. Because of the lower p-value of "PDC28-Poor project management" variable, as seen at Table 4.42, the Games-Howell test was applied. Results of the Games-Howell post-hoc test, there is a difference between Contractors and Designers.

Table 4.42 : Homogeneity of design-construction phase problems (importance).

Causes	Levene Statistic	Sig.
PDC14 - Design Complexity	2,660	0,077
PDC16 - Economic Situation	1,561	0,217
PDC28 - Poor project management	3,861	0,026
PDC29 - Poorly done planning and scheduling	2,852	0,065

Table 4.43 : Games-Howell Post-Hoc analysis of design-construction phase problems (importance).

(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
Dependent Variable:	PDC28 - Poor project management			
Consultant	Contractor	0,547	0,316	0,216
	Designer	-0,276	0,292	0,621
Contractor	Consultant	-0,547	0,316	0,216
	Designer	-.823*	0,224	0,002*
Designer	Consultant	0,276	0,292	0,621
	Contractor	.823*	0,224	0,002*

*. The mean difference is significant at the 0.05 level.

As seen at Table 4.44, in "PDC14-Design Complexity", there is a difference between Contractors and Designers; for "PDC16-Economic Situation", between Consultants and Contractors; for "PDC29-Poorly done planning and scheduling", between Contractors and Designers.

Table 4.44 : Tukey and Gabriel Post-Hoc analysis of design-construction phase problems (importance).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
PDC14 - Design Complexity	Tukey HSD	Consultant	Contractor	0,417	0,336	0,435
			Designer	-0,391	0,415	0,616
		Contractor	Consultant	-0,417	0,336	0,435
			Designer	-.808*	0,326	0,041*
		Designer	Consultant	0,391	0,415	0,616
			Contractor	.808*	0,326	0,041*
	Gabriel	Consultant	Contractor	0,417	0,336	0,479
			Designer	-0,391	0,415	0,722
		Contractor	Consultant	-0,417	0,336	0,479
			Designer	-.808*	0,326	0,034*
		Designer	Consultant	0,391	0,415	0,722
		Contractor	Consultant	-0,417	0,336	0,479
			Designer	-.808*	0,326	0,034*
		Designer	Consultant	0,391	0,415	0,722
			Contractor	.808*	0,326	0,034*
PDC16 - Economic Situation	Tukey HSD	Consultant	Contractor	.779*	0,306	0,035*
			Designer	0,353	0,377	0,621
		Contractor	Consultant	-.779*	0,306	0,035*
			Designer	-0,426	0,296	0,327
		Designer	Consultant	-0,353	0,377	0,621
			Contractor	0,426	0,296	0,327
	Gabriel	Consultant	Contractor	.779*	0,306	0,027*
			Designer	0,353	0,377	0,727
		Contractor	Consultant	-.779*	0,306	0,027*
			Designer	-0,426	0,296	0,354
		Designer	Consultant	-0,353	0,377	0,727
			Contractor	0,426	0,296	0,354
PDC29 - Poorly done planning and scheduling	Tukey HSD	Consultant	Contractor	0,612	0,350	0,195
			Designer	-0,122	0,433	0,957
		Contractor	Consultant	-0,612	0,350	0,195
			Designer	-0,734	0,339	0,085
		Designer	Consultant	0,122	0,433	0,957
			Contractor	0,734	0,339	0,085
	Gabriel	Consultant	Contractor	0,612	0,350	0,195
			Designer	-0,122	0,433	0,989
		Contractor	Consultant	-0,612	0,350	0,195
			Designer	-0,734	0,339	0,078*
		Designer	Consultant	0,122	0,433	0,989
			Contractor	0,734	0,339	0,078*

In addition to these results, there is no significant difference between the groups to compare for the factors about the occurence of the variables as “PDC13-Poorly written contract & vague contract details”, and importance of the variables as “PT5-Awarding the contract to the lower bidder price regardless of the quality of service”, “PC24-Delayed revision of drawings by designer” and PC9-Construction errors and defective work at the construction site”.

5. CONCLUSIONS AND RECOMMENDATIONS

This chapter aims to conclude the research and give recommendations/suggestions for the design-construction interface problems consistent with the research findings. The main problem, objectives and findings that started the study were brought together.

Throughout the research, the design-construction interface problems and their consequences on construction projects were investigated. A comprehensive review of the literature was carried out to achieve the aim of the research. The main goal of the research was to determine the problems in any phase of the project and to minimize their impacts. Ninety-one (91) causes were collected through a literature review and used in the questionnaire survey to analyze the occurrence and importance of the problems among construction project professionals. These causes were grouped under four major phases and distributed to construction project professionals. Seventy-one (71) questionnaires were collected and analyzed quantitively. Results were obtained and finally, recommendations to reduce the impact of the design-construction interface problems in construction projects were brought together.

According to the questionnaire survey results;

The top five most occurred problems from the consultant's point of view;

1. PDC16 - Economic Situation
2. PC15 - Incomplete drawings and specification
3. PC9 - Construction errors and defective work at the construction site
4. PDC17 - Fast Track Construction
5. PDC28 - Poor project management

The top five most important problems from the consultant's point of view;

1. PC9 - Construction errors and defective work at the construction site
2. PDC16 - Economic Situation
3. PT5 - Awarding the contract to the lower bidder price regardless of the quality of service

4. PT9 - Inadequate study for the tender document to observe discrepancies before tender awarding
5. PC24 - Delayed revision of drawings by designer

The top five most occurred problems from the contractor's point of view;

1. PDC17 - Fast Track Construction
2. PD6 - Time limitation in the design phase
3. PD9 - Unstable owner requirements
4. PT5 - Awarding the contract to the lower bidder price regardless of the quality of service
5. PD8 - Lack of proper coordination between various disciplines of the design team

The top five most important problems from the contractor's point of view;

1. PC41 - Lack of Skilled Manpower
2. PC3 - Insufficient working drawing details
3. PC40 - Lack of communication & coordination among all parties
4. PC8 - Design errors
5. PD8 - Lack of proper coordination between various disciplines of the design team

The top five most occurred problems from the designer's point of view;

1. PC10 - Lack of skilled or specialized human resources
2. PD6 - Time limitation in the design phase
3. PD9 - Unstable owner requirements
4. PD15 - Designer busy with too many assignments
5. PT5 - Awarding the contract to the lower bidder price regardless of the quality of service

The top five most important problems from the designer's point of view in the questionnaire were;

1. PD13 - Data provided to the designer are incorrect

2. PD31 - Mistakes and discrepancies in design documents
3. PDC28 - Poor project management
4. PD19 - Designer's knowledge lacking of engineering design techniques and software
5. PT5 - Awarding the contract to the lower bidder price regardless of the quality of service

As a result, "PDC16 - Economic Situation" and "PC9 - Construction errors and defective work at the construction site" determined as the most occurred and most important problems from the consultant's point of view. From the contractor's point of view, the most occurred and most important problem is identified as "PD8 - Lack of proper coordination between various disciplines of the design team". Additionally, "PT5 - Awarding the contract to the lower bidder price regardless of the quality of service" was regarded as the most occurred and most important problem for the designers.

On which issues these three groups should be considered on the same page, "PT5 - Awarding the contract to the lower bidder price regardless of the quality of service" is ranked at the top in every stakeholders' list. As seen from the top list, "PDC17 - Fast Track Construction" becomes critical for consultant and contractor groups; "PD6 - Time limitation in the design phase" and "PD9 - Unstable owner requirements" are for contractor and designer groups.

From these findings, it can be said that the economic situation in a project and construction site activities and errors at that point is critical for consultants. Surprisingly, consultants have more concerns about construction site issues than the contractors have. But these two groups agreed that the problem level in fast track construction ideas is high. Also, this one is a predictable outcome in that contractors have a problem with the lack of coordination between design teams. The design team nurtures the project and the conflict and miscommunication within the project team are reflected in the project and create problems; this in turn, affects the contractor firm. According to another result, owner-related problems affect contractor and designer groups mostly. Given insufficient time for design is related to the owner decisions and if the owner wants to get a profitable and successful project in the end, he/she should be conscious of the necessary areas of time management. Coming to another subject

that if the owner changes his/her thoughts about the project frequently, the process of the project becomes chaotic.

To avoid the above listed problems, related recommendations can be made which are also consistent with other research from the literature:

- It can be seen that “PD6 – Time limitation in the design phase” is a common problem in the survey results. Similarly, giving insufficient time for developing design phases is one of the most common source of problems in the literature. It is known that, without giving adequate time while working on conceptual or other phases of design in a project, it causes misunderstanding at later stages of construction. Because, especially in site activities, all the construction professionals get design documents and know them as final and complete documents, continuing as what they understand from the project. So, with given sufficient time to design professionals, it helps eliminate design conflicts (Arain and Assaf, 2007). Designers must be given adequate time to prepare drawings and specifications in accordance with the most recent building codes. They will be compensated following their efforts (Choudhry and Azhar, 2017). Accordingly, more financial resources and more time should be given to the design.

