

AN EXPLORATORY STUDY ON CAUSES AND IMPACTS OF VARIATION
ORDERS IN PUBLIC-PRIVATE PARTNERSHIP PROJECTS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

KIVANÇ UMUT EJDER

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
CIVIL ENGINEERING

FEBUARY 2022

Approval of the thesis:

**AN EXPLORATORY STUDY ON CAUSES AND IMPACTS OF
VARIATION ORDERS IN PPP PROJECTS**

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ABSTRACT

AN EXPLORATORY STUDY ON CAUSES AND IMPACTS OF VARIATION ORDERS IN PUBLIC-PRIVATE PARTNERSHIP PROJECTS

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February 2022, 96 pages

Variation is an inevitable and inherent factor in public-private partnerships (PPP) projects which are a result of the extensive contract duration and the dynamic environment together with a large number of stakeholders. It is common in all kinds of PPP projects and determines the time limits and projected budget of the projects. For the social and financial viability of the project, it is important to be aware of these variations and their consequences that occur during the project life cycle. One of the most important items that affect the success of PPP projects is variation orders. It is anticipated that the identification of the causes of variation orders may lead to improvement in overall performance of PPP projects.

This thesis aims to determine the causes and impacts of variation orders in PPP projects together with recommendations to minimize them. It is based on a literature review on the causes of variation orders in PPP projects, investigation of real PPP projects and interviews conducted with domain experts. The most important causes can be summarized as change of scope, inadequate design and project objectives, change in specifications, differing site conditions and unforeseen problems whereas

the most important impacts are increase in project cost, schedule delay, disruption of continuity of services, rework and demolition, and interruption in credit payments. A conceptual model to manage variation orders in PPP projects is developed as an output of the thesis.

Keywords: PPP, Public Private Partnership, Change Order, Variation Order, Conceptual Model

ÖZ

KAMU ÖZEL İŞBİRLİĞİ PROJELERİNDEKİ DEĞİŞİKLİK TALİMATLARININ NEDENLERİ VE ETKİLERİ ÜZERİNE BİR KEŞİF ÇALIŞMASI

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Şubat 2022, 96 sayfa

Kapsamlı sözleşme süresi ve çok sayıda paydaşla birlikte dinamik ortamın bir sonucu olan Kamu Özel İşbirliği (KÖİ) projelerinde çeşitlilik kaçınılmaz ve doğal bir faktördür. Her türlü KÖİ projesinde ortaktır ve projelerin zaman sınırlarını ve öngörülen bütçesini belirler. Projenin sosyal ve finansal uygulanabilirliği için, proje yaşam döngüsü boyunca meydana gelen bu değişim emirlerinin ve bunların sonuçlarının farkında olmak önemlidir. KÖİ projelerinin başarısını etkileyen en önemli kalemlerden biri de değişim emirleridir. Değişim emirlerinin nedenlerinin belirlenmesinin, risklerinin olası ortadan kaldırılmasına ve KÖİ projelerinin genel performansında iyileşmeye yol açabileceği tahmin edilmektedir.

Bu tez, KÖİ projelerindeki değişkenlik emirlerinin nedenlerini ve etkilerini, bunları en aza indirecek önerilerle birlikte belirlemeyi amaçlamaktadır. KÖİ projelerindeki değişkenlik emirlerinin nedenlerine ilişkin bir literatür taramasına, gerçek KÖİ projelerinin araştırılmasına ve alan uzmanlarıyla yapılan görüşmelere dayanmaktadır. En önemli nedenler; kapsam değişikliği, yetersiz tasarım ve proje hedefleri, şartnamelerde değişiklik, farklı saha koşulları ve öngörülemeyen sorunlar olarak özetlenebilirken, en önemli etkiler proje maliyetinde artış, iş programı

gecikmesi, hizmetlerin sürekliliğinin bozulması, yeniden yapıp ve yıkım yapılması ve kredi ödemelerinde kesinti olarak özetlenebilir. Tezin çıktısı olarak KÖİ projelerinde deęişiklik emirlerini yönetmek için kavramsal bir model geliştirilmiştir.

Anahtar Kelimeler: KÖİ, Kamu Özel İşbirliği, Deęişiklik Emri, Deęişiklik Talimatı, Kavramsal Model

Specially Dedicated to

My beloved family,

“For your unconditional love through the years”

And

My beloved wife

And daughter

“For their Love”

ACKNOWLEDGMENTS

First and foremost, I offer my sincerest gratitude to my advisors, Prof. Dr. İrem Dikmen Toker, and Prof. Dr. M. Talat Birgönül, who have supported me throughout the thesis with their patience, knowledge and encouragement. I attribute the level of my Master's Degree to their encouragement and effort and without them this thesis, would not have been completed or written. One simply could not wish for a better or friendlier supervisor.

Finally, I would like to thank my family; my mother, my beloved wife, Dilara and my daughter Nevra Liya.

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CHAPTER 1

INTRODUCTION

1.1 Background

As a result of the economically precarious position at the start of the 1980s, governments were forced to take steps in order to minimize public debt. Private capital was more appealing than government investments. Build Operate Transfer (BOT) procurement models, which are a sort of Public Private Partnership (PPP), were popular in the early 1990s for the delivery of public assets such as wastewater and water treatment plants, roads, public buildings, and ports (Regan et al., 2009). Public facilities in developing countries have struggled to cope with the challenges of expanding urbanization in recent years, and PPP has emerged as a viable option for delivering infrastructure projects. The importance of it for the building sector grows over time, particularly in emerging countries. PPP has been employed as a procurement approach for providing public infrastructure in more than 85 countries around the world (Cheung & Chan, 2011).

The ability to spread the costs of big amount of investments throughout the life cycle of a PPP for the public sector is considered as a desirable advantage. The public sector's debt management is made easier because it does not have to give large financial transfers. Despite the lack of a governmental resource, the projects can be carried out with the help of private funds (Meidute & Paliulis, 2011).

A concession is provided to a private company or consortium to finance, build, and operate a public project, as well as to offer the associated product or service and collect the resulting income in a PPP project (Xiong & Zhang, 2014). Because operation by a private firm can provide significant efficiency gains to the public authority body in question, the PPP strategy may raise the economic value of

infrastructure services (Liu et al., 2014; Iossa, 2015). Unexpected circumstances, on the other hand, can result in high-profile project failures. Long-term agreements (often 25–30 years) increase a project's sensitivity to changing circumstances throughout its life cycle. Unexpected events are thus an aspect of life, according to Taleb (2008). Such situations, on the other hand, can change the financial balance of the connection that each party assumed when the partnership agreement was signed, making the agreement sensitive from a commercial or financial standpoint (Mandri-Perrot, 2009). Early withdrawal of a PPP contract can be harmful, and counterparties may suffer as a result (Liu et al., 2017). Experts in PPP underline the importance of unexpected risk occurrences in PPP projects (e.g., Cruz et al., 2014). Rather than considering early contract termination, the stakeholders should engage in negotiations and attempt to resolve the unbalance (Song et al., 2018).

The importance of a dynamic project environment to a complex contract structure in the construction industry is generally accepted (Hagan et al., 2012). Only a few studies, however, explore potential changes in long-term PPP or Design Build Finance Maintain (DBFM) contracts.

1.2 Problem Statement

Public Private Partnership (PPP) implementation has become increasingly important in the development and delivery of public projects. Because of increasing population and expected life standards, the demand for infrastructures is increasing, and due to the limited public funds to meet current and future needs, one method of procurement of public goods and services is the public private partnership. Through to PPP, governments can benefit from the private sector's financial capabilities and expertise to meet the need for public infrastructure and services.

These projects include long term relationship between public and private sides. In addition, the size of these projects is larger than simple construction projects. In public-private partnerships (PPP), variations are inevitable due to the duration and

size of these contracts and the dynamic environment in which PPPs are often implemented. Changes may result in contract variation orders and, as a result, negative reactions from stakeholders. It is critical for the project's social and financial sustainability to have procedures in place that can deal with changes that arise over the project's life cycle (Demirel et al., 2019). To dealing with variations, risk assessment should be done, and necessary actions should be taken accordingly.

Generally, lenders finance these types of projects because the scale of PPP type of construction projects is large. However, variation orders may change the duration and cost of the project. Therefore, managing this risk is important for the lifecycle of the projects. As an investor, the lenders will look primarily to risks of the project from beginning of the project to end of the operation period in order to evaluate risks of loan repayments. Therefore, it is very important to be aware of these variations and their consequences because financial impacts of these changes are enormous. One of the most important items that affect the success of PPP projects is variation orders. It is expected that identifying the reasons of variation orders would lead to a decrease or elimination of their risk and an improvement in the overall performance of PPP projects.

1.3 Aim and Objectives of the Study

This thesis aims to determine the causes and impacts of variation orders in PPP projects together with recommendations to minimize them. This exploratory study can be used by the parties to establish a risk assessment on variation orders. This thesis is based on a literature review on existing investigations and researches on the causes of variation orders in PPP projects together with real PPP projects data. Literature review, desk study and interviews are carried out to identify the causes of variation orders, their impacts on PPP projects and recommendations to minimize them.

The objectives of this paper is to determine the causes and impacts risks caused by variation orders in PPP projects together with recommendations to minimize them based on the problem statement above.

The following research questions could define the overall purpose:

- What are the causes of variation orders in PPP Projects?
- What are the impacts of variation orders in PPP Projects?
- How can we minimize variation orders in PPP Projects?

1.4 Scope of the Study

Currently, there are many PPP projects which are under construction all around the world. PPP has been a very popular project delivery model in Turkey starting from 1990s and several projects have been and are being constructed under this scheme. Although literature survey contains multiple country experiences, the interviews and case projects relate to Turkey. Moreover, data includes only projects conducted after 2010. Thus, it can be said that projects carried out in Turkey for the last 10 years, the time horizon that PPP investments accelerate, constitute the scope of this thesis.

1.5 Structure of the Thesis

The thesis contains six main chapters. These are introduction, literature review, research design and methodology, discussion of findings, conceptual model on variation orders, conclusions and recommendations.

The first chapter includes the background of the study, problem statement, aim and objectives, significance and limitations of the study, and structure of the research.

The second chapter started with literature exploration to answer the research objectives. The causes of variation orders, impacts of variation orders, strategies to minimize variation orders and dealing mechanisms on PPP projects are discussed.

Research Design and Methodology presents the methods used for data collection and research design.

Discussion of findings summarizes the main findings of the study pinpointing critical success factors for managing risk and variation orders.

The last chapter depicts the main conclusions and recommendations based upon the analysis of data, linking them to the problem statement and objectives of the study.

CHAPTER 2

LITERATURE REVIEW

2.1 Public Private Partnership

2.1.1 Definition of PPP

There is currently no agreed definition of PPP among international organizations or governments. Different PPP definitions have been produced by organizations such as the Organization for Economic Cooperation and Development (OECD) and the International Monetary Fund (IMF).

According to the IMF (2006), public-private partnerships (PPPs) "refer to arrangements in which the private sector contributes infrastructure assets and services that have historically been provided by the government". On the other hand, according to the OECD (2008), a public-private partnership (PPP) is "an agreement between the government and one or more private partners (which may include operators and financiers) in which the private partners provide a service in such a way that the government's service delivery targets are aligned with the profit goals of the private partners, and the performance of the alignment is reliant on the enough risk transfer to the private partners".

PPPs, according to the German Public Private Partnership Working Group (Pricewaterhouse-coopers, 2005), are intended to improve the efficiency of infrastructure investments through a long-term partnership between the public and private sectors. As a result, having a holistic view that covers the project's whole life cycle is critical.

PPP is described in South Korea as "a framework in which the private sector constructs and operates a facility to support the public sector in providing public services" (Korean Development Institute (KDI), 2010).

The Canadian Council for Public-Private Partnerships (n.d.) identifies a PPP as "a public-private partnership founded on each partner's expertise that best serves clearly defined public requirements through the right allocation of resources, risks, and rewards". As a result, in order to be evaluated within the scope of the PPP, a project must exhibit the following two qualities. The provision of public services or the development of public infrastructure should be the ultimate goal. Moreover, risk transfer between the public and private sectors should be included. Arrangements that do not have these two elements are not formally termed PPPs and are not included by the Canadian Council for Public-Private Partnerships' research.

As a consequence, while neither international organizations nor countries that have regularly used the PPP model employ a consistent definition, there are common aspects that define the essence of PPPs across implementations. As a result, the presence of the four elements listed below might assist determine whether a procurement model is a PPP:

- Having the private sector provide a service including of one or more of the following parts through a contract for a certain length of time, such as design, construction, finance, operation, and maintenance.
- Presence of government support mechanisms such as the provision of site, the transfer of an existing facility or asset to the private sector, the payment of expropriation costs, the purchase of service outputs, and so on.
- For the provision of services, the private sector is compensated by the public sector or end users.
- Enough risks are transferred from the public to private sectors.

2.1.2 Types of PPP

Lots of different ways of PPPs are used all around the world and some are preferred over others. Some of them are Design-Build-Transfer, Operation – Maintenance, Design-Build-Operate, Build-Lease-Operate-Transfer, Build-Own-Operate-Transfer, Design-Build-Transfer-Operate, Design Build-Finance-Operate, Build-Own-Operate etc. (Adams et al., 2006).

The participation of public and private sectors and the involvement degree of participation between them is shown in below figure.

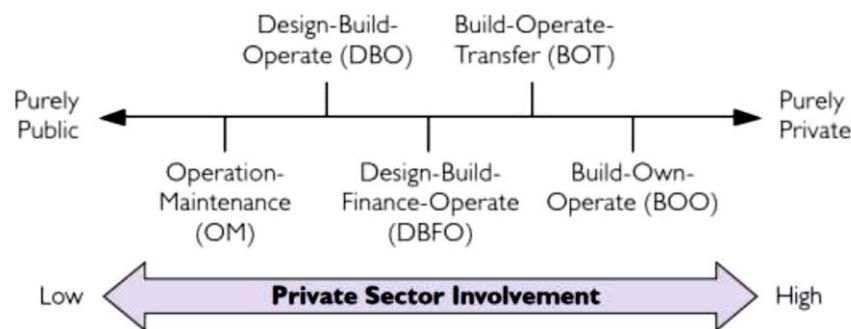


Figure 1. Continuum of Types of PPP (Kwak et al., 2009)

The traditional method involves the government purchasing services or items from the private sector for a set price based on quality requirements. After being purchased from the private sector, these goods and services are either used as input for other services or directly supplied to citizens (OECD, 2008).

