Cost overrun causality model in Saudi Arabian public sector construction projects.

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COST OVERRUN CAUSALITY MODEL IN SAUDI ARABIAN PUBLIC SECTOR CONSTRUCTION PROJECTS

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The candidate confirms that the work submitted is his/her own and that appropriate credit has been given where reference has been made to the work of others.

To the first two mentors in my life who taught me what universities never taught me, I owe you "me".

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Abstract:

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Title: Cost Overrun Causality Model in Saudi Arabian Public Sector Construction Projects.

Keywords: Saudi Public projects, Cost overrun, Contractors' cost overrun.

Saudi public projects construction performance has been poor over the years, with 70% of projects considered as failures and costing the country over 1 trillion SAR (over £202 Billion) between 2005 and 2015. The project delivery mechanism used to deliver construction projects is one of the main reasons for such poor performance as all service providers (consultant, designer, and contractor) are chosen based on the lowest price. The contract evaluation shows that contractors hold most of a project's risks and suffer a cost overrun problem, thereby positioning them as the weakest link in the procurement chain. This study aims to develop a contractors' cost overrun causality model in the Saudi public sector.

A systematic literature review was performed and shows three schools of thoughts regarding the investigation and identifying cost overrun causes. However, none of the three schools has addressed the limitations of exploring the interaction between any causes identified and then linking root causes with a direct cause, nor including the effects of the of the context and the process that used to develop construction projects. Exploring the interaction between causes is important in that the construction projects that provided the research base reported within the literature involved different stakeholders at different phases in a project's life cycle. Moreover, it has been found that the amount and the causes of cost overrun are different based on the projects' global location.

As an approach to achieve the research aim which is to develop contractors' cost overrun causality model in the Saudi public sector that considers the effects of context, the practices, and processes of developing construction projects. The research explore the commercial context of the Saudi public construction projects procurement under four major portfolios (Economy, Business, Resources, and Regulation), as well as the process and practices which are used to develop construction projects in the sector based on the Porter model (diamond) and institutional theory. Then, the research establishes the link between the commercial

context of the Saudi public construction projects procurement and contractors' performance.

Based on the systematic literature review and interviews, the causalities of cost overrun in Saud Arabian construction projects were critically reviewed, established, classified and evaluated. The data created a causes pool with over 200 causes which were passed through a number of sieves resulting in 49 remaining causes. Based on these causes, the study explores the relationship between them to create causal paths and eventually the overall model. During the model's development, the model building process and the resultant outputs were reviewed by two industry experts, resulting in more than one attempt to reduce the complexity of the model. The final model contains 49 causal chains that have been individually explained thoroughly.

Because of the nature of the problem investigated, this research adopts a Pragmatism philosophical and an abductive approach to achieve the stated objectives. Systematic literature review and case study are the main research strategies which were adopted, along with using Interviews, and Project Document as methods to collect the data.

The research emphasises the importance of investigating the context and projects' development process. In fact, the study finds, by comparing the Saudi public sector practices to the identified best practices, that the weaknesses within the context, process, and practices, which occurs in the early stage of project life cycle, work as triggers and contributors for the causal chain. However, during the construction phase, it is established that only direct causes occur. Moreover, the output confirms that the current environment, regulation, practices, and behaviours of the Saudi public sector increase the risks of projects failing and damaging the construction industry.

Therefore, and based on the findings of the research, the Saudi public agency needs to:

1) Adopt a project delivery approach that reduces the fragmentation in delivering a construction project and which is tailored to the project context and characteristics.

2) Adopt a new method to finance construction projects that is less affected by fluctuations in the oil economy.

3) Build a long term relationship with service providers (designers, consultants, and contractors) that is built on trust, sharing of information, and lesson learning and improvement.

4) Adopt a new contract that is based on fair risk appropriation where the risk transfer is to the most suitable party to effectively manage that risk.

5) Generate general regulations and laws that transform the construction industry so as to be less affected by the external environment, more controlled by all the involved parties, and more attractive to invest in.