- “PDC28 - Poor project management” is chosen as one of the most occurred problems according to consultants and the most important problem according to designers. Advanced project management programs are required to create design management (Oladokun and Alshaikh, 2018). Executing a precise action plan from start to finish, defining specific goals for the project team, employing value engineering and reviewing the design phases at 30%, 40%, and 60% (Oladokun and Alshaikh, 2018). Using quality assurance / quality contractors during the design and implementation phases (Oladokun and Alshaikh, 2018; Wanget al., 2016) suggested partnership as a strategy for improving design management (AL Mousli and El-Sayegh, 2016). To improve construction interface management, Lin (2015) suggested using BIM. BIM should be used, according to Elmualim and Gilder (2014), to enhance design management and teamwork (AL Mousli and El-Sayegh, 2016). According to survey results, in construction projects, there should always be a balance between cost, time and quality. In general, the expectation is "A quality and low-cost construction project, but by affecting the duration of the project, or on the contrary, having a quality and fast project can also be possible by affecting the cost". While high quality is not always the primary goal for the client, it is extremely important to a successful project.

- “PT5 - Awarding the contract to the lower bidder price regardless of the quality of service” is ranked as one of the most occurred and important problems according to all three groups. For this reason, owners should examine the tenderers' qualifications, their own financial stability, their level of safety, and the calibre of their heavy equipment. Before the contract is awarded, the technical viability of each proposal must be established (Abu-Reishah and Hiyassat, 2021). Additionally, pinpointing the underlying reasons for interface risks may help to enhance the project management procedure (Abu-Reishah and Hiyassat, 2021). According to survey results, designers think that the contracts are very good does not mean that what is written in the contracts will be realized in practice. For this reason, instead of a low price / tight contract, the right price / tight contract / competent contractor should be used. A competent contractor means that starting from the design architect, the whole project team and then the contractor are competent.

- “PD31 - Mistakes and discrepancies in design documents” becomes one of the most important problems according to the designer group. Also, according to survey results, the construction team should not lack information and should resolve the missing details in communication with the design team. To be able to waive this problem, both the designer and consultant must ensure that all construction plans and specifications are thoroughly examined before on-site construction activity. Managing design modifications can assist stakeholders in achieving maximum project satisfaction. The approval authorities' monitoring role ensures that inconsistencies are avoided (Choudhry and Azhar, 2017). According to survey results, many necessary details must have been solved before the projects went to the site.

- “PDC16 - Economic Situation” is one of the most occurred and important problems from the consultant’s point of view. All stakeholders, particularly the owner, must keep a close eye on the flow of finances for the project to control the risks that develop throughout its implementation (Choudhry and Azhar, 2017). To achieve this, it was recommended by the respondents that in today's conditions, it is very important that the design and construction be predictable with cost.

- To avoid “PC41 - Lack of Skilled Manpower”, contractors must ensure that they are operating with trained personnel while keeping high-quality production (Choudhry and Azhar, 2017).

- “PC40 - Lack of communication & coordination among all parties” is found as a critical point according to contractors. The solution for “the communication gap between designer and constructor” would be “the involvement of the contractor at the design phases”. By doing this, the parties' communication gap will be reduced, and it will also be possible to address the reasons for inconsistent working drawing details. Professionals will also get the chance to improve their coordination for a better work environment (Arain et al., 2006). Even though project partnering could result in participants' dedication to common goals, their comprehension of shared goals and values, and an entirely harmonious and cooperative atmosphere, it may help the construction project move more seamlessly without the interference of interface problems, in particular the coordination and experience factors (Huang et al., 2008). According to survey results, to avoid this problem, the complementary roles of the parties should be clearly expressed in the contracts. In addition to the survey outcomes, as it applies to every stakeholder and their relations with each other, communication is a very important issue. Timing, use of information, and human relations are the criteria that significantly affect the project process. However, the process and relations can be kept under control within the framework of the rules. It is important that everyone undertakes their part and handles it meticulously. Problems are minimized in cases where the coordination between the design and construction teams is complete and the quality control processes are not disrupted.

- To be able to waive “PT9 - Inadequate study for the tender document to observe discrepancies before tender awarding” problem, contractors and designers need to work together to gather a variety of information on the site conditions, the environment, the local economy, and the impacted communities at the initial design stage to manage the risks involved in the bidding process (Zhang et al., 2018). The Contractor-Designer alliance should apply the proper incentives at the final design stage to encourage technically adept designs and improve management of the interfaces between design, procurement, and construction (Zhang et al., 2018). To avoid this problem according to survey respondents, the design team must be skilled and qualified and sufficient time should be given to the design team in the preparation of the tender and construction package. The owner should carefully control the package in question and create its budget well. The questions asked by the contractor candidates at the tender stage are very important and they should hold meetings with

the contractor candidates at the tender stage. Thanks to these meetings, the contractor candidates will better understand the scope of the work and many problems will be eliminated before the construction phase.

- "PD19 - Designer's knowledge lacking engineering design techniques and software" found an important issue from the designers perspective and according to survey results, consultants think that the design team must have information about the production to be made and the material to be used. In addition, the designers need to evaluate the problems that arise during the construction process more constructively. Thus, the problems that may be encountered in the next phases will be reduced.

- From the survey results, to eliminate the "PD9 - Unstable owner requirements" problem, it may be a healthy alternative for the owner to work with a consultant (project management) firm that has knowledge of both the design and construction parts.

- To lessen the impacts of the "PD13 - Data provided to the designer are incorrect" problem, according to survey results, it is necessary to clearly convey the expectations of the owner to the designer, to produce applicable, up-to-date, useful and creative projects, taking into account the expectations of the designer, and to manage the application stages by fully professional teams. Otherwise, it is possible to encounter all kinds of interface problems frequently.

The most common suggestion for resolving the design - construction interface problems is to help in locating the specific problems in the various projects and in assisting in their resolution during project execution. During the project life cycle, it's critical to identify probable problem origins (Arain and Assaf, 2007). There is a need to implement stronger and more extensive methods to coordinate actions at the interface in light of these disputes, which might eventually have an impact on any construction project (Arain and Assaf, 2007).

This study helped to identify the design-construction interface problem areas in construction projects. Future investigation can be focused on the problems that were highly ranked among the survey participants. Accordingly, potential research points can be revealed as follows: Both parties ranked "PD6 – Time limitation in the design phase" as the highest one. Since time is an important input in construction projects, this factor can be further analyzed. Also, "PT5-Awarding the contract to the lower

bidder price regardless of the quality of service" is ranked as one of the highest variables. It can be researched why quality is preferred over cost. It may be necessary to investigate why the owner frequently changes its requirements and changes design. The idea of involving a specialized third party or consultant to implement quality control practices during the construction process can be studied.

In this study, there is not any division according to project delivery systems. For the future studies, for example, design-build system can be taken and survey and analysis of the study can be built upon this delivery system categorization. Also, it is necessary to create the ideal scene based on the main subject and problems of the study. If it is desired to define the ideal scene for each identified stakeholder (designer, consultant, contractor) and the ideal conditions in which the problem is solved, it can be described as follows:

- For designers, time/schedule is one of the most important input. Sufficient time for designers should be defined by the owner especially and should be left free to achieve the best for the project, for the process. It is important that the demands of the owner are stable, that the needs program is taken at once, that the owner is giving information clearly. The low number of revision requests and the designer is not busy with non-project works are factors that contribute to the process. Project management's supportive style process management for the designer team will contribute to the designer and therefore to the project.

- For consultants, the economic status of the project is one of the most important factors. It is important that the fee they demand to the consultants in return for the work is paid in the time frame they demand. A well-managed process by project management team will make all consultants happy.

- For contractors, submission of full package design documents is one of the most important issues beyond all. Because all the site activities, budget, schedule depends on this project data. With the help of sufficient and complete project package, work packaging can be done properly and right sub-contractor can be choosen. In this way, a quality and good project process and finalization will come out. As with designers, it is important that owner requests are consistent and stable throughout the process. Coordination and communication skills between stakeholders should be high, and problems arising from coordination should not occur. Besides, considering the site

activities, the manpower resource should be sufficient and quality work should be targeted.

To conclude, the findings of this thesis research can help construction project professionals by providing an understanding of the primary design-construction interface problems. By having knowledge of the main problems and their impacts, participants can take precautions, make effort to minimize their impacts, and after all make a significant contribution to the successfully completed construction projects.

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APPENDICES

APPENDIX A: Questionnaire “Design-Construction Interface Problems in Construction Projects”

APPENDIX B: Tukey and Gabriel Post-Hoc analysis of design-construction phase problems (occurrence).

APPENDIX A: Questionnaire “Design-Construction Interface Problems in Construction Projects”

Design-Construction Interface Management in Construction Projects // Yapım Projelerinde Tasarım-Yapım Arayüz Yönetimi

!ENGLISH BELOW!

TR

Bu anket, İTÜ Mimarlık Anabilim Dalı, Proje ve Yapım Yönetimi Yüksek Lisans Programı'nda yürütülmekte olan bir yüksek lisans tez çalışması kapsamında oluşturulmuş olup; yapım projelerind "Tasarım" ve "Yapım" süreçlerini irdeleyerek, bu iki aşamada ve aşamaların kesişiminde yaşanan problemlere odaklanmaktadır.

İnşaat sektöründe aktif rol alan İşveren, Mimar, Mühendis, Yüklenici, Danışman vb. tüm paydaşların yanıtlamasına açık olan bu anket çalışmasında, sektörde yukarıda sözü edilen problemlere değinmek hedeflenmiştir. Bu bağlamda, anket katılımcılarının soruları kendi deneyimleri üzerinden yanıtlamaları beklenmektedir.

Bu anket ile elde edilen bilgiler, ankete konu olan yüksek lisans tez çalışmasında yalnızca araştırma amaçlı kullanılacaktır.

Zaman ayırdığınız ve destek verdiğiniz için teşekkür ederiz.