Operation – Maintenance (OM)

All aspects of operation and maintenance are handled by the private sector.

Although the private sector cannot carry financial responsibility, it can manage a capital investment fund and decide how it should be used in collaboration with the public sector (World Bank, 2007).

Design-Build-Operate (DBO)

DBO is a method in which the private sector designs, builds, and operates a project for a limited time before handing it over to the public sector (Kwak et al., 2009).

Design-Build-Finance-Operate (DBFO)

DBFO is a type of PPP procurement in which a private sector effort designs, builds, finances, and operates a facility. (Shaoul et al.,2006)

Build-Operate-Transfer (BOT)

For the period of a concession, the private sector is responsible for the financing, planning, construction, operation, and maintenance of a project. At the end of the concession period, the asset is often given back to the government completely (Kumaraswamy & Zhang, 2001)

Build-Own-Operate (BOO)

BOO refers to a concept in which the private sector keeps control of the equity in perpetuity. For a limited time, the government uses the services generated (Kwak et al., 2009).

2.1.3 Advantages and Disadvantages of PPP

According to Nagesha (2015), advantages of underlying PPP projects are as follows;

- Through long-term investment perspectives and proper attention to maintenance, PPPs can provide ensured and better quality services.
- By making timely intensive infrastructure investments and utilizing sophisticated technology and organizational skills available in the private sector through PPPs, it is possible to successfully address infrastructural bottlenecks.
- Another well-known benefit of PPPs is the potential for scientific project planning, execution, and operation. Due to political considerations, the

traditional mode of infrastructure provision by the government has often allowed for incorrect project selection; adoption of inappropriate designs, etc., whereas under PPPs, the private investor invests only in a given project based on the need and its suitability.

- PPPs can give more focus on improving performance. This character can provide the developer more scope to engage in innovation with the goal of lowering total costs by designing/implementing worldwide best practices on a long-term basis.
- The PPP model is superior because it creates less economic distortion due to the adoption of user payment methods rather than obtaining funds through tax income, which is often highly distorted.
- PPPs can improve accountability in the provision of infrastructure services by ensuring that the quantity and quality of the services are met.
- The public-private partnership (PPP) model of infrastructure provision allows for appropriate administrative and structural reforms in public-sector infrastructure providing, such as state electricity boards and public works departments.
- PPPs promise that projects will be completed on time and on budget. Bundling contracts (construction and operation), the long-term structure of contracts, and provisions for payments to the private firm based on the performance of defined services on a regular basis with specified quality, among other factors, can result in the delivery of services on time. As a result, the economy's growth trend is maintained. These claims, however, are open to empirical verification.
- PPPs maximize the use of private sector skills. Due to the private sector's active participation in PPP mode of infra provision, the State (society) stands to benefit from the superior managerial and technical skills available with the private players. This can naturally lead to an improvement in the quality & efficiency of the infrastructure services.

- PPPs maximize use of all private sector experience. The State (society) stands to benefit from the superior managerial and technical skills available with the private operators as a result of the private sector's active participation in the PPP mode of infrastructure provision. This can naturally lead to an improvement in the infrastructure services' quality and efficiency.
- In a typical PPP project, the private sector accepts responsibility for the project's life cycle costs (construction and operation), i.e., the private participant is in charge of maintaining the project during the concession period (approximately 25-30 years). It is responsible for ensuring the quality and efficiency of the service outlined in a project contract during this time.
- Project risks are distributed between the public and private sectors in PPPs, based on which party is best able to manage or absorb each potential risk. Various types of risks arise in the provision of infrastructure services, making it difficult for the government to manage all risks on its own. Risks are distributed between the public and private sectors when the private sector gets involved. This feature has the potential to improve service quality on a long-term basis.
- PPPs also provide value for money (financial and non-financial savings to all the stake holders). All stakeholders benefit from the use of transparent procurement methods, ex-ante competition, inbuilt contract features, life cycle project risk assessment, payment/reward based on specified quality of services, scope for utilizing the private sector's enriched skills, and many other inbuilt characteristics of PPPs.
- PPPs deal with the issue of a lack of funds for adequate infrastructure investment. PPPs allow for the flow of capital from the private sector. Governments are finding it difficult to invest huge amounts of money in infrastructure due to the current financial crisis. The funding gap is a major symptom of a lack of adequate infrastructure services. The widening funding gap clearly shows that governments are having difficulty raising funds from budgetary sources to build new infrastructure and maintain existing

infrastructure facilities in the traditional manner. As a result, private sector involvement through the PPP framework helps to alleviate some of their investment burden.

- Governments' fiscal health is helped by PPPs. Governments can use PPPs to reduce their debts and avoid the long-term effects of borrowing on intra- and intergenerational liabilities.

According to Nagesha (2015), disadvantages of adopting PPP projects are follows;

- The user fee is collected to earn back the overall project cost, and its rate is determined by the length of the agreement, i.e., the amount of the user fee is inversely proportional to the length of the agreement.
- Some of the thinkers argue that, while the public sector is expected to ensure people's benefits, private sector efforts are profit-oriented, this issue could be effectively addressed by a regular monitoring of the project partners through an independent regulatory mechanism.
- Under the PPP infrastructure provision, private sector shareholders at first bid aggressively at higher rates in order to win the bid, but they often request renegotiations as the project progresses. The private sector's behavior may limit the scope for competition in infrastructure provision.
- Government/public sector limitations in terms of appropriate capacity/skills are a major factor in the adoption of the PPP approach. In this regard, international financial institutions such as the Asian Development Bank (ADB), International Monetary Fund (IMF), World Bank and others can provide governments with appropriate technical and other assistance.
- PPPs indicate that the public sector has less management control: This is true, but the private sector's management skills are generally considered as better to those of the public sector. For project quality improvement and cost minimization, the private sector's professional management skills should be utilized.

- Under PPPs, the public sector carries a great amount of implicit risks, and the economic costs associated with such risks are difficult to calculate, as is evaluating the effects of such risks. As a result, an increase in fiscal risk and contingent liabilities is unavoidable.
- Disclosures: Unlike the public sector, obtaining information on a regular basis on all aspects of PPPs is extremely difficult.
- The PPP procurement procedure is time-consuming and expensive. This factor is determined by the degree of effective planning, preparation of all project implementation stages with a standard time frame for each and every task, scientific implementation by specialists, strong political will, competition factor, and foreign private sector participation, and many other factors.

2.2 Variation Orders

There is no universally accepted definition of variation order. The term 'variation,' as explained and/or defined by many standard forms of contract, changes from one to another, but the concept and/or meaning is more or less the same in essence. A specification of a variation in terms of specific acts and activities is usually included in any standard form of building contract.

Variations are described as changes, materials, additions, or omissions in work, work space, working hours, and so on, according to the construction contract dictionary.

"Variation" implies any change to the works that is directed or approved as a variation, according to FIDIC (1999).

Each standard type of building contract has its own description, according to Hayati (2006), but 'variation,' in a broad sense, refers to any change to the premise on which the contract was let. This indicates that the term encompasses not only changes to the work or items relevant to the job that are made in compliance with the contract's provisions, but also changes to the contract's terms.

Generally, the term 'variation' refers to a change, revision, alteration, modification, or amendment to the contract's and/or its works' original aim. A variation order is an official process that modifies the original contract and becomes part of the project's papers (Fisk, 1997). Moreover, a variation order is a formal direction sent to the contractor after the owner has agreed to the contract and authorizes a change in the work, a change in the contract value, or even a change in the contract period.

2.2.1 Types of Variation Orders

Variations in construction works are prevalent and can arise from a variety of sources, as a result of a variety of factors, at any stage of the project, and can have significant negative effects on costs and schedule delays. A major variation may result in many delays in the project timeline, re-estimation of the work description, and increased equipment, material, labor, and overtime needs. If not managed through a defined variation management procedure, variations can become a serious cause of contract disputes, posing a serious risk of project failure.

In general, categorization of variations applies to modifications in the construction domain. Variations are described by Motawa et al. (2007) as follows:

Table 1. Types of variation (Motawa et al., 2007)

Bases of variation	Types of Variation
Time	Anticipated or Emergent, Pre-fixity or Post-fixity, or Proactive or Reactive
Need	Elective or Required, or Preferential or Regulatory Discretionary or Nondiscretionary
Effect	Beneficial, Disruptive or Neutral

2.2.2 Causes of Variation Orders

Owner related variations:

Modifications in the scope of work or the project plan can occur for a variety of reasons, including illegal project planning or the owner's failure to engage in the design process. These changes can lead to variations from the contract amount (Memon et al., 2014; Arain et al., 2004).

Because of the impact on cash flow and the cost management plan, the owner's financial problems have a considerable impact on project implementation. This may affect the project timeline since the owner may be forced to change the material, specifications, or quality to meet the owner's financial obligations (Maluleke et al., 2019; Hanif et al., 2016; O'Brien, 1998; Clough & Sears, 1994).

Insufficient project objectives require the owner's definition of the project objectives. Or else, the designer faces wasting time during project design due to numerous limitations, which may result in adjustments throughout construction and delay project progress (Ibbs & Allen, 1995). Experts should be involved in the design phase to help define project objectives and determine when their needs aren't being addressed early on (Memon et al., 2014).

Changing materials may be necessary because of financial difficulties with the owner or a change in the owner's specifications, which may result in modifications throughout the construction phase, as well as differences in the technique of application (Keane et al., 2010).

Owners must make timely judgments, especially during project construction, to avoid any delay caused by late owner decisions; or else, the project timeline and cost will be altered (Noraziah & Zabidi, 2019; Memon et al., 2014; Gray & Hughes, 2001; Sanvido et al., 1992).

If the owner has obstinate personality, it may result in change orders during the project's execution because of the repercussions of the owner's decisions and orders

that do not meet the professional's vision at later phases of the project (Memon et al., 2014; Arain et al., 2004; Wang, 2000).

A change to the requirements made by the owner can happen for a variety of reasons, including a lack of project objectives, a change in design, or budgetary difficulties (O'Brien, 1998; Hanif et al., 2016).

Employer intervention may result in late intervention by the employer during the design stage and the construction phase and the delay in the review and approval may affect the progress of the project (Wu et al., 2004).

Consultant related variations:

The consultant's design change is usually to improve the design. The consultant may need to make design adjustments, particularly on projects where the building begins before the design is completed (Fisk, 1997; Arain et al., 2004). This can also happen when the design is altered by the consultant, who may have a different perspective on the design, or when work is rescheduled (Mohammad et al., 2010). The consultant's change in design is primarily to improve the design; nevertheless, the consultant may use changes in design on projects that begin construction before the design is completed (Fisk, 1997; Arain et al., 2004). This can also happen if the consultant revises the design and has a different opinion of it, or if the work is rescheduled (Mohammed et al., 2010).

Depending on the moment of fault detection, variation may arise owing to flaws and omissions in design drawings (Keane et al., 2010; Arain et al., 2004).

Any inconsistency in contract documents may lengthen the time and cost of the project. As a result, contract documentation must be exact and explicit (Memon et al., 2014; Construction Industry Institute, 1986). If the ultimate time for value engineering is postponed, it may result in cost increases and volatility.

Value engineering should ideally be accomplished before building begins (Dell'Isola, 1982; Keane et al., 2010).

Special construction processes and trained craftsmen are required for complex designs. The more complicated the design, the more likely there are to be differences (Memon et al., 2014; Arain et al., 2004; Fisk, 1997).

Work drawings with insufficient details might lead to misunderstandings of actual requirements, so they must be precise and thoroughly detailed (Arain et al., 2004; Geok, 2002; Memon et al., 2014).

To generate a comprehensive design, the consultant must be informed and have a thorough understanding of the available materials and equipment (Geok, 2002; Keane et al., 2010).

Inadequate design is a common cause of building project variances, so designers should provide appropriate designs (Construction Industry Institute (CII), 1990; Fisk, 1997; Memon et al., 2014). It should be noted that in PPP projects, the design decisions together with the conceptual design of a project, which made by the public side during the bidding stage, can directly affect costs and revenues during the concession period of the project. In the case of social infrastructure such as hospitals, schools, courts, and housing, the impact of design on operating revenues and expenses is very essential. In addition to supporting complex functions and business processes, these facilities serve as a focal point for the local communities in which they are located. The design of a project may also affect its constructability, and if this includes non-standard or untested construction processes this can have a substantial impact on project duration and cost outcomes. (Raisbeck, 2009)

Changes in the consultant's specification are frequently made as a result of insufficient project objectives. It could lead to change requests, which could push up the project budget and timeline (Memon et al., 2014; O'Brien, 1998).

Poor work drawings can lead to mistakes during construction, resulting in invariances. These variances may have an impact on the work's progress, as rework

may be required, causing delays and expense increases (Geok, 2002; Arain et al., 2004; Keane et al., 2010).

Contractor related variations:

Many differences may emerge due to the contractor's lack of engagement in the design phase of the project. Contractors have creative and practical ideas that make designs more actual and usable (Arain et al., 2004; Keane et al., 2010).

Contractors must have a sound procurement and resource plan, and any procurement issues might cause delays in the construction phase, affecting the project's completion (O'Brien, 1998; Memon et al., 2014).

Projects using new technologies necessitate specialized resources and qualified labor; nevertheless, due to a lack of expertise, variances may develop, causing delays in the project timeline (Memon et al., 2014; Arain et al., 2004;).

Due to financial requirements, the contractor must pay the worker's salaries regardless of whether the owner pays the contractor or not, and failure to meet these obligations may damage the project's quality and implementation (Memon et al., 2014; Thomas & Napolitan, 1995).

The contractor's desire for profit may lead to variation, as it is viewed as additional financial compensation for increased effort resulting from variances (O'Brien, 1998; Keane et al., 2010).

Unexpected site conditions, such as different soil conditions or unforeseen problems in the construction of the substructure that was not discovered during the contractor's site investigation, can result in additional cost and time being added to the project, as well as requests for changes (Keane et al., 2010; O'Brien, 1998; Fisk, 1997).

Poor craftsmanship can lead to demolition and rework, delaying project completion and increasing project costs (Fisk, 1997; O'Brien, 1998).

It would be difficult for the contractor to carry out work in unfamiliar local conditions, which could result in variances and extend the project's duration and expense (Clough & Sears, 1994; Keane et al., 2010).