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List of Abbreviations:

BECM	Bureau of Experts at the Council of Ministers.
BOQ	Bill of Quantities
BOT	Build–Operate–Transfer
Bpd	Barrels per day.
CESC Design	Consulting engineering services contract (Design).
CESC Supervision	Consulting engineering services contract (Supervision).
CoED	Council of Economic and Development Affairs.
CoM	Council of Ministers.
EPC	Engineering-Procurement-Construction.
FIDIC	The International Federation of Consulting Engineers.
GAP	General Administration of Projects.
GCC	Governmental Contractors Classification.
GDP	Gross Domestic Product.
ISD	Implementation Supervision Department.
KAPSARC	King Abdullah Petroleum Studies and Research Centre.
KASC	King Abdullah Sports City.
KAUST	King Abdullah University of Science and Technology.
KSA	Kingdom of Saudi Arabia.
MEP	Ministry of Economy and Planning.
MoEP	Ministry of Economy and Planning.
MOF	Ministry of Finance.
PCD	Planning and contracting department.
PPP	Public-Private Partnership
PWC	Public Work Contract.
SAGIA	Saudi Arabian General Investment Authority.
SAMA	Saudi Arabian Monetary Authority.
SAR	Saudi Arabian Riyal.

SDD	Studies and Design Department.
STPL	The Saudi Government Tenders and Procurement Law.
USD	United States Dollar.
WGI	Worldwide Governance Indicators.

Chapter 1: Introduction

1.1 Background:

1.1.1 Construction industry characteristics:

The construction industry has been described as a unique industry due to its products being site-based (Ashworth and Perera, 2018). For the construction industry, each project is unique as it is influenced by factors, such as, location (unique site) which affects the products assembled.

Additionally, the relationship between the primary stakeholders (owner and contractor) is adversarial and temporary, typically only for the duration of a project (Fearne and Fowler, 2006; Briscoe and Dainty, 2005). Arguably, the current relationship status within the construction industry does not allow beneficial cooperation and integration of activities between stakeholders (Briscoe and Dainty, 2005). Moreover, a project contains typically a significant number of interdependent tasks performed by different technical teams (Winch, 1989; Gidado, 1996) and thereby the industry can be classed as a complicated industry.

Economically, the construction industry has an impact on a country's Gross Domestic Product (GDP) as well as the employment rate (Takim, 2005). Moreover, some studies claiming that the impact of the construction industry is crucial to a country's economic growth (Yakubu, 2010). Construction projects are generally used as investment vehicles to promote economic improvement and growth (European Commission, 1998; Ansar et al., 2016). According to Ansar et al. (2016), there is a widespread belief in the economics literature of a link between the economic growth of a country and the level of investment on infrastructure projects. However, examples of the poor performance of projects from around the world show that unproductive projects have been chosen and projects do not hit the expected outcome. The result of an investment could be a national build-up of debt rather than economic growth (Ansar et al., 2016). The cost overrun and delay that construction projects may suffer, and undermine any expected economic growth. Also, researchers found that once a construction project begins, it is rarely "killed" even when underperforming, with this behaviour being linked with psychological phenomena such as sunk cost, groupthink, escalation of commitment, and conflicts of interest (Royer, 2003; Simester and Zhang, 2010).

Researchers suggest that the traditional method of construction project management is the primary cause for poor performance as it focuses independently on each stage of the project production and that it should be replaced with a dynamic approach that depends highly on trust and active communication between stakeholders (Agapiou et al., 1998; O'Brien et al., 2004; Akintoye et al., 2000; Vrijhoef and Koskela, 2000; Dainty et al., 2001; Harland, 1996; London and Kenley, 2001; O'Brien et al., 1995; Ofori, 2000b; Hu, 2008; Biemans and Brand, 1995). However, awareness of this is limited, and change is slow compared to other industries (Love, 2000) which could explain the continuing poor performance of construction projects.