Anket veya araştırma konusu ile ilgili herhangi bir sorunuz oluşursa, irtibat kurmaktan çekinmeyiniz.

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ENG

This survey will form a part of the master's thesis research; By examining the "Design" and "Construction" processes in construction projects, it focuses on the problems experienced in these two phases and the intersection of the phases.

In this survey study, which is open to answer by all stakeholders such as Employers, Architects, Engineers, Contractors, Consultants, etc., who take an active role in the construction sector, it has been tried to address the problems encountered in the sector. Participants are expected to answer questions based on their experience.

The information obtained through this survey will be used for research purposes only in the master thesis.

Figure A.1 : Questionnaire.

Thank you for your time and support.

If you have any questions about the survey or research topic, do not hesitate to contact us.

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Section.1 - General Information / Bölüm.1 - Genel Bilgiler

ENG
Please select the best fit option for you.
TR
Lütfen kendinize en uygun olan yanıtı seçiniz.

1. Type of your Organization,Company / Şirketinizin türü *

Yalnızca bir şıkkı işaretleyin.

- ◯ Consulting / Danışmanlık
- ◯ Contractor / Yüklenici
- ◯ Governmental Agency / Devlet Kurumu
- ◯ Designer / Tasarımcı (Mimari, Mühendislik vb. disiplinler)
- ◯ Diğer: _____

Figure A.1 (continued): Questionnaire.

2. Position in the Organization, Company / Şirketinizdeki konumunuz, göreviniz *

Yalnızca bir şıkkı işaretleyin.

- ◯ Owner / Firma sahibi, kurucu
- ◯ Project Manager , Deputy / Proje yöneticisi, vekili
- ◯ Contractor , Main Contractor / Yüklenici, ana yüklenici
- ◯ Construction Project Manager / Yapım yöneticisi
- ◯ Consultant / Danışman
- ◯ Designer / Tasarımcı, projeci (mimari, mühendislik vb.)
- ◯ Architect / Mimar
- ◯ Engineer , Project Engineer / Mühendis
- ◯ Investor / Yatırımcı
- ◯ Real Estate Developer / Gayrimenkul geliştirici
- ◯ Operations & Maintenance / İşletme & bakım
- ◯ Site , Office Engineer / Saha - Ofis Mühendisi, Mimarı
- ◯ Diğer: _____

3. Years of experience / Deneyim *

Yalnızca bir şıkkı işaretleyin.

- ◯ Less than 5 years / 5 yıldan az
- ◯ From 5 years to less than 10 years / 5-10 yıl arası
- ◯ From 10 years to less than 15 years / 10-15 yıl arası
- ◯ 15 years and over / 15 yıldan fazla

Figure A.1 (continued): Questionnaire.

Section.2 - Factors that causing the design - construction interface problems (INDICATE AS THE **DEGREE OF OCCURENCE**) / Bölüm.2 - Tasarım - Yapım arayüzünde problemlere yol açan nedenler (**OLUŞUM DERECESİNE GÖRE** DEĞERLENDİRİNİZ)

ENG
From your point of view, please indicate **the degree of occurrence** that lead to the presence of design – construction interface problems.
TR
Lütfen kendi bakış açınızdan tasarım – yapım arayüz problemlerinin varlığına yol açan faktörlerin **oluşum derecesini** belirtiniz.

4. First: Design Phase / Birinci: Tasarım, Dizayn Aşaması *

Her satırda yalnızca bir şıkkı işaretleyin.

	1 (Hiç-Never)	2 (Nadiren-Seldom)	3 (Bazen-Sometimes)	4 (Sıklıkla-Often)	5 (Her zaman-Always)
Involvement of the contractor in design conceptual phase / Yüklenici'nin tasarım konsept fazına katılımı	◯	◯	◯	◯	◯
Involvement of the contractor in design development phase / Yüklenici'nin tasarım geliştirme aşamasına katılımı	◯	◯	◯	◯	◯
Lack of stipulated data / Öngörülen veri eksikliği	◯	◯	◯	◯	◯
Delay in construction documents preparation / Yapım dokümanlarının hazırlanmasında gecikme	◯	◯	◯	◯	◯

Figure A.1 (continued): Questionnaire.

Lack of human resources for design firm / Tasarım Firması için insan kaynakları eksikliği					
Time limitation in design phase / Tasarım fazında süre kısıtı					
Lack of contractor involvement during the design phase / Tasarım fazında Yüklenici katılımının olmaması					
Lack of proper coordination between various disciplines of design team / Tasarım ekibinin çeşitli disiplinleri arasında koordinasyon eksikliği					
Unstable owner requirements / İşveren'in değişken gereksinimleri					
Contractor is not involved in the conceptual phase of design / Yüklenici'nin tasarımın konsept aşamasına dahil olmaması					
Contractor is not involved in the development phase of design / Yüklenici'nin tasarım geliştirme aşamasına dahil olmaması					
Data provided to designer are incomplete / Tasarımcıya sağlanan verilerin eksik olması					

Figure A.1 (continued): Questionnaire.

Data provided to designer are incorrect / Tasarımcıya sağlanan verilen hatalı olması					
Data is provided late to designer / Tasarımcıya verilerin geç sağlanması					
Designer busy in too many assignments / Tasarımcının çok fazla görevle meşgul olması					
Lack of awareness about governmental regulations, municipality requirements, statues and their modifications / Devlet düzenlemeleri, belediye gereklilikleri, statüler ve bunların değişiklikleri hakkında farkındalık eksikliği					
Designer's knowledge is lacking in constructability of design / Tasarımın yapılabilirliği konusunda tasarımcının bilgi eksikliği					
Lack of awareness about the availability of construction materials and equipment in the local market / Yerel pazarda inşaat malzemeleri ve ekipmanlarının mevcudiyeti konusunda farkındalık eksikliği					
Designer's knowledge is lacking on engineering					

Figure A.1 (continued): Questionnaire.

design technique and software / Tasarımcının mühendislik tasarım tekniği ve yazılımı konusunda bilgi eksikliği					
Frequent replacement of designer by the owner / Tasarımcının İşveren tarafından sık sık değiştirilmesi					
Personal and social problems of designer / Tasarımcının kişisel ve sosyal sorunları					
Lack of reward, delayed payment or less payment to designer by owner / Ödül eksikliği, gecikmeli ödeme veya İşveren tarafından tasarımcıya az ödeme yapılması					
Too little time is given to designer for completion of the design documents / Tasarım Dokümanlarının tamamlanması için tasarımcıya çok az zaman verilmesi					
Lack of project planning and analysis by owner at the project start / Proje başlangıcında İşveren tarafından yapılan proje planlama ve analiz eksikliği					
Frequent changes in the design due to owner dis-					

Figure A.1 (continued): Questionnaire.

satisfaction / İşverenin memnuniyetsizliği sebebiyle tasarımda sık sık değişiklik yapılması					
Approving authorities do not check carefully that the structure is designed according to the building bye-laws, codes and government rules / Onaylayan makamların, yapının bina yönetmeliğine, yönetmeliklere ve hükümet kurallarına göre tasarlandığını dikkatlice kontrol etmemesi					
Lack of awareness about the construction knowledge and ongoing site operations / Yapım bilgisi ve devam eden saha operasyonları hakkında farkındalık eksikliği					
Inaccurate estimation of project element costs and quantities / Proje öğesi maliyetlerinin ve miktarlarının yanlış tahmini					
Lack of design quality assurance practices / Tasarım kalite güvence uygulamalarının eksikliği					
Unclear definition for scope of work / İş kapsamının belirsiz olması					
Mistakes and discrepancies in design					

Figure A.1 (continued): Questionnaire.

documents / Tasarım belgelerindeki hatalar ve tutarsızlıklar					
Insufficient or inaccurate geotechnical investigation / Yetersiz veya hatalı jeoteknik araştırma					
Outsourcing of design services / Tasarım hizmetleri için dış kaynak kullanımı					
Involvement of the designer as a consultant / Tasarımcının danışman olarak sürece katılımı					
Delays in design approval by owner / İşveren tarafından tasarım onayının verilmesinde gecikme yaşanması					
Delays in preparing designs by design team / Tsarım ekibi tarafından tasarım paketinin tamamlanmasının gecikmesi					

5. Second: Tendering Phase / İkinci: İhale Aşaması *

Her satırda yalnızca bir şıkkı işaretleyin.

	1 (Hiç-Never)	2 (Nadiren-Seldom)	3 (Bazen-Sometimes)	4 (Sıklıkla-Often)	5 (Her zaman-Always)
Incomplete or inaccurate design documents					

Figure A.1 (continued): Questionnaire.

unintentionally provided with bidding documents / İhale belgeleriyle birlikte kasıtsız olarak sağlanan eksik veya yanlış tasarım belgeleri	○	○	○	○	○
Incomplete or inaccurate design documents intentionally provided with bidding documents / İhale belgeleriyle birlikte kasıtlı olarak sağlanan eksik veya yanlış tasarım belgeleri	○	○	○	○	○
Type of construction contract in use / Kullanımdaki inşaat sözleşmesinin türü	○	○	○	○	○
Contractor did not consider that the design is exotic, complex or not have the required expertise / Yüklenicinin, tasarımın egzotik, karmaşık olduğunu veya gerekli uzmanlığa sahip olmadığını düşünmemesi	○	○	○	○	○
Awarding the contract to the lower bidder price regardless of the quality of service / Hizmet kalitesinden bağımsız olarak daha düşük teklif veren ile sözleşme imzalanması	○	○	○	○	○
Absence of third party validation during defect liability period / Kusur sorumluluk süresi boyunca	○	○	○	○	○

Figure A.1 (continued): Questionnaire.