Fast-track construction necessitates a well-organized system to carry out the independent project operations; otherwise, there is a considerable danger of variations occurring during construction, affecting project execution and increasing the project's total cost and duration (Fisk, 1997; Keane et al., 2010).

Poor procurement can cause delays in project completion by causing deviations and affecting the project cycle (Fisk, 1997; Memon et al., 2014).

Procurements with a long lead time have an impact on project schedules and construction. To complete the project on time, the contractor may be required to speed up the construction process, which may result in adjustments as a result of the increased cost and additional labor (Fisk, 1997; Keane et al., 2010).

A key issue is a supplier or subcontractor, especially if the site management is poor (Hsieh et al., 2004).

Poor cooperation among subcontractors from various disciplines is expected, which could result in project changes and delays (Hsieh et al., 2004).

Project management related variations:

Due to a lack of coordination between stakeholders, project completion may be hampered, resulting in variances and the owner's unhappiness (Arain et al., 2004).

Lack of communication between parties wreaks havoc on project execution, resulting in rework, demolition, and essential changes (Keane et al., 2010; Arain et al., 2004).

In projects where construction begins before the design is completed, strategic planning is common (Memon et al., 2014; O'Brien, 1998; Clough & Sears 1994).

Variations may occur if safety regulations and requirements are not followed. Also, to complete the project effectively, safety is critical (Clough & Sears, 1994; Keane et al, 2010).

Other types of variations:

Bad weather for outdoor activities can lead to an increase in overall duration and cost, as extra days are needed to compensate for the days that are delayed (Keane et al., 2010; O'Brien, 1998; Fisk, 1997).

Changes in economic conditions are one of the most substantial elements that might affect project costs and length of execution (Fisk, 1997; Keane et al., 2010).

Authorities may have their own set of rules and regulations that must be followed. Generally, a designer ensures that his design is code compliant. New regulations between design and construction, on the other hand, maybe imposed, forcing certain alterations (Al-Dubaisi, 2000).

Different socio-cultural origins contribute to a lack of coordination, communication, and understanding among project team members, which can lead to differences (O'Brien, 1998; Keane et al., 2010).

Unexpected issues can halt project development, and if not addressed by professionals, can result in variations (Keane et al., 2010; O'Brien, 1998; Clough & Sears, 1994).

Force majeure can have clear ramifications, and while it does not occur frequently, it has a significant impact on the construction process, and it may cause work on the site to be halted (Love et al., 2002).

Table 2 shows the list of the causes of variation orders found from the previously stated sources.

Table 2. Causes of Variation Orders in Literature

No	Causes of Variation Order	References
1	Change of scope	(Memon et al., 2014; Arain et al., 2004)
2	Owner's financial problems	(Maluleke et al. 2019; Hanif et al., 2016; O'Brien, 1998; Clough & Sears, 1994)
3	Inadequate project objectives	(Ibbs & Allen, 1995)
4	Replacement of materials or procedures	(Keane et al., 2010)
5	Impediment to prompt decision-making process	(Noraziah & Zabidi, 2019; Memon et al., 2014; Gray & Hughes, 2001; Sanvido et al., 1992)
6	Obstinate nature of owner	(Wang, 2000; Arain et al., 2004; Memon et al., 2014)
7	Change in specifications by the owner	(O'Brien, 1998; Hanif et al., 2016)
8	Interference of employer	(Wu et al., 2004)
9	Change in design by the consultant	(Noraziah & Zabidi, 2019; Arain et al., 2004; Fisk, 1997)
10	Errors and omissions in design	(Arain et al., 2004; Keane et al., 2010)
11	Conflicts among contract documents	(Construction Industry Institute, 1986; Memon et al., 2014)
12	Value engineering	(Keane et al., 2010; Dell'Isola, 1982)
13	Design complexity	(Memon et al., 2014; Arain et al., 2004; Fisk, 1997)
14	Inadequate working drawing details	(Arain et al., 2004; Geok, 2002; Memon et al., 2014)
15	Poor knowledge of available materials and equipment	(Geok, 2002; Keane et al., 2010)
16	Inadequate design	(Memon et al., 2014; Fisk, 1997; Construction Industry Institute, 1990)
17	Change in specification by the consultant	(Memon et al., 2014; O'Brien, 1998;)
18	Poor drawings	(Keane et al., 2010; Arain et al., 2004; Geok, 2002)

Table 2 (continued)

19	Lack of involvement in design	(Arain et al., 2004; Keane et al., 2010)
20	Unavailability of equipment	(Memon et al., 2014; O'Brien, 1998)
21	Unavailability of skills	(Memon et al., 2014; Arain et al., 2004)
22	Contractor's financial difficulties	(Memon et al., 2014; Thomas & Napolitan, 1995)
23	Desired profitability	(Keane et al., 2010; O'Brien, 1998)
24	Differing site conditions	(Maluleke et al. 2019; Keane et al., 2010; O'Brien, 1998; Fisk, 1997)
25	Poor workmanship	(O'Brien, 1998; Fisk, 1997)
26	Unfamiliarity with local conditions	(Keane et al., 2010; Clough & Sears, 1994)
27	Fast-track construction	(Fisk, 1997; Keane et al., 2010)
28	Poor procurement process	(Maluleke et al. 2019; Fisk, 1997; Memon et al., 2014)
29	Long-lead procurement	(Fisk, 1997; Keane et al., 2010)
30	Bad sub-contractor or supplier	(Hsieh et al., 2004)
31	Lack of coordination	(Noraziah & Zabidi, 2019; Arain et al., 2004)
32	Lack of communication between parties	(Keane et al., 2010; Arain et al., 2004)
33	Lack of strategic planning	(Memon et al., 2014; O'Brien, 1998; Clough & Sears 1994)
34	Health and safety	(Keane et al., 2010; Clough & Sears, 1994)
35	Weather conditions	(Keane et al., 2010; O'Brien, 1998; Fisk, 1997)
36	Change in economic conditions	(Keane et al., 2010; Fisk, 1997)
37	Change in government regulations	(Maluleke et al. 2019; Al-Dubaisi, 2000)
38	Sociocultural factors	(Keane et al., 2010; O'Brien, 1998)
39	Unforeseen problems	(Keane et al., 2010; O'Brien, 1998; Clough & Sears, 1994)
40	Force majeure	(Love et al., 2002)

2.2.3 Impact of Variation Orders

Many researchers have observed the effects of variances, and their prevalence harms project performance. According to Ruben (2008), variation orders influence overall project performance, and the most significant negative consequence of variation orders is time and expense overruns, as well as contract conflicts. Furthermore, Hanna et al. (2002) discovered that the contractor can be less productive than expected in the projects with a lot of variation orders. Schedule overruns, cost overruns, quality degradation, health and safety difficulties, and professional relations are result of variation orders. Several studies have been done to determine the effects of variants, as well as the links between variations and their effects.

Table 3. Impacts of Variation Orders in Literature

No	Impacts of Variation Orders	References
1	Increase in project cost	(Ruben, 2008)
2	Progress is affected but without any delay	(Bower, 2000)
3	Increase in overhead expenses	(Gunduz & Mohammad, 2020; O'Brien, 1998)
4	Delay in payment	(Staiti et al., 2016; CII, 1995; CII, 1990)
5	Quality degradation	(Ismail et al., 2012; Fisk, 1997; CII, 1995)
6	Productivity degradation	(Thakar, 2020; Hanna & Iskandar, 2017; Hester et al., 1991)
7	Procurement delay	(Clough & Sears, 1994)
8	Rework and demolition	(Gunduz & Mohammad, 2020; Clough & Sears, 1994)
9	Logistics delays	(Staiti et al., 2016; Hester et al., 1991)
10	Firm's reputation	(Staiti et al., 2016; Fisk, 1997)
11	Poor safety conditions	(Gunduz & Mohammad, 2020; O'Brien, 1998)

Table 3 (continued)

12	Poor professional relations	(Fisk, 1997)
13	Additional payments for contractor	(O'Brien, 1998)
14	Disputes among professionals	(Thakar,2020; CII, 1995)
15	Completion schedule delay	(Thakar,2020; Ibbs, 1997)

Increase in cost

Variation orders harm costs, as Ruben (2008) discovered in his study. In almost every construction project, contractors include a contingency fund for unexpected changes in the project while calculating the total budget intact. The more variation requests there are, the more likely they are to affect the ultimate building delivery cost. Variation orders, in reality, have a direct and indirect cost impact. The additional expenditures incurred to carry out the operations of the present variation orders are referred to as direct costs. As Bower (2000) identified, the following are the direct costs connected with variation orders:

- Time and material expenses for jobs that are directly affected;;
- Network recalculation, additional time-related costs, and overheads;
- Standing time and reworks;
- Timing impacts, such as in the winter;
- Inflation, changes in cash flow, and profit loss; and
- Management time, head office and site charges.

Indirect costs, according to Bower (2000), are expenditures caused as a result of variation orders, whether or not they appear to be linked to them. These are some of them:

- Productivity loss due to interruptions in which the gang must become acquainted with new working conditions, tools, and materials
- Rework and payment on impacted trades other than the variation order

- Change in cash flow as a result of the impact of inflation and financial charges;
- The cost of redesigning and managing the variation order; and
- Litigation fees if a disagreement arises as a result of the variation order.

The process and implementation of building project changes would increase overhead costs for all parties involved (Gunduz & Mohammad, 2020; O'Brien, 1998).

Delay in payment

Payment delays were common as a result of changes in construction projects (CII, 1990). Variations may stymie project development, causing delays in meeting the project's goals during construction (CII, 1995).

Quality degradation

If variations occur frequently, they may harm the quality of the job (Fisk, 1997). Contractors may incur expenditures in terms of quality and quantity in order to maximize income on contracts that include a high degree of risk due to unknown variables. Contractors have a tendency to compensate for losses, according to CII (1995). As a result, the quality of work was frequently low.

Productivity degradation

Workers' productivity would be substantially damaged, according to Hester et al. (1991), if they were had to perform overtime for extended periods to compensate for schedule delays.

Rework and Demolition

Due to the varying nature of construction projects, rework and demolition is common occurrences (Gunduz & Mohammad, 2020; Clough & Sears, 1994). Variations made when construction is ongoing or even completed typically result in reworks and project delays (CII, 1990).

Completion Schedule Delay

Variations in construction projects frequently cause completion timeline delays (Ibbs, 1997). Variation orders given at various phases of building projects, according to Koushki (2005), have an impact on project completion time and cost.

2.2.4 Recommended Strategies to Minimize Variation Order

If various strategies are explicitly presented, the potential impact of variation orders can be avoided. Ruben (2008) came up with some suggestions for reducing the number of variation orders. Baharuddin (2005) found the following recommended tactics and approaches to limit the incidence of variation orders, among other things. Many studies have been carried out to discover possible solutions for reducing variance orders. The following is a list of solutions proposed by several scholars (Ruben, 2008; Bin-Ali, 2008; Baharuddin, 2005; Arain & Pheng, 2005; Bower, 2000; Chan & Yeong, 1995; Willis, 1980; Ming et al., 2004; Levy, 2006; Al-Hakim, 2005; Formoso et al., 1999; Sweeney, 1998). These are:

Table 4. Recommended Strategies to Minimize Variation Order in Literature

No	Recommended Strategies to Minimize Variation Order	References
1	Complete the drawings at tender stage	(Yadeta, 2016; Bower, 2000)
2	Carry out detail site investigation including detail soil investigations and consider it during tendering stage	(Baharuddin, 2005)
3	All involved parties should plan adequately before works start on site	(Yadeta, 2016; Chan & Yeong, 1995)
4	The consultant should produce a concluding design and contract documents	(Arain, 2005)
5	Spend adequate time on pre-tender planning phase	(Ruben, 2008)
6	The consultant should co-ordinate closely at tender stage	(Ruben, 2008)
7	Supervise the works with an experienced and dedicated supervisor	(Bin-Ali, 2008)

Table 4 (continued)

8	Place experienced and knowledgeable executives in the engineering and design department	(Bin-Ali, 2008)
9	Consultants should ensure that the design/specifications fall within the approved budget	(Yadeta, 2016; Willis, 1980)
10	Clients should provide a clear brief of the scope of works	(Ming et al., 2004)
11	All parties should forecast unforeseen situations	(Levy, 2006)
12	Enhance communication between all parties	(Al-Hakim, 2005)
13	Get accurate information and research with regard to procurement procedure, material and plant	(Al-Hakim, 2005)
14	Once the tender is awarded, make no changes to the specifications	(Yadeta, 2016; Sweeney, 1998)
15	Have the land application or land purchase completed before awarding contracts	(Formoso et al., 1999)

2.2.5 Dealing Mechanisms for Variations in PPP

Although there are proactive strategies to minimize the variation orders before they happen, there are also some reactive dealing mechanisms which can be named as resilience strategy. These strategies can help the system to remain resilient in case it encounters variation order. According to Demirel et al. (2019), dealing mechanisms are critical for coordinating PPPs under contract variations, ensuring that the contract effectively manages the parties' interaction during the course of the contract and that both parties reap the benefits.

Contract requirements defined by formal legal systems are a necessary foundation for dealing with infrastructural differences, but they must be flexible. They must be adaptable over time, allowing for the addition of new sub clauses, the removal of ex-post clauses, and even the addition of a new contract. This implies that the contract should be able to adapt to changing circumstances.

Collaborative problem-solving and coordinated efforts are aided by strong relationships. The establishment of a favorable renegotiation climate based on trust rather than rigid norms is aided by transparency and openness between partners. A shared vision of how to relate to one another is also crucial, as seen by the authority's new market strategy, which encourages commercial companies and governments to work together.

The predetermined organizational structure of PPP projects is vital in establishing partnerships during the early stages of the project, but it should be flexible and adaptable over time. Due to personal preferences and differing competencies, counterparts switched roles during the project's implementation. Contractual processes are supplemented by relational dynamism, which allows ex-post flexibility.

When dealing with variations, transparent digitalized information-exchange systems that structure information can aid decision-making. Using a shared cloud system facilitates the interchange of ideas, lowers knowledge asymmetry, enhances transparency, and fosters project trust, all of which strengthens partner relationships. Investing in a good information-exchange system that supports the project team's competencies is critical for any infrastructure project, not only complex PPP projects.

An important mechanism is professional expertise, particularly experience from past projects (e.g., comprehending the contract from legal, technical, and environmental aspects). Continuous learning and knowledge development improve the ability to deal with change. Although some cross-project learning was detected, project learning in public and private entities involved in PPPs might be made clearer.