Other characteristics of the construction industry that could hinder the adoption of this approach are: project-based production systems, customer influence, low investment in training and development, participants' multiple goals, fragmentation within the industry, resistance to change, number and type of stakeholders, lack of openness, and opportunistic behaviour (Fearne and Fowler, 2006; Pesämaa et al., 2009; Kornelius and Wamelink, 1998; Miller et al., 2002; Lu and Yan, 2007; Arantes et al., 2015; Egan, 1998; Cheng et al., 2010; Love et al., 2002; Baiden et al., 2006; Hu, 2008; Briscoe and Dainty, 2005; Yadav and Ray, 2015; Kumaraswamy et al., 2005; Cheng et al., 2001; Xue et al., 2007; Huxham, 1996; Cox and Townsend, 1998).

Construction projects and organisations consider being an open system as they interact with the external environment (Yahya, 2010). Researchers have emphasised the effects of a project's environment in developing countries where construction projects face social and economic stress, resource limitation, unusual organisation structures and limited ability to tackle main problems, besides the usual technical challenges (Musa et al., 2015). The projects' environment differs from one country to another as the culture, regulations, laws, and management approaches vary. Thus, the nature of a project's host country, as well as the environment, must be illustrated and evaluated to investigate problems related to construction projects. As a result, a deep understanding of the problem will be gained, and the interdependency between factors will be evident.

Considering the above, the nature of the construction industry in Saudi Arabia needs to be illustrated, as well as the environment of public construction, laws, and regulation. Therefore an investigation within the Saudi context is performed in the next section.

1.1.2 Nature of the Saudi construction industry and public projects:

The Kingdom of Saudi Arabia (KSA), is the biggest country area in the middle east region covering 2.25 million Sq.KM. With high yearly population growth rate (2-6%), the population of the country has quadrupled over the last 40 years, rising from 7.5 million in 1975 to 32.5 million in 2017 (GASTAT, 2018). The population boom happened after oil was discovered in the late 1940s and commercially developed in the 1970s to become the biggest oil producer which changed the country's demographic.

KSA is an absolute monarchy as the king has the final say on the public affairs as well as head of the Council of Ministers (the Cabinet) which has executive authority to supervise all public affairs as well as producing laws and regulation (Jabbra and Jabbra, 2005; Al-Ghanim, 2010). The public does not participate in electing the key personnel who are responsible for making, monitoring and supervision of policy, laws, and regulation as well as public affairs.

The current government system has been scoring medium to low ranking among the 186 countries in the World Bank's Worldwide Governance Indicators (WGI) (Table 1). The flexibility and reforming of the whole system, or part of it, are less likely which is not in the system's favour within the current era where change and reforming are needed more regularly.

The Saudi construction industry is relatively young compared to developed countries. However, the construction industry has grown to be one of the biggest in the Middle-East region and the second largest industry in Saudi Arabia after oil (EDRT, 2010). Figure 1 illustrates the size of the total construction contract value over ten years with a total of USD 650 bn (EDRT, 2010). As a rule of thumb, the Saudi construction industry employs 10% of the total workforce in Saudi Arabia and contributes 7% to the Saudi GDP (MEP, 2010b). The rapid increase in the industry's growth was mainly a result of government investment in infrastructure projects to cope with the growth of the population (Alrashed et al., 2014) resulting in hundreds of projects build each year.

While it can be argued that the Saudi construction industry is, overall, unique when compared to construction industries around the world (discussed later in chapter two) but, in part, also has similarities with construction industries elsewhere. For example, the construction industry in Saudi Arabia, like anywhere else, is affected by the country's economic cycle. Before the oil price increase in 1973, Saudi Arabia was an emerging country and government spending was very limited which resulted in a fragile economy. The increase in oil prices and oil production during the 1970s and early 1980s led to a substantial increase in government revenue, which in turn allowed the Saudi government an opportunity to invest in the infrastructure of the country. Both the First (1970-1975) and the Second (1975- 1980) National Development Plans gave construction priority in spending terms which created a boom in the construction industry and the share of construction in GDP terms increased from 4.5% in 1970 to 14.4% in 1982 (MEP, 1970; MEP, 1975).