üçüncü taraf doğrulamasının olmaması					
Inappropriate work packaging and subcontracting / Uygun olmayan şekilde iş paketi dağıtımı ve taşeronluk	◯	◯	◯	◯	◯
Restricting the contractor classification and a specific experience for the subcontractors in the contract form by the client / Müşteri tarafından sözleşme formunda yüklenici sınıflandırmasının ve alt yükleniciler için belirli bir deneyimin kısıtlanması	◯	◯	◯	◯	◯
Inadequate study for tender document to observe discrepancies before tender awarding / İhalenin verilmesinden önce tutarsızlıkları gözlemlemek için ihale dokümanında yetersiz çalışma	◯	◯	◯	◯	◯

6. Third: Construction Phase / Üçüncü: Yapım Aşaması *

Her satırda yalnızca bir şıkkı işaretleyin.

	1 (Hiç-Never)	2 (Nadiren-Seldom)	3 (Bazen-Sometimes)	4 (Sıklıkla-Often)	5 (Her zaman-Always)
Lack of designer knowledge of available material and equipments /	◯	◯	◯	◯	◯

Figure A.1 (continued): Questionnaire.

Mevcut malzeme ve ekipmanlar hakkında tasarımcı bilgisi eksikliği					
Incomplete & adequate plans and specs / Eksik ve yetersiz planlar ve spektler					
Insufficient working drawing details / Yetersiz çizim detayları					
Exotic design & technology / Egzotik tasarım ve teknoloji					
Ambigious design details / Belirsiz tasarım detayları					
Lack of specialized construction manager / Uzman yapım müdürü eksikliği					
Material changes in types & specs during construction phase / İnşaat aşamasında spekt ve malzeme değişikliği					
Design errors / Tasarım hataları					
Construction errors and defective work at the construction site / Şantiye Sahasında inşaat hataları ve kusurlu işler					
Lack of skilled or specialized human resources / Nitelikli veya uzman insan kaynağı eksikliği					

Figure A.1 (continued): Questionnaire.

Designer's lack of awareness about on-going construction process / Tasarımcının devam eden inşaat süreci hakkında farkındalık eksikliği					
Contractor's lack of comprehension of drawings details and specs / Yüklenicinin çizim detaylarını ve teknik özellikleri anlamaması					
Involvement of designer as design consultant / Tasarımcının tasarım danışmanı olarak katılımı					
Contractor's lack of sufficient knowledge about new technology / Yüklenicinin yeni teknoloji hakkında yeterli bilgi sahibi olmaması					
Incomplete drawings and specification / Eksik çizimler ve spektler					
Delay in material approval (submittals) / Malzeme onaylarında (ve teslimlerinde) gecikme yaşanması					
Owner proposes changes because he had planned to make changes during construction / İşverenin inşaat sırasında değişiklik yapmayı planlamasından					

Figure A.1 (continued): Questionnaire.

ötürü değişiklik önermesi					
Owner proposes changes during construction due to sudden changes in his requirements / expectations / İşverenin, beklentilerdeki ani değişiklikler nedeniyle inşaat sırasında değişiklik önermesi					
Owner proposes changes during construction due to change in ownership / İşverenin, mülkiyet değişikliği nedeniyle inşaat sırasında değişiklik önermesi					
Owner proposes changes to assert his authority and make undue interference in construction / İşverenin, yetkisini kanıtlamak ve inşaatta gereksiz müdahalelerde bulunmak için değişiklik teklif etmesi					
Owner proposes changes due to financial problems / İşverenin mali sorunlar nedeniyle değişiklik teklif etmesi					
Slowness in decision making process by owner / İşveren tarafından karar sürecinde yaşanan yavaşlık					
Changes in building codes, bye-laws and government					

Figure A.1 (continued): Questionnaire.

rules / Bina kodlarında, tüzüklerde ve hükümet kurallarında değişiklikler					
Delayed revision of drawings by designer / Tasarımcı tarafından revizyon çizimlerinde gecikilmesi					
Drawings not properly stamped or certified by designer / Tasarımcı tarafından uygun şekilde damgalanmamış veya onaylanmamış çizimler					
Custody and supply of drawings at site / Sahada çizimlerin saklanması ve temini					
Delayed approval of drawings by owner or consultant / Çizimlerin İşveren veya Danışman tarafından geç onaylanması					
Material changes due to shortage of particular material in the market / Piyasada belirli bir malzeme kıtlığı nedeniyle malzeme değişiklikleri					
Material changes due to procurement delays by contractor / Yüklenici tarafından tedarik gecikmeleri nedeniyle malzeme değişiklikleri					

Figure A.1 (continued): Questionnaire.

Contractor does not follow recommended construction methods and reluctant to use proper construction equipment / Yüklenicinin önerilen inşaat yöntemini takip etmede ve uygun ekipmanları kullanmada isteksiz olması					
Contractor lacks in coordination and management during construction / Yüklenicinin yapım aşamasında koordinasyon ve yönetimden yoksun olması					
Contractor's staff facing shortage of tools and or equipment for measurement, alignment and or for adjustment at corners / Yüklenicinin personeli, ölçüm, hizalama ve/veya köşelerde ayarlama için alet ve/veya ekipman sıkıntısıyla karşı karşıya kalması					
Contractor and his staff focusing on other projects / Yüklenici ve ekibinin diğer projelere odaklanması					
Unanticipated weather conditions / Beklenmeyen hava koşulları					
Unforeseen problems and differing site conditions /					

Figure A.1 (continued)d: Questionnaire.

Öngörülemeyen sorunlar ve farklı saha koşulları					
Timing of proposed changes, i.e. whether at the start or at the end of construction / Önerilen değişikliklerin zamanlaması (inşaat başı veya sonu)	○	○	○	○	○
Approving authorities do not check carefully that the structure is constructed according to the approved building plans / Onaylayan makamların, yapının onaylanmış imar planlarına göre inşa edildiğini dikkatli bir şekilde kontrol etmemesi	○	○	○	○	○
Communication Gap between Constructor and Designer / Yüklenici ve tasarımcı arasındaki iletişim boşluğu	○	○	○	○	○
Lack of Mutual Respect between Constructor and Designer / Yüklenici ve tasarımcı arasında karşılıklı saygı eksikliği	○	○	○	○	○
Lack of communication & coordination among all parties / Tüm taraflar arasında iletişim ve koordinasyon eksikliği	○	○	○	○	○
Lack of Skilled Manpower / Nitelikli insan gücü	○	○	○	○	○

Figure A.1 (continued): Questionnaire.

eksikliği					
Interference of client during implementation / uygulama sırasında İşverenin müdahalesi	◯	◯	◯	◯	◯
Bad decision making / Kararların kötü bir şekilde alınması	◯	◯	◯	◯	◯
Lack of specialized quality control team / Kalite kontrol ekibinin yetersiz olması	◯	◯	◯	◯	◯
Frequent changes of subcontractors / Taşeronların sık değişmesi	◯	◯	◯	◯	◯
Financial and technical status of the contractor / Yüklenicinin mali ve teknik durumu	◯	◯	◯	◯	◯
Lateness in preparing construction documents (such as schedule, detailed drawings) / İnşaat belgelerinin hazırlanmasında gecikme (program, detaylı çizimler gibi)	◯	◯	◯	◯	◯

7. Forth: Design-Construction Phase / Dördüncü: Tasarım-Yapım Aşaması *

Her satırda yalnızca bir şıkkı işaretleyin.

	1 (Hiç-Never)	2 (Nadiren-Seldom)	3 (Bazen-Sometimes)	4 (Sıklıkla-Often)	5 (Her zaman-Always)

Figure A.1 (continued): Questionnaire.

Building codes / Bina kodları					
Governmental regulations / Devlet düzenlemeleri					
Lack of professional experience & judgement / Mesleki deneyim ve muhakeme eksikliği					
Obstinate nature of participants / Paydaşların inatçı doğası					
Participant's honest wrong beliefs / Paydaşların dürüst fakat yanlış inançları					
Unforeseen problems / Öngörülemeyen problemler					
Design omission / Tasarım ihmali					
Type of contract with the owner / İşverenle yapılan sözleşmenin türü					
Involvement of contractor as consultant / Yüklenicinin danışman olarak dahil olması					
Lack of buildability (constructability) studies / İnşa edilebilirlik çalışmalarının eksikliği					
Delay in approvals by government authorities / Hükümet yetkilileri					

Figure A.1 (continued): Questionnaire.

tarafından onaylarda gecikme					
Conflicts due to cultural differences / Kültürel farklılıklardan kaynaklanan çatışmalar	◯	◯	◯	◯	◯
Poorly written contract & vague contract details / Kötü yazılmış sözleşme ve belirsiz sözleşme detayları	◯	◯	◯	◯	◯
Design Complexity / Tasarım Karmaşıklığı	◯	◯	◯	◯	◯
Lack of Professionals Experience and Judgement / Profesyonellerin Tecrübe ve Yargı Yetersizliği	◯	◯	◯	◯	◯
Economic Situation / Ekonomik durum	◯	◯	◯	◯	◯
Fast Track Construction / Tasarım tamamlanmadan inşaata başlanması	◯	◯	◯	◯	◯
Weather Conditions / Hava durumları	◯	◯	◯	◯	◯
Nationalities of Participants / Paydaşların uyruğu	◯	◯	◯	◯	◯
Poor exchange of information leads to rework and change order / Yetersiz bilgi alışverişinden kaynaklı yeniden yapım ve değişiklik talebinin oluşması	◯	◯	◯	◯	◯

Figure A.1 (continued): Questionnaire.