Project managers may use a variety of strategies to deal with variations including contract stipulations, human interactions, organizational structure, digital tools, professional knowledge, and actor skills. Human relationships refer to personal relationships between parties, while contract conditions refer to DBFM agreement articles. The project management systems in organizations are referred to as

relational governance in this study. Shared IT systems are referred to as digitalized tools. Actor competencies refer to the abilities of the project participants, whereas knowledge refers to both tacit and explicit knowledge.

2.3 Literature Review Findings

Although there are lots of different definitions for public-private partnership, to determine a procurement model is a PPP or not, four elements may be examined:

- Having the private sector provide a service including of one or more of the following parts through a contract for a certain length of time, such as design, construction, finance, operation, and maintenance.
- Presence of government support mechanisms such as the provision of site, the transfer of an existing facility or asset to the private sector, the payment of expropriation costs, the purchase of service outputs, and so on.
- For the provision of services, the private sector is compensated by the public sector or end users.
- Enough risks are transferred from the public to private sectors.

There are different types of PPP projects according to the involvement of the private partner. Some of them are preferred over others. For the desk study of this thesis, Build-Operate-Transfer (BOT) types of projects in Turkey will be examined.

Compared to the traditional method, PPP projects can have many advantages and disadvantages. Before selecting the procurement method, these pros and cons should be evaluated by the governments.

According to Yadeta (2016), the major causes of variation orders on construction projects are incomplete contract documents, change in design, inadequate working drawing details, impediment in prompt decision making process and change in specifications. Also, Yadeta (2016) highlighted the major impacts of variation orders which are increase in project cost, additional payment for the contractor, completion schedule delay, increase in overhead expenses. Best practices for minimizing

variation orders on construction projects are concluded as; drawings should be complete at tender stage; concluding design and contract documents should be produced; enhancing communication between all parties; works should be supervised with an experienced and dedicated supervisor; carrying out detail site investigation including detail soil investigations and considering it during tendering stage.

There are proactive strategies as well as reactive dealing mechanisms which can be named as resilience strategy. These strategies can help the system to remain resilient in case it encounters variation order. These dealing mechanisms with variation orders may be concluded as contract stipulations, human interactions, organizational structure, digital tools, professional knowledge, and actor skills.

In the next chapters, it will be discussed whether these factors in the literature review on construction projects match with interviewees' experiences on PPP projects and desk study on PPP projects carried out in Turkey.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter describes the methodology used in this research and defines the tools and strategies used. Research design will be explained as well as the context of this study.

3.2 Research design

For the purpose of that study, as the first step, a literature survey was made. The output of this survey was set of causes, impacts and strategies to minimize variation orders in construction projects. Secondly, a desk study was conducted on specific real PPP projects. The output of this step was causes and impacts of variation orders in real projects. Thirdly, interviews were conducted with the experts. Interviews were conducted with a group of construction industry professionals and consultants that are currently working on PPP projects, and the focus was on their perspectives on variation orders according to their experiences. As a next step, the literature research findings were examined and modified by experts and customized for public-private partnership projects. Finally, evaluated literature review, desk study and interview results were combined, and variation orders conceptual model was created.

Below flowchart given in Figure 2 shows the research steps.

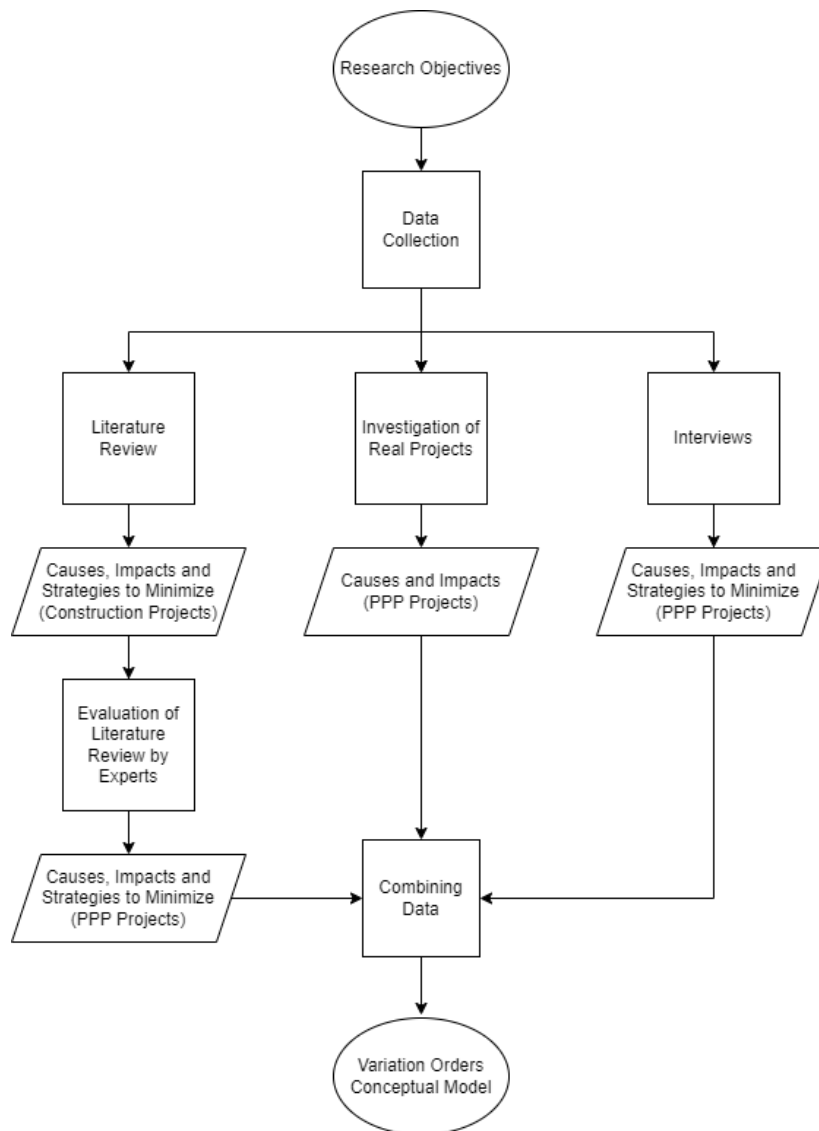


Figure 2. Research Flowchart

3.3 Data Collection

Data was obtained using a desk study and interviews to have a better understanding of the applicability of the various mechanisms utilized in assessing the causes and impacts of variation orders.

3.3.1 Desk Study

For the purpose of this study, there were 8 PPP projects which are from different sectors in Turkey. These projects are either under construction or completed from the commencement of work from 2010.

The project data was received from a consultancy company that participated many PPP projects in Turkey. Data was collected from official letters, monthly progress reports and technical due diligent reports of the projects in order to obtain information on the identified problem. This aids in understanding the link between theories and real project practices. Project names have been coded for confidentiality reasons. Projects are listed in Table 5.

Table 5. PPP Projects in the Desk Study

Project Code	Project Name
Project A	Integrated Health Campus 1
Project B	Integrated Health Campus 2
Project C	Integrated Health Campus 3
Project D	Integrated Health Campus 4
Project E	Integrated Health Campus 5
Project F	Bridge and Motorway 1
Project G	Bridge and Motorway 2
Project H	Tunnel Project 1

3.3.2 Interviews

The interview took place face-to-face, with the interviewer asking questions to a group of individuals. The interview is an excellent technique for obtaining information that would be difficult to get through other techniques, such as observations and surveys. Senior project consultants and senior project managers were contacted in interviews to learn more about the causes and effects of variation orders on PPP projects.

An average of 2 hours of face-to-face interviews were conducted with each interviewee. In order not to affect the opinions of the experts on the subject, the findings obtained as a result of the literature review were not shown during or before the interview. Instead, they were asked to give answers based on their own experiences, and then these answers were compared with the literature review and desk study findings. Firstly, the following questions were asked to the interviewees:

- From your previous project experiences, what are the causes of variation orders on PPP projects?
- From your previous project experiences, what are the various impacts of variation orders on PPP projects?
- What do you suggest for minimizing the variation orders on PPP projects?

After collecting the answers for each question, experts were asked to evaluate the results obtained in the literature review. Lists of causes, impacts and recommended strategies obtained from literature review was showed to each expert and asked to evaluate them.

Interviewee A is project director who worked in different PPP projects in Turkey as a construction manager and currently he is working as a project director in a consultancy company and worked in different PPP projects in different countries such as Kazakhstan, Romania etc. His overall construction experience is 26 years, while the PPP experience is 10 years.

Interviewee B is a project manager who worked in different PPP projects in Turkey and France. His overall construction experience is 16 years, while the PPP experience is 7 years.

Interviewee C is a project control manager who worked in different PPP projects in Turkey. His overall construction experience is 15 years, while the PPP experience is 6 years.

In the next chapter, research findings will be depicted and compared with literature.

CHAPTER 4

DISCUSSION OF FINDINGS

4.1 Introduction

This chapter depicts the findings from the desk study and interviews. Finally, comparisons are conducted with literature survey findings.

4.2 Analysis of Data from the Desk Study

Variation orders of 8 projects are reviewed in detail, in order to understand the causes and impacts of variation orders on PPP projects.

Table 6: List of Selected PPP Projects (TFI = total fixed investment)

Project	Project Name	Initial TFI	Revised TFI	V.O (%)
Project A	Integrated Health Campus 1	608,396,920 TRY	1,088,902,955 TRY	78.98 %
Project B	Integrated Health Campus 2	405,482,815 TRY	465,493,640 TRY	14.80%
Project C	Integrated Health Campus 3	1,404,374,044 TRY	1,433,854,036 TRY	2.10%
Project D	Integrated Health Campus 4	905,613,790 TRY	976,836,211 TRY	7.86%
Project E	Integrated Health Campus 5	720,478,933 TRY	771,014,900 TRY	7.01%
Project F	Bridge and Motorway 1	4,979,520,000 TRY	6,198,790,492 TRY	24.49%
Project G	Bridge and Motorway 2	11,258,108,595 TRY	12,321,322,280 TRY	9.44%
Project H	Tunnel Project 1	789,379,968 USD	929,537,864 USD	17.76%

4.2.1 Project A

This is a hospital project with an initial capacity of over 900 beds. However, the capacity was increased to over 1400 according to decision of the Ministry of Health. The gross construction area was increased from circa 250,000 m2 to circa 450,000 m2. The Total Fixed Investment Sum for Project A was 608,396,920 TRY and the original planned construction duration was 36 months. The original planned operational period was 25 years which makes overall concession period of 28 years. After the variation order, the Total Fixed Investment Sum is 1,088,902,955 TRY. Time extension was agreed as circa 25 months.

Because of the variation order, the investment amounts changes in different categories in the project is shown below;

Table 7: Change in Total Investment in Project A

Category	Tendered Amount TL	After Variation Order Amount TL	Percentage of Change (%)
Construction	504,279,283.20	930,920,336.57	84.60%
Construction Works	495,795,978.05	906,008,873.56	82.74%
Land Arrangement, Infrastructure and Superstructure Works	8,483,305.15	24,911,463.01	193.65%
Other Expenses	27,048,000.00	50,075,897.95	85.14%
Design And Engineering	4,928,000.00	9,123,559.04	85.14%
Commissioning Expenses	5,880,000.00	10,886,064.77	85.14%
Project Management, Commission and Commitment Expense	16,240,000.00	30,066,274.13	85.14%
Fixture	77,069,637.22	107,906,720.76	40.01%
Furnishings	9,063,237.22	16,966,130.98	87.20%
Medical Equipment	68,006,400.00	90,940,589.78	33.72%
TOTAL	608,396,920.42	1,088,902,955.28	78.98%

Because of lack of strategic planning, the capacity of the hospital had to be changed and together with the capacity, additional buildings were built which increased the construction area and changed the design. Also, one of the services was removed from the scope of the private company. Additionally, due to imbalance in the exchange rates, the public side changed the formulation of the payments. As a result of these overall changes, project cost increased, and government increased the concession period. According to the PPP agreement signed between the public and the private parties, maximum change order limit was 20%. However, the amount of variation in this project reached 79%. This caused problems between parties and lenders stopped the credit payments until the problem was resolved.

4.2.2 Project B

This is a hospital project with a capacity of over 600 beds. The gross construction area was increased from circa 170,000 m² to circa 200,000 m². According to the variation order, the medical equipment and furniture lists changed. The Total Fixed Investment Sum for Project B was 405,482,815 TRY and the original planned construction duration was 36 months. The original planned operational period was 25 years which makes overall concession period of 28 years. After the variation order, the Total Fixed Investment Sum is 465,493,640 TRY. Time extension for construction was agreed as 3 months.

Because of the variation order, the investment amounts changes in different categories in the project is shown below;

Table 8: Change in Total Investment in Project B

Category	Tendered Amount TL	After Variation Order Amount TL	Percentage of Change (%)
Construction Works	375,691,049.69	426,879,969.34	13.63%
Fixture	29,791,765.20	38,613,670.49	29.61%
Furnishings	2,593,811.63	5,602,625.15	116.00%
Medical Equipment	27,197,953.57	33,011,045.34	21.37%
TOTAL	405,482,814.89	465,493,639.82	14.80%

The Ministry of Health decided to change the specifications, and this caused the increase in floor area of the project. Also, due to lack of strategic planning, furniture and medical equipment amounts, types and qualities were changed. These changes affected the concession period and the project cost. In additionally, due to imbalance in the exchange rates, the public side changed the formulation of the payments.

4.2.3 Project C

This is a hospital project with a capacity of over 2300 beds. The gross construction area was increased from circa 640,000 m² to circa 705,000 m². The Total Fixed Investment Sum for Project C was 1,404,374,044 TRY. The hospital is currently under construction. According to the current discussions ongoing for the variation order, the Total Fixed Investment Sum is expected to be 1,433,854,036 TRY.

Because of the variation order, the investment amounts changes in different categories in the project is shown below;

Table 9: Change in Total Investment in Project C

Category	Tendered Amount TL	After Variation Order Amount TL	Percentage of Change (%)
Construction	1,106,441,488	1,132,329,258	2.34%
Construction Works	1,032,235,425	1,087,157,329	5.32%
Land Preparation and Pre-Works	29,548,724	29,548,724	0.00%
Grey Water System	207,577	-	-100.00%
Underground Heating Pumps	4,717,657	-	-100.00%
Trigeneration System	15,568,268	3,412,006	-78.08%
Solar Panels	471,765	471,765	0.00%
Seismic Isolators	23,588,284	11,635,645	-50.67%
Rain Water Collection System	103,788	103,788	0.00%
Other Expenses	49,280,000	52,872,223	7.29%
Engineering and Design	18,480,000	19,920,907	7.80%
Testing and Commissioning	6,160,000	6,522,164	5.88%
Project Management & Other Costs	24,640,000	26,429,152	7.26%
Fixture	248,652,554	248,652,554	0.00%
Furniture	57,162,459	57,162,459	0.00%
Medical Equipment	191,490,095	191,490,095	0.00%
TOTAL	1,404,374,042	1,433,854,035	2.10%

The items included in the variation calculations are listed by private party as follows;

- GFA Increase,
- Design Change,
- MoH New Regulation about Grey Water System
- Cancellation of Underground Heating Pumps
- Capacity of Trigeneration System
- Seismic Isolator need according to the Site Calculations

In addition, due to impediment to prompt decision making process of the Ministry of Health, the duration of the project was affected. As a result of these changes, the

project cost increased, and schedule delay occurred. Because of the delays, lenders stopped loan payments until construction progress returned to planned level. The Ministry of Health suggested to increase in concession period or make payments for the variation orders. Private party selected additional payments during the construction period.

4.2.4 Project D

This is a hospital project with a capacity of over 1300 beds. The gross construction area was increased from circa 375,000 m² to circa 430,000 m². The Total Fixed Investment Sum for Project D was 905,613,790 TRY. The hospital is currently under construction. According to the current discussions ongoing for the variation order, the Total Fixed Investment Sum is expected to be 976,836,211 TRY. The items included in the variation calculations are;

- GFA Increase,
- Design Change,
- MoH New Regulation about Grey Water System
- Cancellation of Underground Heating Pumps
- Capacity of Trigeneration System
- Seismic Isolator need according to the Site Calculations

Because of the variation order, the investment amounts changes in different categories in the project is shown below;

Table 10: Change in Total Investment in Project D

Category	Tendered Amount TL	After Variation Order Amount TL	Percentage of Change (%)
Construction	674,653,713	737,527,482	9.32%
Construction Works	614,447,167	703,083,198	14.43%
Land Preparation and Pre-Works	17,589,136	17,589,136	0.00%
Grey Water System	120,285	-	-100.00%
Underground Heating Pumps	2,999,284	-	-100.00%
Trigeneration System	11,724,474	2,936,129	-74.96%
Solar Panels	408,994	408,994	0.00%
Seismic Isolators	27,266,216	13,411,867	-50.81%
Rain Water Collection System	98,158	98,158	0.00%
Other Expenses	76,160,000	84,508,655	10.96%
Engineering and Design	11,200,000	12,469,336	11.33%
Testing and Commissioning	22,400,000	24,273,474	8.36%
Project Management & Other Costs	42,560,000	47,765,844	12.23%
Fixture	154,800,075	154,800,075	0.00%
Furniture	39,755,800	39,755,800	0.00%
Medical Equipment	115,044,275	115,044,275	0.00%
TOTAL	905,613,789	976,836,212	7.86%

The items included in the variation calculations are listed by private party as follows;

- GFA Increase,
- Design Change,
- MoH New Regulation about Grey Water System
- Cancellation of Underground Heating Pumps
- Capacity of Trigeneration System
- Seismic Isolator need according to the Site Calculations

Moreover, due to impediment to prompt decision making process of the Ministry of Health, the duration of the project was affected. As a result of these changes, the

project cost increased, and schedule delay occurred. Because of the delays, lenders stopped loan payments until construction progress returned to planned level. The Ministry of Health suggested to increase in concession period or make payments for the variation orders. Private party selected additional payments during the construction period.

4.2.5 Project E

This is a hospital project with an initial capacity of over 1400 beds. However, the capacity was increased to over 1450. The gross construction area was increased from circa 350,000 m² to circa 410,000 m². The Total Fixed Investment Sum for Project E was 720,478,933 TRY. After the variation order, the Total Fixed Investment Sum is 771,014,900 TRY.

Because of the variation order, the investment amounts changes in different categories in the project as shown in Table 11.

Table 11: Change in Total Investment in Project E

Category	Tendered Amount TL	After Variation Order Amount TL	Percentage of Change (%)
Construction Works	586,161,268.26	627,275,900.66	7.01%
Civil Works	166,149,744.69	177,803,850.89	7.01%
Architectural + Finishing Works	123,051,221.22	131,682,302.81	7.01%
Façade + Roof Works	49,676,747.27	53,161,182.89	7.01%
Mechanical Works	120,738,282.40	129,207,129.40	7.01%
Electrical Works	81,177,896.61	86,871,891.69	7.01%
Vertical Transportation	16,392,787.38	17,542,613.31	7.01%
Tri-generation Plant	11,367,802.16	12,165,164.65	7.01%
Landscaping & External Works	11,871,662.55	12,704,366.91	7.01%
Infrastructure Works	5,735,123.98	6,137,398.11	7.01%
Other Expenses	135,966,432.30	145,503,415.01	7.01%

Table 11 (continued)

Design & Permits	31,576,626.05	33,791,479.61	7.01%
Mobilization + Management	97,840,508.59	104,703,255.69	7.01%
Test and Commissioning	6,549,297.66	7,008,679.71	7.01%
Fixture	84,808,704.89	90,757,372.80	7.01%
Furnishings	10,079,553.68	10,786,555.61	7.01%
Medical Equipment	74,729,151.21	79,970,817.19	7.01%
TOTAL	806,936,405.45	863,536,688.47	7.01%

Due to area increase and additional construction works requested by the MoH; the private party raised a request for variation. As a result of this request, the Total Fixed Investment Sum has been increased by 7.01%. Building and Land Services and Extraordinary Maintenance and Repair Services annual amount have been increased by 7.0%, Cleaning and Pest Control Service amounts have been increased by 12.60%, Security Service, Help Desk and HIMS have been increased by 2.25% and Car Parking Service revenue has been reduced circa 1.98% due to area decrease in Car Park area. The Availability Payment (“AP”) has been increased by 7.05. The Concession Term has not been extended.

4.2.6 Project F

The base scope included motorway with a stay cable stiffened suspension bridge. The Total Fixed Investment Sum for Project I was 4,979,520,000 TRY. After the variation order, the Total Fixed Investment Sum is 6,198,790,492 TRY. Cost increase is 24.5%. Initial concession period was circa 4180 days. However, it is increased to circa 5220 days. Concession period increase is 24.9%.

Table 12: Change in Total Investment in Project F

Category	Total Investment Sum TL	Concession Period (Day)
Original Works	4,979,520,000	4,178
Other Cost Increase (1.39%)	69,292,467	44
Big Structures	2,217,359	-
Tunnel Works	3,880,378	-
Other Works	63,194,730	-
Change Order A	892,536,841	566
Additional Lane	206,664,722	-
Interchange Connection Roads	685,872,119	-
Expropriation Delays in Original Works	-	291
Additional Works	257,441,184	246
Payment Adjustment Addendum	-	-106
TOTAL	6,198,790,492	5,218

There has been changes to the scope during construction increasing the total toll able length of the Project. As per the original preliminary design criteria, the Original Works Motorway Length was circa 120 km, which was increased to circa 140 km based on the Implementation Drawings, reviewed, and approved by KGM. With a variation order, the motorway length is increased to circa 175 km.

There are a couple of variation orders in this project. One of them is that the design for construction of the original project incorporated changes and was mainly utilized to create additional capacity expected to be required due to the imminent construction of a new major infrastructure nearby. Another variation order was related to specifications. For example, pavement depth and surface layer specification changed for the motorway and the bridge. Toll collection system and intelligent transport system specifications changed during the construction. As a result of these changes, project cost and concession period increased.

Another variation order was related to economic conditions. Due to imbalance in the exchange rates, the public side changed the payments from yearly to semiannually. This also caused decrease in concession period.

4.2.7 Project G

The base scope included motorway with a stay cable stiffened suspension bridge. The Total Fixed Investment Sum for Project J was 11,258,108,595 TRY. After the variation order, the Total Fixed Investment Sum is 12,321,322,280 TRY. Cost increase is 9.4%. Initial concession period was circa 9130 days. However, it is increased to circa 9400 days. Concession period increase is 2.9%.

Table 13: Change in Total Investment in Project G

Category	Total Investment Sum TL	Concession Period (Day)
Original Scope	11,258,108,595	9,128
Approved Change Orders	1,063,213,684	592
Viaduct	320,778,490	-
Railway Junction Line	16,242,631	-
Design Change due to Environmental Issues	614,221,068	-
Guardrail Revision	20,542,472	-
WPP Pole	3,966,180	-
Vertical Road Traffic Signs	19,007,606	-
Intersection	31,141,323	-
Ecological Bridge	8,332,059	-
Tunnel Revision	4,520,671	-
Link Road Additional Works	5,516,469	-
Several Additional Works (Underpass, Box Culvert, Overpass etc.)	18,944,715	-
Payment Adjustment Addendum	-	-405
Construction Period Extension	-	83
TOTAL	12,321,322,280	9,398

There has been changes to the scope during construction increasing the total toll able length of the Project. The actual length of the project is circa 450 km.

A part of state highway has been taken under the responsibility of the project company and several additional works related to this part has been done. Also, due a revision made to the route to avoid the archaeological area, and therefore, the

highway length increased, and many additional works had to be done. Additionally, Because of the changes in environmental-related specifications, there have been changes in the design and an ecological bridge has been built. As a result of these changes, project cost and concession period increased.

Another variation order was related to economic conditions. Due to imbalance in the exchange rates, the public side changed the payments from yearly to semiannually. This also caused decrease in concession period.

4.2.1 Project H

Total project alignment is 16.4 km including a special tunnel with 6 km. The Total Fixed Investment Sum for Project H was 789,379,968 USD. After the variation order, the Total Fixed Investment Sum is 929,537,864 USD. Concession period of the project is 30 years. Concession period decrease is 5%.

Because of the variation order, the investment amounts changes in different categories in the project is shown below in Table 14.

Table 14. Change in Total Investment in Project H

Category	Tendered Amount (USD)	After Variation Order Amount (USD)	Percentage of Change (%)
Tendered Construction Works	789,379,968	805,356,018	2.0%
Section 1			
Side Road, side road and highway arrangement	34,877,283	35,400,441	1.5%
Region 1 U-turn	11,317,457	5,002,315	-55.8%
Region 2 U-Turn	8,633,658	-	-100.0%
Region 3 U-turn	20,016,619	25,501,172	27.4%
Region 4 underpass	41,038,710	75,388,109	83.7%
Region 4 U-turn	13,434,709	21,267,145	58.3%
Region 5 Underpass	13,621,046	4,168,040	-69.4%
Pedestrian overpass	4,852,200	2,770,606	-42.9%
Section 2			
Tunnel	611,410,625	611,410,625	0.0%

Table 14 (continued)

Section 3			
Side Road, side road and highway arrangement	16,377,404	12,332,186	-24.7%
Region 6 Intersection	9,326,392	9,326,392	0.0%
Region 7 Intersection	2,788,986	2,788,986	0.0%
Pedestrian overpass	1,684,881	-	-100.0%
Additional Works	-	120,127,236	
Tunnel Additional works	-	104,283,814	
Region 8 Additional works for project route change	-	2,845,353	
Region 9 Additional works for project route change	-	31,136	
Region 1 Additional works for project route change	-	38,752	
Additional works related to relocation of toll plazas	-	8,821,382	
Side road due to possible expropriation problems	-	762,904	
Construction of two additional pedestrian overpasses on the Section 3	-	708,390	
Adding disabled lifts to pedestrian overpasses	-	1,139,460	
Adding additional metal barriers to underpasses	-	1,496,046	
Change Orders (Ferry Station + Archeology + Water and Sewerage)	-	4,054,611	
Total	789,379,968.16	929,537,864.64	17.76%

The operations duration has been reduced by 1.5 years because of the VAT exemption.

Because of inadequate design, lots of changes had to be done on project route, underpasses, side roads, connection roads, etc. Also, due to change in specifications on underpasses and overpasses, additional works had to be done. In additionally, several additional works were done by the project company related to local municipality such as water and sewer infrastructure and ferry stations. As a result of these changes, project cost and concession period increased.

Another variation order was related to economic conditions. Due to imbalance in the exchange rates, the public side changed the payments from yearly to semiannually. This also caused decrease in concession period.

4.3 Summary of Findings from the Desk Study

Below table (Table 15) shows the summary of findings from the reviewed PPP Projects.

Table 15: Causes and impact of variation orders data from the desk study

Project	Causes of V.O	Impact of V.O
Project A	Lack of Strategic Planning Change in scope Inadequate design Change in economic conditions	Increase in project cost Change in concession period Interruption in Credit Payments Disputes among the parties Change in Payment mechanism
Project B	Change in specifications by the owner Lack of strategic planning Change in economic conditions	Increase in project cost Change in concession period Change in Payment mechanism
Project C	Inadequate design Change in government regulations Impediment to prompt decision-making process	Increase in project cost Completion schedule delay Additional payments for contractor Interruption in Credit Payments
Project D	Inadequate design Change in government regulations Impediment to prompt decision-making process	Increase in project cost Completion schedule delay Additional payments for contractor Interruption in Credit Payments
Project E	Inadequate design Change in scope	Increase in project cost
Project F	Change of scope Change in specifications by the owner Inadequate design Change in economic conditions	Increase in project cost Change in concession period Change in Payment mechanism

Table 15 (continued)

Project G	Change of scope Change in specifications by the owner Inadequate design Change in economic conditions	Increase in project cost Change in concession period Change in Payment mechanism
Project H	Change of scope Change in specifications by the owner Inadequate design Change in government regulations Change in economic conditions	Increase in project cost Change in concession period Change in Payment mechanism

4.3.1 Discussion of Findings from the Desk Study

The results of the desk study revealed that there are several causes of variation in answering the first objective. Because of the repetition, it was further synthesized into 7 causes of variation orders and ranked from the most to the least repetitive.

Table 16: Causes of Variation Orders from the Desk Study

S.N	Causes of Variation Orders
1	Inadequate design
2	Change in economic conditions
3	Change of scope
4	Change in specifications by the owner
5	Change in government regulations
6	Impediment to prompt decision-making process
7	Lack of Strategic Planning

Table 17 is a summary of the impacts of variation ordering based on the findings of the desk study. In order to answer the second objective, 26 impacts were discovered. These variables were then synthesized into 7 variables and ranked from the most to the least repetitive.