Preparation and Approval of Shop Drawings / İmalat çizimlerinin hazırlanması ve onaylanması					
Personal Conflicts of Professionals / Profesyonellerin Kişisel Çatışmaları					
Incompetence of professional project management as individual service / Bireysel hizmet olarak profesyonel proje yönetiminin yetersizliği					
Inadequate choice of project contract type (Lump sum, unit price, etc.) / Yetersiz proje sözleşmesi türü seçimi (Anahtar teslim, birim fiyat vb.)					
Inadequate choice of project delivery system (deign-bid-build, etc.) / Yetersiz proje teslim sistemi seçimi (tasarla-ihale et-inşa et vb.)					
Delay in shop drawings, change orders and permits acceptance and inquiries / İmalat çizimlerinde, değişiklik taleplerinde ve izinlerin kabul ve sorgulanmasında gecikme					
Unrealistic client expectations regarding project time, cost and					

Figure A.1 (continued): Questionnaire.

quality / Proje süresi, maliyeti ve kalitesi ile ilgili gerçekçi olmayan İşveren beklentileri					
Poor project management / Kötü proje yönetimi					
Poorly done planning and scheduling / Planlamanın kötü yapılması					
Poor interface management / Kötü arayüz yönetimi					
Conflict resolution / Çatışma çözümü					
Incapability to predict and resolve project's problems related to new technological techniques / Yeni teknolojik tekniklerle ilgili proje sorunlarını tahmin edememe ve çözememe					
Violating conditions of the contract / Sözleşme şartlarını ihlal etmek					
Inconsistent planning / Tutarsız planlama					
Quality of design/contract documents / Tasarım ve sözleşme dokümanlarının kalitesi					

Figure A.1 (continued): Questionnaire.

Section.3 - Factors that causing the design - construction interface problems (INDICATE AS THE **IMPORTANCE**) / Bölüm.3 - Tasarım-Yapım arayüzünde problemlere yol açan nedenler (**ÖNEM DERECESİNE GÖRE** DEĞERLENDİRİNİZ)

ENG
From your point of view, please indicate **the importance of factors** that lead to the presence o design – construction interface problems.
TR
Lütfen kendi bakış açınızdan tasarım – yapım arayüz problemlerinin varlığına yol açan faktörlerin **önem derecesini** belirtiniz.

8. First: Design Phase / Birinci: Tasarım, Dizayn Aşaması *

Her satırda yalnızca bir şıkkı işaretleyin.

	1 (Önemsiz-Not important)	2 (Az önemli-Less important)	3 (Ne önemli ne değil-So so)	4 (Önemli-Important)	5 (Çok önemli-Ver important)
Involvement of the contractor in design conceptual phase / Yüklenici'nin tasarım konsept fazına katılımı					
Involvement of the contractor in design development phase / Yüklenici'nin tasarım geliştirme aşamasına katılımı					
Lack of stipulated data / Öngörülen veri eksikliği					
Delay in construction documents					

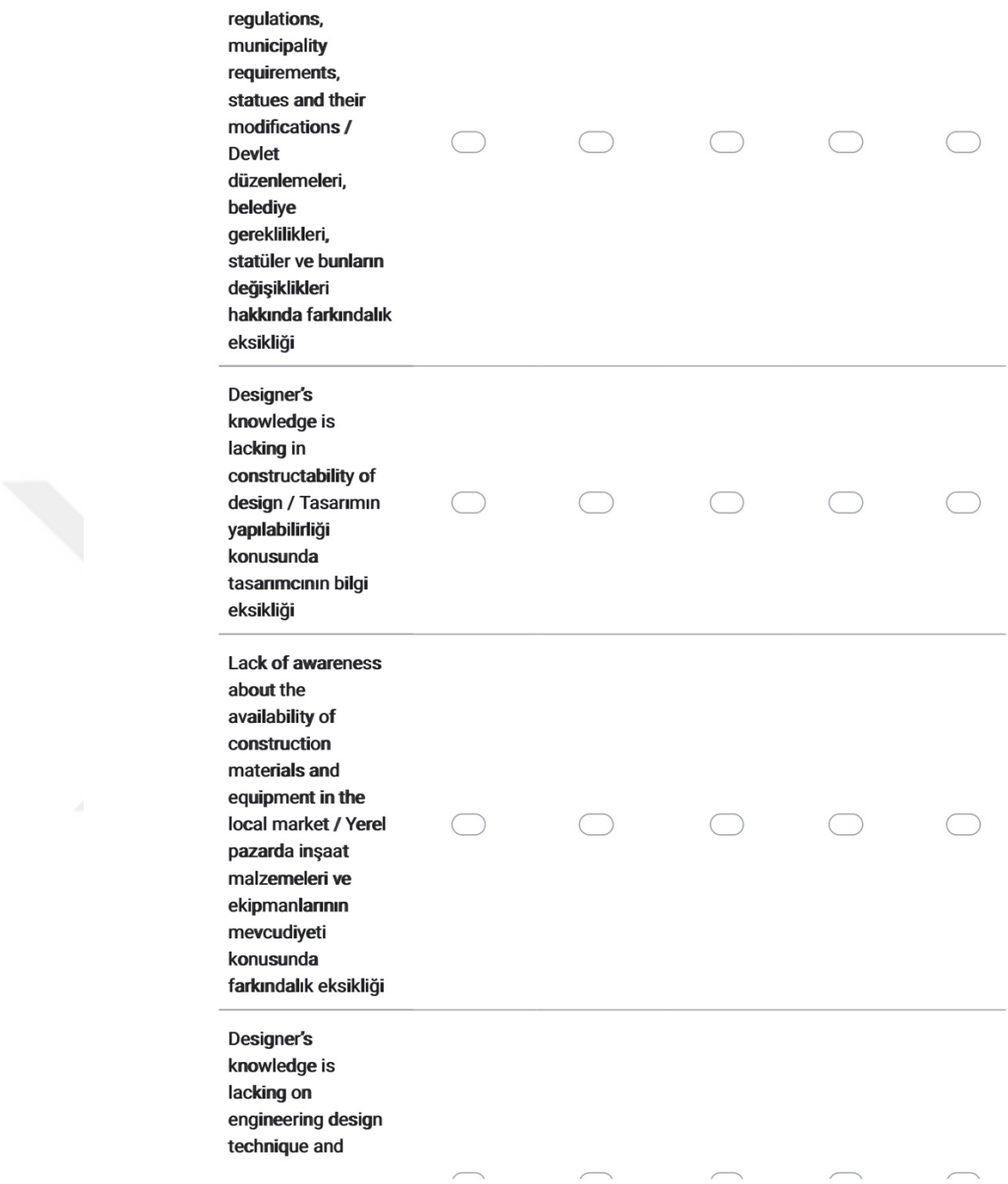
Figure A.1 (continued): Questionnaire.

preparation / Yapım dokümanlarının hazırlanmasında gecikme					
Lack of human resources for design firm / Tasarım Firması için insan kaynakları eksikliği					
Time limitation in design phase / Tasarım fazında süre kısıtı					
Lack of contractor involvement during the design phase / Tasarım fazında Yüklenici katılımının olmaması					
Lack of proper coordination between various disciplines of design team / Tasarım ekibinin çeşitli disiplinleri arasında koordinasyon eksikliği					
Unstable owner requirements / İşveren'in değişken gereksinimleri					
Contractor is not involved in the conceptual phase of					

Figure A.1 (continued): Questionnaire.

design / Yüklenici'nin tasarımın konsept aşamasına dahil olmaması					
Contractor is not involved in the development phase of design / Yüklenici'nin tasarım geliştirme aşamasına dahil olmaması					
Data provided to designer are incomplete / Tasarımcıya sağlanan verilerin eksik olması					
Data provided to designer are incorrect / Tasarımcıya sağlanan verilen hatalı olması					
Data is provided late to designer / Tasarımcıya verilerin geç sağlanması					
Designer busy in too many assignments / Tasarımcının çok fazla görevle meşgul olması					
Lack of awareness about governmental					

Figure A.1 (continued): Questionnaire.



regulations, municipality requirements, statues and their modifications / Devlet düzenlemeleri, belediye gereklilikleri, statüler ve bunların değişiklikleri hakkında farkındalık eksikliği					
Designer's knowledge is lacking in constructability of design / Tasarımın yapılabilirliği konusunda tasarımcının bilgi eksikliği					
Lack of awareness about the availability of construction materials and equipment in the local market / Yerel pazarda inşaat malzemeleri ve ekipmanlarının mevcudiyeti konusunda farkındalık eksikliği					
Designer's knowledge is lacking on engineering design technique and					

Figure A.1 (continued): Questionnaire.

software / Tasarımcının mühendislik tasarım tekniği ve yazılımı konusunda bilgi eksikliği					
Frequent replacement of designer by the owner / Tasarımcının İşveren tarafından sık sık değiştirilmesi					
Personal and social problems of designer / Tasarımcının kişisel ve sosyal sorunları					
Lack of reward, delayed payment or less payment to designer by owner / Ödül eksikliği, gecikmeli ödeme veya İşveren tarafından tasarımcıya az ödeme yapılması					
Too little time is given to designer for completion of the design documents / Tasarım Dokümanlarının tamamlanması için tasarımcıya çok az zaman verilmesi					

Figure A.1 (continued): Questionnaire.