Table 17: Impact of Variation Orders from the Desk Study

S.N	Impact of Variation Orders
1	Increase in project cost
2	Change in concession period
3	Change in Payment mechanism
4	Interruption in Credit Payments
5	Additional payments for contractor
6	Completion schedule delay
7	Disputes among the parties

As a summary, the desk study shows causes of variation orders could be inadequate design, change in economic conditions, change of scope, change in specifications by the owner, change in government regulations, impediment to prompt decision-making process and lack of strategic planning. The impacts of these variation orders could be increase in project cost, change in concession period, change in payment mechanism, Interruption in Credit Payments, Additional payments for contractor, Completion schedule delay and disputes among the parties.

It was observed that the rate of variation orders of some projects can be quite high compared to others. However, no project has been observed that has not received a variation order. This could be an accepted feature as a nature of PPP projects.

The highest variation order among the observed projects is Project A. When Total Fixed Investment Sum is compared, this project is in the 7th place among 8 projects. The project with the second highest variation order rate is Project F. When Total Fixed Investment Sum of this project is compared, it is in the second place. The project with the third highest variation order rate is Project H. When the Total Fixed Investment Sum of this project is compared, it is in the 5th place. This shows that the amount of the initial investment may not affect the variation order rate.

The observed 8 PPP projects can be divided into 2 groups which are health campuses and highway transportation projects. Among the health campuses projects, Project A has the highest variation order rate although its number of beds and investment amount is less than most of other projects. No direct relation between the number of

beds or investment amount and variation order rate is observed. Among the 3 highway transportation projects, the highest variation order rate belongs to Project F which has the second highest investment amount and the second longest length in its group. No direct relation between length or investment amount and variation order rate is observed. The reason could be all of 8 PPP projects are unique. Each project has its own capacity, requirements, conditions and properties.

It was observed that one of the biggest problems faced by PPP projects is inadequate design. In PPP projects, the design decisions together with the conceptual design of a project made by the public side during the bidding stage. PPP projects are unique projects, and they may have different properties according to the location. Common tender specifications for different PPP projects may cause problems. For example, having seismic isolators in the hospitals was included in the specifications as a design criterion. However, in places where there was no earthquake zone, this requirement increased the cost unnecessarily.

Change in economic conditions was caused variations orders in several PPP projects. The exchange rate uncertainty caused financial damages to the contractors. Public and private parties agreed on the new payment mechanism.

In most projects, increase in project cost occurs as a result of variation orders caused by change of scope. These increases may include indirect or direct project costs. According to the PPP agreements of the projects, there is maximum limit for the variation order amount. The clause says that the cumulative sum of the increases to be realized shall not exceed a certain amount of the Total Fixed Investment Amount during the Investment Period. If it is exceeded, the project may be terminated. In the one of the projects, this limit is exceeded, and lenders stopped the credit payments due to the uncertainty.

In the two of the projects, variation orders due to change in specifications and regulations, the project cost increased. As a result of this increase, contractors wanted additional payments instead of concession period increase or payment mechanism change.

Impediment to prompt decision-making process may lead problems. PPP projects includes EPC contracts which contain engineering, procurement and construction. These projects don't have a final design before the tender stage. Therefore, design is an ongoing process during the construction. However, public side should approve the design. Sometimes, this approving process may take too much time and contractor may lose time. This loss can be remedied with an extension of concession period.

Lack of strategic planning may lead variation orders. If it is noticed after the tender that insufficient feasibility study has been done, this may cause variation order. Feasibility study for the PPP projects should be done carefully before the tender stage. Demand analysis is one of the most important studies which determine the needs of the projects. If enough time and resources are not allocated to the demand analysis, the project may have difficulty meeting the needs and this may cause variation order. In the one of the observed projects, the capacity of the project is increased more than 50% which shows that the feasibility study was insufficient.

All of the observed projects are located in Turkey. Turkey is a developing country, and in developing countries, the procedures on the public side may not be well established or not done properly. This situation may be the root cause of lack of strategic planning, inadequate design and impediment to prompt decision-making process.

In the developing countries, positions in ministries may not be very settled. Each ministers bring their own team. These teams learn everything from the beginning, and they want to implement their own ideas to the projects. Therefore, projects are exposed to different interventions each time. For example, between 2010 and 2022, there were 5 changes in Minister of Health in Turkey. Same situation is valid for the transport projects. Between 2010 and 2022, there were 9 changes in Minister of Transport and Infrastructure in Turkey. This situation may be the root cause of the change of scope, change in specifications and government regulations.

Additionally, economies of developing countries may not be very stable. Sometimes their economy can have a very good momentum and feasibility studies and payment mechanisms can be shaped accordingly. Projects may also be adversely affected if the economy does not go as expected later on. This situation may be the root cause of the change in economic conditions.

All of the causes for variation orders found as a result of the desk study match with also the items found in the literature review. For the impacts of the variation orders in PPP projects, desk study shows there are different impacts such as change in concession period, change in payment mechanism, interruption in credit payments not widely discussed in the literature.

4.4 Analysis of Data from the Interviews

These interviews were conducted with a group of construction industry professionals and consultants that are currently working on PPP projects, and the focus was on their perspectives on variation orders. In total three interviews were conducted. The purpose of the interview was to learn more about the causes of variation orders and how they affect PPP projects, as well as to get advice on how to reduce their occurrence.

In the interviews, the interviewees were asked to explain the causes and impacts of the variation orders based on their past project experiences.

According to the interviewees' experiences during their professional life, following factors affect variation orders:

- Unforeseen problems due to long life of investments: Due to unforeseen problems variation orders may occur. The lifecycle of some of these projects may be up to 30 years. During this period, there is a high probability of having an unforeseen problem. These unforeseen problems may occur even before the operation period. According to Interviewee B's previous experiences, the time between the tender stage and operation stage may be up to 5 years. The

required equipment may not be produced anymore and because of the technological innovations, a new equipment may be required by the public side. This may lead a variation order.

- Change in laws and regulations: Change in law and change in regulations may occur especially in developing countries. According to Interviewee A's previous experiences, a developing country may start to use European legislations and regulations after tendering the projects. These changes may increase additional works or equipment which result increase the project cost.
- Owner-related problems: According to Interviewee A, flaws of the owner in representations of local conditions may be a cause of variation order. The local conditions may be not known by the contractor. If it is a project carried out in an area with archaeological remains, such information should be specified in advance.
- Force majeure: According to Interviewee C, force majeure is a very well known cause for variation orders although it does not occur frequently. Its impact could be very high to the construction, and it may stop the work on the site. In their current project, Although the Covid-19 pandemic process affected construction works like all other sectors, it could not be counted as force majeure in Turkey because the government allowed construction works to continue.
- Design-related problems: Inadequate design and objectives may lead variation orders.
- Problems in the decision-making process: According to the interviewee B' experiences, with the change of the minister in the relevant ministry, the team carrying out the process also changes. The perspective of the new team may be different from the previous team. For this reason, they may request changes in the scope. Even if it is a built place, it can be demanded to demolish it and rebuild it.

The interviews show causes of variation orders could be change in law, unforeseen problems, inadequate design, flaws of the owner in representations of local

conditions, inadequate project objectives, impediment to prompt decision-making process, change of scope, force majeure and lack of strategic planning.

The impacts of variation orders mentioned by the interviewees are; Increase in project cost, Completion schedule delay, Disrupting continuity of services, Rework and demolition, Financing Problems, Disputes among the parties, Interruption in Credit Payments.

Recommended Strategies

The interviewees suggested many strategies to minimize the variation orders in PPP projects. These are follows;

- Carry out detail site investigation including detail soil investigations and consider it during tendering stage
- Spend adequate time on pre-tender planning phase
- Have the land application or land purchase completed before awarding contracts
- Combine different concepts from qualified bidders and make the final bidding stage for conditions equalized final concept
- Mechanism to share risk in case of lack of demand
- Negotiating with the participants and deciding on the requirements of the specifications after the tender
- Fast design approval process
- Having a clause in the contract for buffer purposes, variation order mechanism may not work up to a certain percentage.
- Making city planning in accordance with the project in advance

According to the interviewee B, one of the best practices to reduce variation orders is carrying out detail site investigation. In the international practice, there should be 3 levels of geotechnical study before the tender. However, this practice may not be applied in some of countries, and this may result variation orders due to unforeseen ground conditions.

According to interviewee A, public side should complete the expropriation the land of the project before the tender stage to avoid possible delays during the construction. Sometimes the public side initiates the expropriation, but as a result of the landowners suing, the project can be stopped until the case is concluded.

Some countries use the method of equalized final concept as a competitive dialog for their tender stage and Turkey is one of these countries. Interviewee A explained that at the first stage of the tender, different contractors may suggest different concept designs which may include unique solutions for the problems . For example, a contractor may suggest cogeneration, other may suggest solar power panels and other may suggest artificial intelligence in their operation applications. The public side combines the best parts of these different concept designs and creates a new specification. Later, a new tender stage for the shortlisted contractors is done for the new specifications. This method reduces the possibility of having variation order in the future.

Although there is a guarantee mechanism in Turkish PPP projects, it is not a common practice in other countries. According to Interviewee A, in some cases, demand analysis may not meet actual values. If there is not mechanism to share risk in case of lack of demand, the private side may request variation order to recover their losses. This mechanism doesn't have to cover all the demand, but it may share the risk between the public and private. Also, to avoid this problem, the administration needs to make the demand analysis very sensitive and accurate.

Interviewee C suggested a strategy about having a clause in the contract for buffer purposes so that variation order mechanism may not work up to a certain percentage. In Turkey, there is such a clause in PPP projects which suggest generally 1% of the changes. However, all of the observed projects shows that there are always variation orders higher than 1%. Therefore, this clause doesn't work in practice. An analysis for the possible variation order amount could be done and a reasonable amount could be placed in this clause.

In some of the projects, because of insufficient city planning, variation orders may occur. Interviewee C explained that infrastructure services such as water, sewerage, electricity, natural gas may be insufficient for the region where the project will be built. Although the construction of the project is finished, the construction of the relevant infrastructures may not catch up with the opening of the project by the public side and this may delay the opening of the project. Therefore, making city planning in accordance with the project in advance could be a strategy to minimize the variation order.

The proposed strategies are all actions that can be taken by the public side. Therefore, the experts were also asked about what can be done to help the private side get through this process more easily.

Interviewee A explained that private side could work with expert consultants in the specific fields during the tender stage so that any gaps in the tender document that may create a change order can be closed before awarding. All of the gaps can be asked to the public side during tender stage and these gaps can be closed by public side.

According to Interviewee B's experiences, in underdeveloped countries, it is easier to come to terms with human relations. Both sides can pull strings to each other. Public side may want favors from private side without issuing variation orders, and the contractor may accept this request in a way that they will receive compensation in other ways. However, in developed countries, all kinds of variations are properly documented, and contractual requirements are made. It is not possible to cancel or change the amount of the variation order with human relations.

Interviewee C suggested to have a proper documentation system to manage the variation process smoother. All the official letters should be properly stored. In underdeveloped countries, the public side can verbally request additional works from the contractor. The contractor may consider complying with these requests without any official writing and reaching a compromise at the end of the construction. The purpose of this is not to conflict with the administration side. However, this strategy

may not work out as the contractor expected at the end. Therefore, contractor should prepare all the cost and time related studies for this variation before taking action and present them to the administration side.

Table 18 summarizes the responses of the interviewees.

Table 18: Interview Results

Questions	Interviewee A	Interviewee B	Interviewee C
From your experience, what are the causes of variation orders on PPP projects?	<ul style="list-style-type: none"> • Change in Law • Unforeseen Condition • Inadequate Design • Flaws of the owner in representations of local conditions 	<ul style="list-style-type: none"> • Inadequate project objectives • Inadequate design • Unforeseen problems • Impediment to prompt decision-making process 	<ul style="list-style-type: none"> • Change of scope • Force Majeure • Inadequate project objectives • Inadequate design • Lack of Strategic Planning
What are the various impacts of variation orders on PPP projects?	<ul style="list-style-type: none"> • Increase in project cost • Completion schedule delay • Disrupting continuity of services 	<ul style="list-style-type: none"> • Increase in direct and indirect costs • Completion schedule delay • Rework and demolition 	<ul style="list-style-type: none"> • Disputes among the parties • Completion schedule delay • Interruption in Credit Payments

Table 18 (continued)

<p style="writing-mode: vertical-rl; transform: rotate(180deg);">What do you suggest minimizing the variation orders on PPP projects?</p>	<ul style="list-style-type: none"> • Combine different concepts from qualified bidders and make the final bidding stage for conditions equalized final concept • Making the demand analysis very sensitive and accurate • Mechanism to share risk in case of lack of demand • Having the land application or land purchase completed before awarding • The consultant should co-ordinate closely at tender stage 	<ul style="list-style-type: none"> • Negotiating with the participants and deciding on the requirements of the specifications after the tender • Fast design approval process • Detail site investigation and consider it during tendering stage • Enhance communication between parties 	<ul style="list-style-type: none"> • Having a clause in the contract for buffer purposes, variation order mechanism may not work up to a certain percentage. • Making city planning in accordance with the project in advance • Spend adequate time on pre-tender planning phase • Having proper documentation system
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4.5 Findings from the Interviews

The interview provided 9 causes of variation orders (Table 19) in addressing the first question, 6 impacts of variation orders (Table 20) in addressing the second question, and 13 strategies to minimize variation orders (Table 21) in addressing the third question. These answers were combined and reviewed to see if they match with literature.

Findings from the interviews are summarized in below tables (Table 19- 21).