Lack of project planning and analysis by owner at the project start / Proje başlangıcında İşveren tarafından yapılan proje planlama ve analiz eksikliği	○	○	○	○	○
Frequent changes in the design due to owner dis-satisfaction / İşverenin memnuniyetsizliği sebebiyle tasarımda sık sık değişiklik yapılması	○	○	○	○	○
Approving authorities do not check carefully that the structure is designed according to the building bye-laws, codes and government rules / Onaylayan makamların, yapının bina yönetmeliğine, yönetmeliklere ve hükümet kurallarına göre tasarlandığını dikkatlice kontrol etmemesi	○	○	○	○	○
Lack of awareness about the construction knowledge and ongoing site operations / Yapım	○	○	○	○	○

Figure A.1 (continued): Questionnaire.

bilgisi ve devam eden saha operasyonları hakkında farkındalık eksikliği					
Inaccurate estimation of project element costs and quantities / Proje öğesi maliyetlerinin ve miktarlarının yanlış tahmini					
Lack of design quality assurance practices / Tasarım kalite güvence uygulamalarının eksikliği					
Unclear definition for scope of work / İş kapsamının belirsiz olması					
Mistakes and discrepancies in design documents / Tasarım belgelerindeki hatalar ve tutarsızlıklar					
Insufficient or inaccurate geotechnical investigation / Yetersiz veya hatalı jeoteknik araştırma					
Outsourcing of					

Figure A.1 (continued): Questionnaire.

design services / Tasarım hizmetleri için dış kaynak kullanımı					
Involvement of the designer as a consultant / Tasarımcının danışman olarak sürece katılımı					
Delays in design approval by owner / İşveren tarafından tasarım onayının verilmesinde gecikme yaşanması					
Delays in preparing designs by design team / Tsarım ekibi tarafından tasarım paketinin tamamlanmasının gecikmesi					

9. Second: Tendering Phase / İkinci: İhale Aşaması *

Her satırda yalnızca bir şıkkı işaretleyin.

	1 (Önemsiz-Not important)	2 (Az önemli-Less important)	3 (Ne önemli ne değil-So so)	4 (Önemli-Important)	5 (Çok önemli-Very important)
Incomplete or inaccurate design documents unintentionally provided with bidding documents / İhale belgeleriyle					

Figure A.1 (continued): Questionnaire.

birlikte kasıtsız olarak sağlanan eksik veya yanlış tasarım belgeleri					
Incomplete or inaccurate design documents intentionally provided with bidding documents / İhale belgeleriyle birlikte kasıtlı olarak sağlanan eksik veya yanlış tasarım belgeleri					
Type of construction contract in use / Kullanımdaki inşaat sözleşmesinin türü					
Contractor did not consider that the design is exotic, complex or not have the required expertise / Yüklenicinin, tasarımın egzotik, karmaşık olduğunu veya gerekli uzmanlığa sahip olmadığını düşünmemesi					
Awarding the contract to the lower bidder price regardless of the quality of service / Hizmet kalitesinden					

Figure A.1 (continued): Questionnaire.

bağımsız olarak daha düşük teklif veren ile sözleşme imzalanması					
Absence of third party validation during defect liability period / Kusur sorumluluk süresi boyunca üçüncü taraf doğrulamasının olmaması	○	○	○	○	○
Inappropriate work packaging and subcontracting / Uygun olmayan şekilde iş paketi dağıtımı ve taşeronluk	○	○	○	○	○
Restricting the contractor classification and a specific experience for the subcontractors in the contract form by the client / Müşteri tarafından sözleşme formunda yüklenici sınıflandırmasının ve alt yükleniciler için belirli bir deneyimin kısıtlanması	○	○	○	○	○
Inadequate study for tender document to observe					

Figure A.1 (continued): Questionnaire.

discrepancies before tender awarding / İhalenin verilmesinden önce tutarsızlıkları gözlemlemek için ihale dokümanında yetersiz çalışma					

10. Third: Construction Phase / Üçüncü: Yapım Aşaması *

Her satırda yalnızca bir şıkkı işaretleyin.

	1 (Önemsiz-Not important)	2 (Az önemli-Less important)	3 (Ne önemli ne değil-So so)	4 (Önemli-Important)	5 (Çok önemli-Very important)
Lack of designer knowledge of available material and equipments / Mevcut malzeme ve ekipmanlar hakkında tasarımcı bilgisi eksikliği					
Incomplete & adequate plans and specs / Eksik ve yetersiz planlar ve spektler					
Insufficient working drawing details / Yetersiz çizim detayları					
Exotic design & technology / Egzotik tasarım ve teknoloji					

Figure A.1 (continued): Questionnaire.

Ambigious design details / Belirsiz tasarım detayları					
Lack of specialized construction manager / Uzman yapım müdürü eksikliği					
Material changes in types & specs during construction phase / İnşaat aşamasında spekt ve malzeme değişikliği					
Design errors / Tasarım hataları					
Construction errors and defective work at the construction site / Şantiye Sahasında inşaat hataları ve kusurlu işler					
Lack of skilled or specialized human resources / Nitelikli veya uzman insan kaynağı eksikliği					
Designer's lack of awareness about on-going construction process / Tasarımcının devam eden inşaat süreci hakkında					

Figure A.1 (continued): Questionnaire.

farkındalık eksikliği					
Contractor's lack of comprehension of drawings details and specs / Yüklenicinin çizim detaylarını ve teknik özellikleri anlamaması					
Involvement of designer as design consultant / Tasarımcının tasarım danışmanı olarak katılımı					
Contractor's lack of sufficient knowledge about new technology / Yüklenicinin yeni teknoloji hakkında yeterli bilgi sahibi olmaması					
Incomplete drawings and specification / Eksik çizimler ve spektler					
Delay in material approval (submittals) / Malzeme onaylarında (ve teslimlerinde) gecikme yaşanması					
Owner proposes changes because					

Figure A.1 (continued): Questionnaire.

he had planned to make changes during construction / İşverenin inşaat sırasında değişiklik yapmayı planlamasından ötürü değişiklik önermesi					
Owner proposes changes during construction due to sudden changes in his requirements / expectations / İşverenin, beklentilerdeki ani değişiklikler nedeniyle inşaat sırasında değişiklik önermesi					
Owner proposes changes during construction due to change in ownership / İşverenin, mülkiyet değişikliği nedeniyle inşaat sırasında değişiklik önermesi					
Owner proposes changes to assert his authority and make undue interference in construction / İşverenin, yetkisini kanıtlamak ve inşaatta gereksiz müdahalelerde					

Figure A.1 (continued): Questionnaire.

bulunmak için değişiklik teklif etmesi					
Owner proposes changes due to financial problems / İşverenin mali sorunlar nedeniyle değişiklik teklif etmesi	◯	◯	◯	◯	◯
Slowness in decision making process by owner / İşveren tarafından karar sürecinde yaşanan yavaşlık	◯	◯	◯	◯	◯
Changes in building codes, bye-laws and government rules / Bina kodlarında, tüzüklerde ve hükümet kurallarında değişiklikler	◯	◯	◯	◯	◯
Delayed revision of drawings by designer / Tasarımcı tarafından revizyon çizimlerinde gecikilmesi	◯	◯	◯	◯	◯
Drawings not properly stamped or certified by designer / Tasarımcı tarafından uygun	◯	◯	◯	◯	◯

Figure A.1 (continued): Questionnaire.

şekilde damgalanmamış veya onaylanmamış çizimler					
Custody and supply of drawings at site / Sahada çizimlerin saklanması ve temini	◯	◯	◯	◯	◯
Delayed approval of drawings by owner or consultant / Çizimlerin İşveren veya Danışman tarafından geç onaylanması	◯	◯	◯	◯	◯
Material changes due to shortage of particular material in the market / Piyasada belirli bir malzeme kıtlığı nedeniyle malzeme değişiklikleri	◯	◯	◯	◯	◯
Material changes due to procurement delays by contractor / Yüklenici tarafından tedarik gecikmeleri nedeniyle malzeme değişiklikleri	◯	◯	◯	◯	◯
Contractor does not follow recommended construction methods and reluctant to use					

Figure A.1 (continued): Questionnaire.

proper construction equipment / Yüklenicinin önerilen inşaat yöntemini takip etmede ve uygun ekipmanları kullanmada isteksiz olması					
Contractor lacks in coordination and management during construction / Yüklenicinin yapım aşamasında koordinasyon ve yönetimden yoksun olması					
Contractor's staff facing shortage of tools and or equipment for measurement, alignment and or for adjustment at corners / Yüklenicinin personeli, ölçüm, hizalama ve/veya köşelerde ayarlama için alet ve/veya ekipman sıkıntısıyla karşı karşıya kalması					
Contractor and his staff focusing on other projects / Yüklenici ve ekibinin diğer proejelere odaklanması					

Figure A.1 (continued): Questionnaire.

Unanticipated weather conditions / Beklenmeyen hava koşulları					
Unforeseen problems and differing site conditions / Öngörülemeyen sorunlar ve farklı saha koşulları					
Timing of proposed changes, i.e. whether at the start or at the end of construction / Önerilen değişikliklerin zamanlaması (inşaat başı veya sonu)					
Approving authorities do not check carefully that the structure is constructed according to the approved building plans / Onaylayan makamların, yapının onaylanmış imar planlarına göre inşa edildiğini dikkatli bir şekilde kontrol etmemesi					
Communication Gap between Constructor and Designer / Yüklenici					

Figure A.1 (continued): Questionnaire.

ve tasarımcı arasındaki iletişim boşluğu					
Lack of Mutual Respect between Constructor and Designer / Yüklenici ve tasarımcı arasında karşılıklı saygı eksikliği					
Lack of communication & coordination among all parties / Tüm taraflar arasında iletişim ve koordinasyon eksikliği					
Lack of Skilled Manpower / Nitelikli insan gücü eksikliği					
Interference of client during implementation / uygulama sırasında işverenin müdahalesi					
Bad decision making / Kararların kötü bir şekilde alınması					
Lack of specialized quality control team / Kalite kontrol ekibinin yetersiz olması					

Figure A.1 (continued): Questionnaire.

Frequent changes of subcontractors / Taşeronların sık değişmesi	◯	◯	◯	◯	◯
Financial and technical status of the contractor / Yüklenicinin mali ve teknik durumu	◯	◯	◯	◯	◯
Lateness in preparing construction documents (such as schedule, detailed drawings) / İnşaat belgelerinin hazırlanmasında gecikme (program, detaylı çizimler gibi)	◯	◯	◯	◯	◯

11. Forth: Design-Construction Phase / Dördüncü: Tasarım-Yapım Aşaması *

Her satırda yalnızca bir şıkkı işaretleyin.

	1 (Önemsiz-Not important)	2 (Az önemli-Less important)	3 (Ne önemli ne değil-So so)	4 (Önemli-Important)	5 (Çok önemli-Very important)
Building codes / Bina kodları	◯	◯	◯	◯	◯
Governmental regulations / Devlet düzenlemeleri	◯	◯	◯	◯	◯
Lack of professional experience & judgement / Mesleki deneyim ve	◯	◯	◯	◯	◯

Figure A.1 (continued): Questionnaire.

muhakeme eksikliği					
Obstinate nature of participants / Paydaşların inatçı doğası	◯	◯	◯	◯	◯
Participant's honest wrong beliefs / Paydaşların dürüst fakat yanlış inançları	◯	◯	◯	◯	◯
Unforeseen problems / Öngörülemeyen problemler	◯	◯	◯	◯	◯
Design omission / Tasarım ihmali	◯	◯	◯	◯	◯
Type of contract with the owner / İşverenle yapılan sözleşmenin türü	◯	◯	◯	◯	◯
Involvement of contractor as consultant / Yüklenicinin danışman olarak dahil olması	◯	◯	◯	◯	◯
Lack of buildability (constructability) studies / İnşa edilebilirlik çalışmalarının eksikliği	◯	◯	◯	◯	◯
Delay in approvals by government authorities /	◯	◯	◯	◯	◯

Figure A.1 (continued): Questionnaire.

Hükümet yetkilileri tarafından onaylarda gecikme					
Conflicts due to cultural differences / Kültürel farklılıklardan kaynaklanan çatışmalar	◯	◯	◯	◯	◯
Poorly written contract & vague contract details / Kötü yazılmış sözleşme ve belirsiz sözleşme detayları	◯	◯	◯	◯	◯
Design Complexity / Tasarım Karmaşıklığı	◯	◯	◯	◯	◯
Lack of Professionals Experience and Judgement / Profesyonellerin Tecrübe ve Yargı Yetersizliği	◯	◯	◯	◯	◯
Economic Situation / Ekonomik durum	◯	◯	◯	◯	◯
Fast Track Construction / Tasarım tamamlanmadan inşaata başlanması	◯	◯	◯	◯	◯
Weather Conditions / Hava durumları	◯	◯	◯	◯	◯

Figure A.1 (continued): Questionnaire.

Nationalities of Participants / Paydaşların uyruğu					
Poor exchange of information leads to rework and change order / Yetersiz bilgi alışverişinden kaynaklı yeniden yapım ve değişiklik talebinin oluşması					
Preparation and Approval of Shop Drawings / İmalat çizimlerinin hazırlanması ve onaylanması					
Personal Conflicts of Professionals / Profesyonellerin Kişisel Çatışmaları					
Incompetence of professional project management as individual service / Bireysel hizmet olarak profesyonel proje yönetiminin yetersizliği					
Inadequate choice of project contract type (Lump sum, unit price, etc.) / Yetersiz proje sözleşmesi türü seçimi (Anahtar teslim, birim fiyat					

Figure A.1 (continued): Questionnaire.

vb.)					
Inadequate choice of project delivery system (deign-bid-build, etc.) / Yetersiz proje teslim sistemi seçimi (tasarla-ihale et-inşa et vb.)	◯	◯	◯	◯	◯
Delay in shop drawings, change orders and permits acceptance and inquiries / İmalat çizimlerinde, değişiklik taleplerinde ve izinlerin kabul ve sorgulanmasında gecikme	◯	◯	◯	◯	◯
Unrealistic client expectations regarding project time, cost and quality / Proje süresi, maliyeti ve kalitesi ile ilgili gerçekçi olmayan İşveren beklentileri	◯	◯	◯	◯	◯
Poor project management / Kötü proje yönetimi	◯	◯	◯	◯	◯
Poorly done planning and scheduling / Planlamanın kötü yapılması	◯	◯	◯	◯	◯

Figure A.1 (continued): Questionnaire.

Poor interface management / Kötü arayüz yönetimi					
Conflict resolution / Çatışma çözümü					
Incapability to predict and resolve project's problems related to new technological techniques / Yeni teknolojik tekniklerle ilgili proje sorunlarını tahmin edememe ve çözememe					
Violating conditions of the contract / Sözleşme şartlarını ihlal etmek					
Inconsistent planning / Tutarsız planlama					
Quality of design/contract documents / Tasarım ve sözleşme dokümanlarının kalitesi					

Figure A.1 (continued): Questionnaire.

Section.4 - Recommendations, Suggestions, Comments / Bölüm.4 - Tavsiyeler, Öneriler, Yorumlar

ENG
Please give us your opinion besides the causes above.
TR
Lütfen yukarıdaki nedenlerin yanı sıra görüşünüzü bize bildirin.

12. Do you have any further comments or suggestions relative to the design-construction interface problems? / Tasarım-yapım arayüz sorunları ile ilgili başka yorum veya önerileriniz var mı?

Bu içerik Google tarafından oluşturulmamış veya onaylanmamıştır.

Google Formlar

Figure A.1 (continued): Questionnaire.

APPENDIX B: Tukey and Gabriel Post-Hoc analysis of design-construction phase problems (occurence).

Table B.1 : Tukey and Gabriel Post-Hoc analysis of design-construction phase problems (occurence).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
PDC7 - Design omission	Tukey HSD	Consultant	Contractor	.964*	0,309	0,008*
			Designer	0,218	0,382	0,836
		Contractor	Consultant	-.964*	0,309	0,008*
			Designer	-.746*	0,300	0,040*
		Designer	Consultant	-0,218	0,382	0,836
			Contractor	.746*	0,300	0,040*
	Gabriel	Consultant	Contractor	.964*	0,309	0,005*
			Designer	0,218	0,382	0,919
		Contractor	Consultant	-.964*	0,309	0,005*
			Designer	-.746*	0,300	0,034*
		Designer	Consultant	-0,218	0,382	0,919
			Contractor	.746*	0,300	0,034*
PDC8 - Type of contract with the owner	Tukey HSD	Consultant	Contractor	.975*	0,275	0,002*
			Designer	-0,032	0,340	0,995
		Contractor	Consultant	-.975*	0,275	0,002*
			Designer	-1.007*	0,267	0,001*
		Designer	Consultant	0,032	0,340	0,995
			Contractor	1.007*	0,267	0,001*
	Gabriel	Consultant	Contractor	.975*	0,275	0,001*
			Designer	-0,032	0,340	1,000
		Contractor	Consultant	-.975*	0,275	0,001*
			Designer	-1.007*	0,267	0,001*
		Designer	Consultant	0,032	0,340	1,000
			Contractor	1.007*	0,267	0,001*
PDC10 - Lack of buildability (constructability) studies	Tukey HSD	Consultant	Contractor	.815*	0,338	0,049*
			Designer	0,135	0,418	0,944
		Contractor	Consultant	-.815*	0,338	0,049*
			Designer	-0,681	0,328	0,103
		Designer	Consultant	-0,135	0,418	0,944
			Contractor	0,681	0,328	0,103
	Gabriel	Consultant	Contractor	.815*	0,338	0,040*
			Designer	0,135	0,418	0,984
		Contractor	Consultant	-.815*	0,338	0,040*
			Designer	-0,681	0,328	0,096
		Designer	Consultant	-0,135	0,418	0,984
			Contractor	0,681	0,328	0,096