Table 19. Causes of Variation Orders from Interviews

S.N	Causes of Variation Orders
1	Change in Law
2	Unforeseen Problems
3	Inadequate Design
4	Flaws of the owner in representations of local conditions
5	Inadequate project objectives
6	Impediment to prompt decision-making process
7	Change of scope
8	Force Majeure
9	Lack of Strategic Planning

Table 20. Impacts of Variation Orders from Interviews

S.N	Impacts of Variation Orders
1	Increase in project cost
2	Completion schedule delay
3	Disrupting continuity of services
4	Rework and demolition
5	Disputes among the parties
6	Interruption in Credit Payments

Table 21. Recommended Strategies from Interviews

No	Recommended Strategies to Minimize Variation Order
1	Combine different concepts from qualified bidders and make the final bidding stage for conditions equalized final concept
2	Making the demand analysis very sensitive and accurate
3	Mechanism to share risk in case of lack of demand
4	Negotiating with the participants and deciding on the requirements of the specifications after the tender
5	Fast design approval process
6	Having a clause in the contract for buffer purposes, variation order mechanism may not work up to a certain percentage.
7	Making city planning in accordance with the project in advance
8	Carry out detail site investigation including detail soil investigations and consider it during tendering stage
9	Spend adequate time on pre-tender planning phase

Table 21 (continued)

10	Have the land application or land purchase completed before awarding contracts
11	The consultant should co-ordinate closely at tender stage
12	Enhance communication between all parties
13	Having proper documentation system

For the causes of the variation orders in PPP projects, interviews show there are causes which are change in law and flaws of the owner in representations of local conditions which are not mentioned in previous studies. This may be due to the fact that these factors are representative of developing countries such as Turkey.

For the impacts of the variation orders in PPP projects, the different impacts not widely seen in the literature are disruption of continuity of services and interruption in credit payments. Interruption in credit payments was also an outcome of the desk study, which is a critical issue that may lead to significant delays in projects.

During the interviews, 8 most important strategies highlighted by the experts are ;

- Combine different concepts from qualified bidders and make the final bidding stage for conditions equalized final concept
- Making the demand analysis very sensitive and accurate
- Mechanism to share risk in case of lack of demand
- Negotiating with the participants and deciding on the requirements of the specifications after the tender
- Fast design approval process
- Having a clause in the contract for buffer purposes, variation order mechanism may not work up to a certain percentage.
- Making city planning in accordance with the project in advance
- Having proper documentation system

4.6 Evaluation of Literature Review by the Experts

As a result of the literature review, causes of variation orders, impacts of variation orders, recommended strategies to minimize them in general construction projects were prepared as lists and submitted to the experts for their review. Some of the items found for general construction projects were not applicable in PPP projects. These factors were deleted from the lists by experts. Deleted items and experts' reasons are summarized below.

Causes of Variation Order

Owner's financial problems: Public side's financial problem causes switching to the default state rather than having a variation order. Feasibility studies are very important in PPP projects because the concession period is 25-30 years generally. If there is a chance to have a financial problem in public side, then it is not a feasible project, and the project doesn't start. If this situation happens after starting the project, then termination of the agreement takes place.

Change in design by the consultant: In PPP projects, responsibility of design belongs to the private party. Therefore, it doesn't cause a variation order.

Value Engineering: In other construction projects, value engineering can degrade the quality of the structure. However, in PPP projects, specifications are based on output. Any solution that gives the specified performance is accepted.

Design Complexity: The private party accepts the concept design, and the responsibility of details belongs to them.

Inadequate working drawing details: Responsibility of working drawings belongs to private party.

Poor knowledge of available materials and equipment: This item can be realized between the contractor and sub-contractor but not between the public side.

Change in specification by the consultant: Public side has owner's consultants to control the design drawings. But they don't have a right to change specifications.

Poor drawings: Responsibility of drawings belongs to private party.

Lack of involvement in design: Public side doesn't involve detail design stage.

Unavailability of skills: In the agreements between the public and the private sides, private side undertakes to do this job in the best possible way. Therefore, it is not possible to have a variation order for this item.

Contractor's financial difficulties: If contractor has financial difficulties and can't finish the project, then it is replaced by another contractor.

Poor workmanship: Public side already control the works via owner's engineers and fix them.

Unfamiliarity with local conditions: Local conditions should be identified by the public side before tender stage. However, after identification, the responsibility belongs to private party.

Long-lead procurement: Private party should prioritize the long lead items.

Bad sub-contractor or supplier: This item is not a problem that concerns the administration. This clause is a situation that may occur between Engineering, Procurement, and Construction (EPC) company and its subcontractor or between Operation and Maintenance (O&M) company and its subcontractors.

Health and safety: There is no variation order due to a problem related to health and safety in the field.

Weather conditions: Unless there is specific force majeure, there is no variation order due to weather conditions.

Sociocultural factors: This item is not a problem that concerns the administration.

Impacts of Variation Order

Firm's reputation: This can't be an impact due to the variation orders in PPP projects.

Poor professional relations: This item may be valid due to the variation order not being concluded, but the occurrence of variation order has no effect on this issue. This can't be an impact due to the variation orders in PPP projects.

Recommended Strategies to Minimize Variation Order

Complete the drawings at tender stage: In PPP projects, only conceptual design is prepared at tender stage. Detailed design drawings are not available at this stage.

The consultant should produce a concluding design and contract documents: In PPP projects, consultants only prepare conceptual design. They can't prepare concluding design in this stage.

Get accurate information and research with regard to procurement procedure, material and plant: This item could be valid in case of having a detailed design. In PPP projects, responsibility of creating detailed design belongs to private party. Output specifications doesn't include equipment or material detail.

Thus, in the next chapter, all of the findings are synthesized and a conceptual model to manage variation orders will be presented.

CHAPTER 5

CONCEPTUAL MODEL ON VARIATION ORDERS IN PPP PROJECTS

Based on research findings, a conceptual model is developed to explain why and how variation orders occur in PPP projects, their impact and strategies to manage them.

5.1 Summary of Findings that Guide the Conceptual Model

Causes of Variation Orders in PPP Projects

From the evaluated literature review, desk study and interviews, the common causes of variation orders on PPP are synthesized as follows; Inadequate design, Change of scope, Impediment to prompt decision-making process, Lack of Strategic Planning, Change in economic conditions, Change in specifications by the owner, Change in government regulations, Unforeseen Problems, Inadequate project objectives and Force Majeure as given in Table 22.

Table 22. Combined List of Causes of Variation Order

No	Causes of Variation Order	Evaluated Literature	Desk Study	Interviews
1	Change of scope	X	X	X
2	Inadequate project objectives	X		X
3	Replacement of materials or procedures	X		
4	Impediment to prompt decision-making process	X	X	X
5	Obstinate nature of owner	X		
6	Change in specifications by the owner	X	X	
7	Interference of employer	X		
8	Errors and omissions in design	X		
9	Conflicts among contract documents	X		
10	Inadequate design	X	X	X

Table 22 (continued)

11	Unavailability of equipment	X		
12	Desired profitability	X		
13	Differing site conditions	X		
14	Fast-track construction	X		
15	Poor procurement process	X		
16	Lack of coordination and communication	X		
17	Lack of strategic planning	X	X	X
18	Change in economic conditions	X	X	
19	Change in government regulations	X	X	
20	Unforeseen problems	X		X
21	Force majeure	X		X
22	Change in Law			X
23	Flaws of the owner in representations of local conditions			X

The combined list of causes was shared with the experts, and they were asked to select the most important ones.

According to the interviewee A, most important causes are change in law, change in government regulations, poor procurement process, inadequate design and project objectives, unforeseen problems and change of scope.

According to the interviewee B, most important causes are change of scope, change in specifications, differing site conditions, unforeseen problems and replacement of materials or procedures.

According to the interviewee C, most important causes are change of scope, inadequate design and project objectives, impediment to prompt decision-making process, error and omissions in design and change in specifications.

According to experts' selections, the most important causes can be summarized as change of scope, inadequate design and project objectives, change in specifications, differing site conditions and unforeseen problems.

Impacts of Variation Orders in PPP Projects

From the evaluated literature review, desk study and interviews, the common impacts of variation orders on PPP are follows; increase in project cost, additional payments for contractor, completion schedule delay, disputes among the parties, rework and demolition, and interruption in credit payments.

The combination of the evaluated literature review, desk study and interviews is given in Table 23.

Table 23. Combined List of Impacts of Variation Order

No	Impacts of Variation Orders	Evaluated Literature	Desk Study	Interviews
1	Increase in project cost	X	X	X
2	Increase in overhead expenses	X		
3	Delay in payment	X		
4	Quality degradation	X		
5	Productivity degradation	X		
6	Procurement delay	X		
7	Rework and demolition	X		X
8	Logistics delays	X		
9	Poor safety conditions	X		
10	Additional payments for contractor	X	X	
11	Completion schedule delay	X	X	X
12	Change in concession period		X	
13	Change in Payment mechanism		X	
14	Interruption in Credit Payments			X
15	Disputes among the parties	X	X	X
16	Disrupting continuity of services			X

According to this study, there are 15 different impacts of variation orders in PPP projects. The combined list of impacts was shared with the experts, and they were asked to select the most important ones.

According to the interviewee A, most important impacts are Disrupting continuity of services, Change in concession period, Increase in project cost, Completion schedule delay and Procurement delay.

According to the interviewee B, most important impacts are Increase in project cost, Rework and demolition, Completion schedule delay, Increase in overhead expenses and Interruption in Credit Payments.

According to the interviewee C, most important impacts are Completion schedule delay, Increase in project cost, Interruption in Credit Payments, Disrupting continuity of services and Rework and demolition.

According to experts' selections, the most important impacts can be summarized as Increase in project cost, Completion schedule delay, Disrupting continuity of services, Rework and demolition, and Interruption in Credit Payments.

Recommended Strategies to Minimize Variation Orders in PPP Projects

From the evaluated literature review and interviews, the common strategies to minimize variation orders on PPP are follows; Carry out detail site investigation including detail soil investigations and consider it during tendering stage, spend adequate time on pre-tender planning phase, Have the land application or land purchase completed before awarding contracts, the consultant should co-ordinate closely at tender stage and Enhance communication between all parties.

The combination of the evaluated literature review and interviews for the strategies to minimize variation orders is given in Table 24.

Table 24. Combined List of Recommended Strategies

No	Recommended Strategies to Minimize Variation Order	Evaluated Literature	Interviews
1	Carry out detail site investigation including detail soil investigations and consider it during tendering stage	X	X
2	All involved parties should plan adequately before works start on site	X	
3	Spend adequate time on pre-tender planning phase	X	X
4	The consultant should co-ordinate closely at tender stage	X	X
5	Supervise the works with an experienced and dedicated supervisor	X	

Table 24 (continued)

6	Place experienced and knowledgeable executives in the engineering and design department	X	
7	Consultants should ensure that the design/specifications fall within the approved budget	X	
8	Clients should provide a clear brief of the scope of works	X	
9	All parties should forecast unforeseen situations	X	
10	Enhance communication between all parties	X	X
11	Once the tender is awarded, make no changes to the specifications	X	
12	Have the land application or land purchase completed before awarding contracts	X	X
13	Combine different concepts from qualified bidders and make the final bidding stage for conditions equalized final concept		X
14	Making the demand analysis very sensitive and accurate		X
15	Mechanism to share risk in case of lack of demand		X
16	Negotiating with the participants and deciding on the requirements of the specifications after the tender		X
17	Fast design approval process		X
18	Having a clause in the contract for buffer purposes, variation order mechanism may not work up to a certain percentage.		X
19	Making city planning in accordance with the project in advance		X
20	Having proper documentation system		X

According to this study, there are 20 different strategies which are recommended to minimize variation orders in PPP projects.

The combined list of strategies was shared with the experts, and they were asked to select the most important ones.

According to the interviewee A, most important strategies are follows;

- Spend adequate time on pre-tender planning phase

- Clients should provide a clear brief of the scope of works
- Combine different concepts from qualified bidders and make the final bidding stage for conditions equalized final concept
- Making the demand analysis very sensitive and accurate
- Mechanism to share risk in case of lack of demand
- Having a clause in the contract for buffer purposes, variation order mechanism may not work up to a certain percentage

According to the interviewee B, most important strategies are follows;

- All involved parties should plan adequately before works start on site
- The consultant should co-ordinate closely at tender stage
- Spend adequate time on pre-tender planning phase
- Carry out detail site investigation including detail soil investigations and consider it during tendering stage
- Place experienced and knowledgeable executives in the engineering and design department

According to the interviewee C, most important strategies are follows;

- Making city planning in accordance with the project in advance
- Carry out detail site investigation including detail soil investigations and consider it during tendering stage
- All involved parties should plan adequately before works start on site
- Having a clause in the contract for buffer purposes, variation order mechanism may not work up to a certain percentage.
- Fast design approval process

According to experts' selections, the most important strategies can be summarized as;

- Carry out detail site investigation including detail soil investigations and consider it during tendering stage

- All involved parties should plan adequately before works start on site
- Spend adequate time on pre-tender planning phase
- Having a clause in the contract for buffer purposes, variation order mechanism may not work up to a certain percentage.

In the PPP projects, variation order process is slightly different than the traditional procurement projects. For this reason, an explanatory framework has been prepared to understand the process better. Firstly, there are causes of variation orders in the PPP project which should be identified. Later, all possible impacts of these changes should be evaluated. Evaluating the possible impacts can be used to filter out changes that have already happened or are about to happen. This step results in a proposed variation order with a new budget, schedule, updated action plan, etc. As the next step, proposed variation orders should follow the formal process. Public side should be involved and make decisions based on the entire set of changes detailed in the proposed variation orders. In this stage, public side can reject the variation order or suggest improvements through negotiations or accept it. Even though, rejected variation orders should be recorded so that they can be reevaluated when they are ready, and parties should be informed. After final decision of the variation order, all stakeholders are informed, all actions are properly coordinated, and all aspects are kept updated. At this point, all disputes coming from variation orders can be settled by justifying and assessing all direct and indirect causes of the variation order.