Table B.1 (continued): Tukey and Gabriel Post-Hoc analysis of design-construction phase problems (occurence).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
PDC11 - Delay in approvals by government authorities	Tukey HSD	Consultant	Contractor	0,710	0,326	0,083
			Designer	-0,103	0,403	0,965
		Contractor	Consultant	-0,710	0,326	0,083
			Designer	-.813*	0,316	0,033*
		Designer	Consultant	0,103	0,403	0,965
			Contractor	.813*	0,316	0,033*
	Gabriel	Consultant	Contractor	0,710	0,326	0,073
			Designer	-0,103	0,403	0,992
		Contractor	Consultant	-0,710	0,326	0,073
			Designer	-.813*	0,316	0,027*
		Designer	Consultant	0,103	0,403	0,992
			Contractor	.813*	0,316	0,027*
PDC13 - Poorly written contract & vague contract details	Tukey HSD	Consultant	Contractor	0,645	0,316	0,111
			Designer	0,051	0,391	0,991
		Contractor	Consultant	-0,645	0,316	0,111
			Designer	-0,594	0,306	0,136
		Designer	Consultant	-0,051	0,391	0,991
			Contractor	0,594	0,306	0,136
	Gabriel	Consultant	Contractor	0,645	0,316	0,102
			Designer	0,051	0,391	0,999
		Contractor	Consultant	-0,645	0,316	0,102
			Designer	-0,594	0,306	0,133
		Designer	Consultant	-0,051	0,391	0,999
			Contractor	0,594	0,306	0,133
PDC16 - Economic Situation	Tukey HSD	Consultant	Contractor	1.123*	0,281	0,000*
			Designer	0,744	0,347	0,088
		Contractor	Consultant	-1.123*	0,281	0,000*
			Designer	-0,380	0,272	0,349
		Designer	Consultant	-0,744	0,347	0,088
			Contractor	0,380	0,272	0,349
	Gabriel	Consultant	Contractor	1.123*	0,281	0,000*
			Designer	0,744	0,347	0,102
		Contractor	Consultant	-1.123*	0,281	0,000*
			Designer	-0,380	0,272	0,381
		Designer	Consultant	-0,744	0,347	0,102
			Contractor	0,380	0,272	0,381

Table B.1 (continued): Tukey and Gabriel Post-Hoc analysis of design-construction phase problems (occurence).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
PDC20 - Poor exchange of information leads to rework and change order	Tukey HSD	Consultant	Contractor	1.062*	0,320	0,004*
			Designer	0,314	0,395	0,707
		Contractor	Consultant	-1.062*	0,320	0,004*
			Designer	-.747*	0,310	0,048*
		Designer	Consultant	-0,314	0,395	0,707
			Contractor	.747*	0,310	0,048*
	Gabriel	Consultant	Contractor	1.062*	0,320	0,003*
			Designer	0,314	0,395	0,811
		Contractor	Consultant	-1.062*	0,320	0,003*
			Designer	-.747*	0,310	0,041*
		Designer	Consultant	-0,314	0,395	0,811
			Contractor	.747*	0,310	0,041*
PDC23 - Incompetence of professional project management as individual service	Tukey HSD	Consultant	Contractor	.764*	0,287	0,026*
			Designer	0,686	0,354	0,136
		Contractor	Consultant	-.764*	0,287	0,026*
			Designer	-0,079	0,278	0,957
		Designer	Consultant	-0,686	0,354	0,136
			Contractor	0,079	0,278	0,957
	Gabriel	Consultant	Contractor	.764*	0,287	0,020*
			Designer	0,686	0,354	0,159
		Contractor	Consultant	-.764*	0,287	0,020*
			Designer	-0,079	0,278	0,987
		Designer	Consultant	-0,686	0,354	0,159
			Contractor	0,079	0,278	0,987
PDC24 - Inadequate choice of project contract type (Lump sum, unit price, etc.)	Tukey HSD	Consultant	Contractor	.982*	0,285	0,003*
			Designer	0,224	0,352	0,800
		Contractor	Consultant	-.982*	0,285	0,003*
			Designer	-.758*	0,276	0,021*
		Designer	Consultant	-0,224	0,352	0,800
			Contractor	.758*	0,276	0,021*
	Gabriel	Consultant	Contractor	.982*	0,285	0,002*
			Designer	0,224	0,352	0,891
		Contractor	Consultant	-.982*	0,285	0,002*
			Designer	-.758*	0,276	0,016*
		Designer	Consultant	-0,224	0,352	0,891
			Contractor	.758*	0,276	0,016*

Table B.1 (continued): Tukey and Gabriel Post-Hoc analysis of design-construction phase problems (occurence).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
PDC25 - Inadequate choice of project delivery system (deign-bid-build, etc.)	Tukey HSD	Consultant	Contractor	1.065*	0,284	0,001*
			Designer	0,462	0,350	0,390
		Contractor	Consultant	-1.065*	0,284	0,001*
			Designer	-0,604	0,275	0,079
		Designer	Consultant	-0,462	0,350	0,390
			Contractor	0,604	0,275	0,079
	Gabriel	Consultant	Contractor	1.065*	0,284	0,001*
			Designer	0,462	0,350	0,469
		Contractor	Consultant	-1.065*	0,284	0,001*
			Designer	-0,604	0,275	0,072
		Designer	Consultant	-0,462	0,350	0,469
			Contractor	0,604	0,275	0,072
PDC26 - Delay in shop drawings, change orders and permits acceptance and inquiries	Tukey HSD	Consultant	Contractor	.953*	0,292	0,005*
			Designer	0,545	0,361	0,293
		Contractor	Consultant	-.953*	0,292	0,005*
			Designer	-0,408	0,283	0,327
		Designer	Consultant	-0,545	0,361	0,293
			Contractor	0,408	0,283	0,327
	Gabriel	Consultant	Contractor	.953*	0,292	0,003*
			Designer	0,545	0,361	0,352
		Contractor	Consultant	-.953*	0,292	0,003*
			Designer	-0,408	0,283	0,354
		Designer	Consultant	-0,545	0,361	0,352
			Contractor	0,408	0,283	0,354
PDC28 - Poor project management	Tukey HSD	Consultant	Contractor	.964*	0,310	0,008*
			Designer	0,410	0,383	0,535
		Contractor	Consultant	-.964*	0,310	0,008*
			Designer	-0,554	0,301	0,164
		Designer	Consultant	-0,410	0,383	0,535
			Contractor	0,554	0,301	0,164
	Gabriel	Consultant	Contractor	.964*	0,310	0,005*
			Designer	0,410	0,383	0,635
		Contractor	Consultant	-.964*	0,310	0,005*
			Designer	-0,554	0,301	0,164
		Designer	Consultant	-0,410	0,383	0,635
			Contractor	0,554	0,301	0,164

Table B.1 (continued): Tukey and Gabriel Post-Hoc analysis of design-construction phase problems (occurence).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
PDC29 - Poorly done planning and scheduling	Tukey HSD	Consultant	Contractor	.750*	0,303	0,041*
			Designer	0,404	0,374	0,530
		Contractor	Consultant	-.750*	0,303	0,041*
			Designer	-0,346	0,294	0,470
		Designer	Consultant	-0,404	0,374	0,530
			Contractor	0,346	0,294	0,470
	Gabriel	Consultant	Contractor	.750*	0,303	0,034*
			Designer	0,404	0,374	0,630
		Contractor	Consultant	-.750*	0,303	0,034*
			Designer	-0,346	0,294	0,525
		Designer	Consultant	-0,404	0,374	0,630
			Contractor	0,346	0,294	0,525
PDC30 - Poor interface management	Tukey HSD	Consultant	Contractor	.949*	0,260	0,001*
			Designer	.936*	0,321	0,013*
		Contractor	Consultant	-.949*	0,260	0,001*
			Designer	-0,013	0,252	0,998
		Designer	Consultant	-.936*	0,321	0,013*
			Contractor	0,013	0,252	0,998
	Gabriel	Consultant	Contractor	.949*	0,260	0,001*
			Designer	.936*	0,321	0,014*
		Contractor	Consultant	-.949*	0,260	0,001*
			Designer	-0,013	0,252	1,000
		Designer	Consultant	-.936*	0,321	0,014*
			Contractor	0,013	0,252	1,000
PDC33 - Violating conditions of the contract	Tukey HSD	Consultant	Contractor	.779*	0,302	0,032*
			Designer	0,276	0,373	0,741
		Contractor	Consultant	-.779*	0,302	0,032*
			Designer	-0,503	0,292	0,205
		Designer	Consultant	-0,276	0,373	0,741
			Contractor	0,503	0,292	0,205
	Gabriel	Consultant	Contractor	.779*	0,302	0,025*
			Designer	0,276	0,373	0,842
		Contractor	Consultant	-.779*	0,302	0,025*
			Designer	-0,503	0,292	0,210
		Designer	Consultant	-0,276	0,373	0,842
			Contractor	0,503	0,292	0,210

Table B.1 (continued): Tukey and Gabriel Post-Hoc analysis of design-construction phase problems (occurence).

Dependent Variable		(I) Company Role	(J) Company Role	Mean Difference (I-J)	Std. Error	Sig.
PDC35 - Quality of design/contract documents	Tukey HSD	Consultant	Contractor	.790*	0,296	0,025*
			Designer	0,218	0,365	0,822
		Contractor	Consultant	-.790*	0,296	0,025*
			Designer	-0,572	0,287	0,121
		Designer	Consultant	-0,218	0,365	0,822
			Contractor	0,572	0,287	0,121
	Gabriel	Consultant	Contractor	.790*	0,296	0,019*
			Designer	0,218	0,365	0,909
		Contractor	Consultant	-.790*	0,296	0,019*
			Designer	-0,572	0,287	0,116
		Designer	Consultant	-0,218	0,365	0,909
			Contractor	0,572	0,287	0,116

*. The mean difference is significant at the 0.05 level.

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- **Buğan, E. E.** and Irlayıcı Cakmak, F. P. (2022). Design-Construction Interface Problems in Construction Projects, 7th International Project and Construction Management Conference, 461-469.