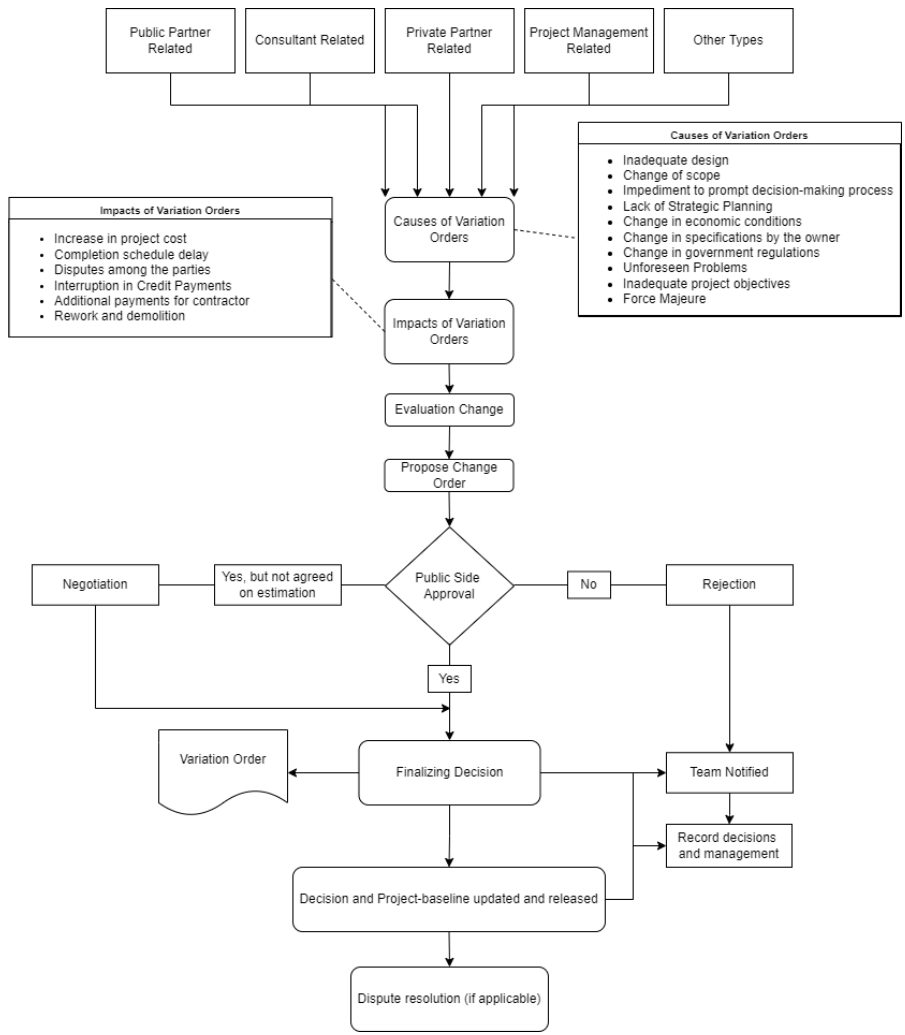


Figure 3. Variation Orders Process Framework in PPP Projects

5.2 Developing a Conceptual Model for Variation Orders in PPP Projects

According to the findings explained in the previous section, a conceptual model for variation orders in PPP projects is developed. By using this conceptual model, the parties can determine the critical success factors of the projects. Also, the contractor can use this model while making risk assessment.

The lender’s advisors already make risk assessments for the projects during the period between commercial and financial close. During the risk assessment, advisors ensure that mitigation plans are prepared for each risk. However, advisors should be

good at their fields and not miss any risk. Generally, advisors analyze the risks from the documents provided to themselves. However, they must be aware of the gaps in the tender and the provided documents.

Having a risk assessment for variation orders helps the contractors. Thanks to the risk assessment, they may be aware of the variation orders before happening. This will help the contractor to prepare itself. The contractor can include the cost increase that will result from this variation order in the budget it has prepared, or they can revise their cashflow accordingly. Also, this risk analysis paves the way for the necessary studies to make the variation order official. Before the variation order process, necessary time and cost studies must be done by the contractor which may take some time. The delay in the preparation of these studies may have negative consequences for the contractor.

According to Liu et al. (2014), below framework shows the life-cycle of PPPs.

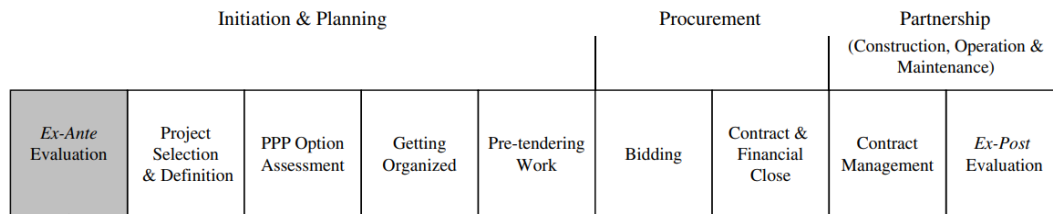


Figure 4. Life-cycle framework for PPPs (adapted from Liu et al., 2014)

According to the framework given in Figure 4, PPP projects includes 3 main stages which are initiation & planning, procurement and partnership. The conceptual model will include these 3 stages in detail.

For a variation order to take place, the commercial close should be done which means tender should be awarded to the contractor. Therefore, impacts should be seen on partnership stage. However, it should be noted that the causes may actually include problems during all stages. Model separates the causes, impacts and strategies according to their stages.

Below framework shows the conceptual model for variation orders on PPP projects.

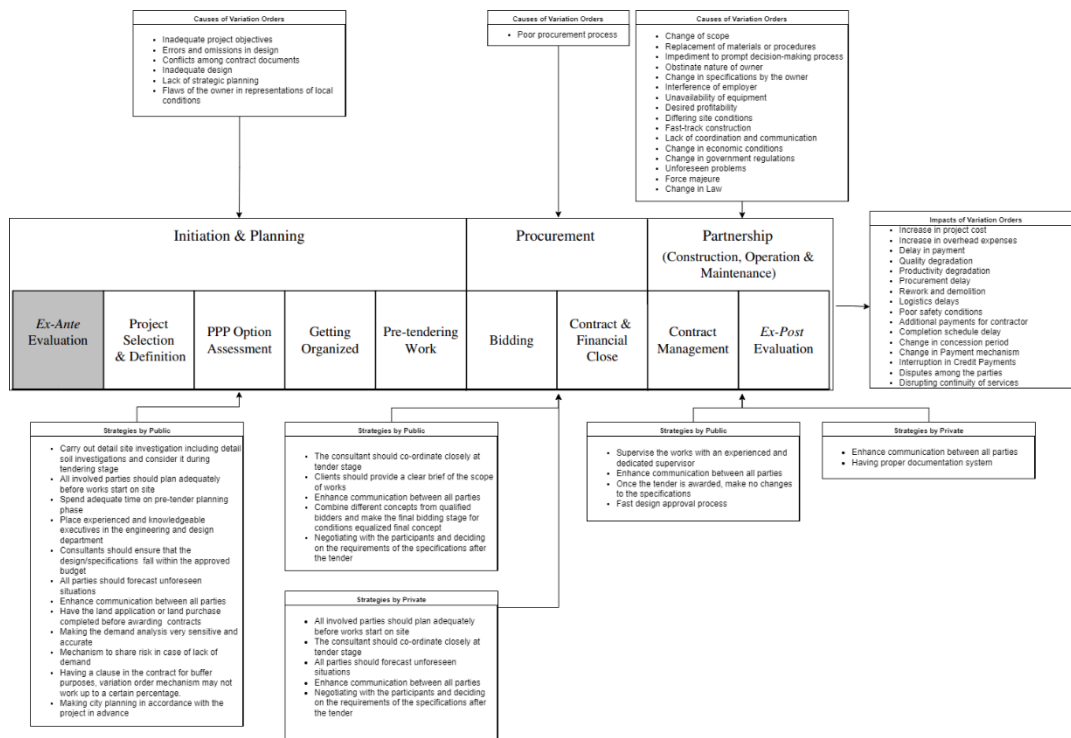


Figure 5. Conceptual Model for Variation Orders in PPP Projects

In initiation & planning stage, causes of variation orders could be following items;

- Inadequate project objectives
- Errors and omissions in design
- Conflicts among contract documents
- Inadequate design
- Lack of strategic planning
- Flaws of the owner in representations of local conditions

In initiation & planning stage, strategies by public side could be following items;

- Carry out detail site investigation including detail soil investigations and consider it during tendering stage
- All involved parties should plan adequately before works start on site

- Spend adequate time on pre-tender planning phase
- Place experienced and knowledgeable executives in the engineering and design department
- Consultants should ensure that the design/specifications fall within the approved budget
- All parties should forecast unforeseen situations
- Enhance communication between all parties
- Have the land application or land purchase completed before awarding contracts
- Making the demand analysis very sensitive and accurate
- Mechanism to share risk in case of lack of demand
- Having a clause in the contract for buffer purposes, variation order mechanism may not work up to a certain percentage.
- Making city planning in accordance with the project in advance

There is no strategies can be applied in this stage by private side.

In procurement stage, only one cause is found which is poor procurement process. If the public side mismanages the tender process and does not specify what they want which may not in the tender document, it may cause a change order later. By combining different concepts from qualified bidders and making the final bidding stage for conditions equalized final concept, public side can prevent this problem.

In procurement stage, strategies by public side could be following items;

- The consultant should co-ordinate closely at tender stage
- Clients should provide a clear brief of the scope of works
- Enhance communication between all parties
- Combine different concepts from qualified bidders and make the final bidding stage for conditions equalized final concept
- Negotiating with the participants and deciding on the requirements of the specifications after the tender

In procurement stage, strategies by private side could be following items;

- All involved parties should plan adequately before works start on site
- The consultant should co-ordinate closely at tender stage
- All parties should forecast unforeseen situations
- Enhance communication between all parties
- Negotiating with the participants and deciding on the requirements of the specifications after the tender

In partnership stage, causes of variation orders could be following items;

- Change of scope
- Replacement of materials or procedures
- Impediment to prompt decision-making process
- Obstinate nature of owner
- Change in specifications by the owner
- Interference of employer
- Unavailability of equipment
- Desired profitability
- Differing site conditions
- Fast-track construction
- Lack of coordination and communication
- Change in economic conditions
- Change in government regulations
- Unforeseen problems
- Force majeure
- Change in Law

In partnership stage, strategies by public side could be following items;

- Supervise the works with an experienced and dedicated supervisor
- Enhance communication between all parties

- Once the tender is awarded, make no changes to the specifications
- Fast design approval process

In partnership stage, strategies by private side could be following items;

- Enhance communication between all parties
- Having proper documentation system

As a result of the variation orders in partnership stage, impacts could be following items;

- Increase in project cost
- Increase in overhead expenses
- Delay in payment
- Quality degradation
- Productivity degradation
- Procurement delay
- Rework and demolition
- Logistics delays
- Poor safety conditions
- Additional payments for contractor
- Completion schedule delay
- Change in concession period
- Change in Payment mechanism
- Interruption in Credit Payments
- Disputes among the parties
- Disrupting continuity of services

Thus, in order to minimize the impact of these VOs, parties are advised to carry out risk analysis to estimate level of impact based on identified causes and implement necessary strategies.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Concluding Remarks

Variation orders may be realized as a result of different causes. In fact, each of these factors has a different impact on the project, and they are difficult to foresee and plan for. In this thesis, causes and impacts of variation orders in PPP projects together with recommendations to minimize them are studied. For the achievement of the thesis objectives, a detailed literature review is done. As a result of the literature review, causes of variation orders, impacts of variation orders, recommended strategies to minimize them in general construction projects were found. Later, these studies are reviewed by the experts and modified according to the PPP projects. In addition to the evaluation of the literature review, desk study which includes 8 different PPP projects in Turkey and interviews with the experts were carried out.

It is very important to be aware of these variations and their consequences during the lifecycle of the project. One of the most important items that affect the success of PPP projects is variation orders. It is anticipated that the identification of the causes of variation orders may lead to reduction possible elimination of their risk and improvement in overall performance of PPP projects. Also, recommended strategies can be used by the parties to minimize the variation orders and their effects.

Based on the evaluated literature review, desk study and interviews, a conceptual model is developed to explain why and how variation orders occur in PPP projects, their impact and strategies to manage them.

The most important causes can be summarized as change of scope, inadequate design and project objectives, change in specifications, differing site conditions and unforeseen problems.

The most important impacts can be summarized as Increase in project cost, Completion schedule delay, Disrupting continuity of services, Rework and demolition, and Interruption in Credit Payments.

The most important strategies can be summarized as;

- Carry out detail site investigation including detail soil investigations and consider it during tendering stage
- All involved parties should plan adequately before works start on site
- Spend adequate time on pre-tender planning phase
- Having a clause in the contract for buffer purposes, variation order mechanism may not work up to a certain percentage.

It was observed that the rate of variation orders of some projects can be quite high compared to others. However, no project has been observed that has not received a variation order. This could be an accepted feature as a nature of PPP projects.

In the desk study, it is observed that amount of the initial investment may not affect the variation order rate. No direct relation between the number of beds/length or investment amount and variation order rate is observed. The reason could be all of 8 PPP projects are unique. Each project has its own capacity, requirements, conditions and properties.

In developing countries, the procedures on the public side may not be well established or not done properly. This situation may be the root cause of lack of strategic planning, inadequate design and impediment to prompt decision-making process. Positions in ministries may not be very settled in the developing countries. Each ministers bring their own team. These teams learn everything from the beginning, and they want to implement their own ideas to the projects. Therefore, projects are exposed to different interventions each time. This situation may be the

root cause of the change of scope, change in specifications and government regulations. Additionally, economies of developing countries may not be very stable. Fluctuations in the economy may cause the plans to be disrupted. This situation may be the root cause of the change in economic conditions. In developed countries, the probability of having high variation order may be less since the above-mentioned problems do not exist.

A conceptual model for variation orders in PPP projects is developed as an output of the thesis. It shows the causes, impacts and strategies can be applied by private and public sides in every stage of the life cycle of PPP projects. By using this conceptual model, the parties can determine the critical success factors of the projects. Also, the contractor can use this model while making risk assessment.

A risk assessment for variation orders may help the contractors so that they may be aware of the variation orders before happening. This may help the contractor to prepare itself. The contractor can include the cost increase that will result from this variation order in the budget it has prepared, or they can revise their cashflow accordingly. Also, this risk analysis paves the way for the necessary studies to make the variation order official. Before the variation order process, necessary time and cost studies must be done by the contractor which may take some time. The delay in the preparation of these studies may have negative consequences for the contractor.

1.2.Recommendations for Further Research

The thesis study has some shortcomings. First of all, only 3 experts were interviewed. By increasing this number, different causes, impacts and strategies can be discovered. Moreover, the data was related with the PPP project in Turkey, thus, may not reflect the realities of different countries. This is a major limitation. A survey could be done by using the above lists and evaluate the importance of the causes, impacts and strategies empirically. Data from different countries can improve the generalizability of findings and also if enough number of responses are achieved, statistical analysis can be conducted to reveal relative importance of causes, impacts and strategies to manage them. The conceptual model produced in this thesis can

guide parties involved in the PPP process, however its validity could not be tested during this study. As a further research, model can be tested, and its applicability can be assessed. The factors found in this thesis can be used to develop quantitative risk analysis models, which is recommended for further research.

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