Indicator	Score		Ranking	
	1996 (%)	2016 (%)	1996 (out of 193)	2016 (out of 194)
Voice and Accountability	9	4	177	186
Political Stability and Absence of Violence	41	29	108	137
Government Effectiveness	49	63	91	67
Regulatory Quality	41	56	109	82
Rule of Law	56	68	83	58
Control of Corruption	51	63	89	67

Table 1: Worldwide Governance Indicators for Saudi Arabia.
Source: (World Bank, 2018b).

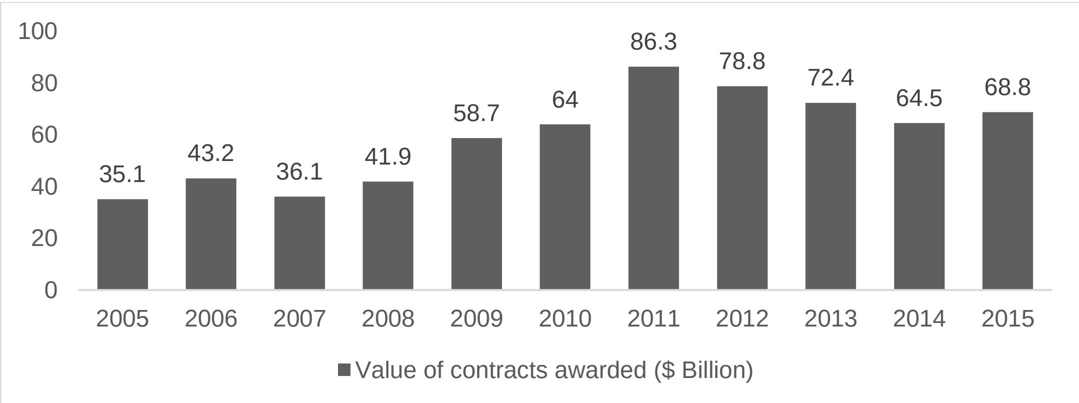

Figure 1: Total construction contract value between 2005 and 2015.
Source:(MEP, 2005; MEP, 2010b; MEP, 2010a; MEP, 2015).

1.1.3 Cost overrun in construction projects:

It is a challenge to meet the projects' professional requirements (finish projects on time, on budget, and within specification). A study conducted by The Standish Group studying over 8000 projects showed that only 16% of the projects could satisfy the three important performance criteria: completing projects on time, within budgeted cost and quality standard (The Standish Group, 1995). Construction projects face similar challenges, with studies describing cost overrun in construction projects as a regular feature and a ubiquitous global problem (IDFC, 2002; Kaming et al., 1997a;

Frimpong et al., 2003; Rosenfeld, 2013), while the knowledge that has been gained about this problem seems unable to resolve the issue.

Construction projects have been described as unique, expensive and usually carried out within a limited time frame, as well as complicated and uncertain in nature, as each construction project is carried out uniquely (Alalshikh, 2010; Federal Transit Administration, 2009; British Standards Institution, 2000). Based on projects' ownership, construction projects classified into private and public projects. Each year, public sectors in almost all countries execute thousands of construction projects for different reasons. For example, in the 1990s, construction projects were executed globally to reflect countries' political and economic status in a competitive global context (Jia et al., 2011) which could explain the increased number of projects.

Evaluation of a project's success is considered as one of the vaguest areas in project management as different stakeholders are involved in each phase of the project's life cycle. Each stakeholder has its own needs and expectations which affect their definition of project success (Cleland and Ireland, 2004). History shows that some projects which are considered as "failed" from the project manager perspective (cost and time overrun) may be considered as successful projects from the end-user perspective. Furthermore, it is seen that project success has different criteria and factors during the project life cycle. For example, Atkinson (1999) and Shenhar et al. (1997) consider cost, time and quality as temporary success criteria during the delivery stage. Other success factors have been added in recent research such as scope and risk (Mirza et al., 2013). For construction projects, a framework was developed by Lim and Mohamed (1999) to look at project success during the different phases of a construction project. The framework shows that the success criteria during the construction phase (micro viewpoint) are time, cost, performance, quality, safety. While during the rest of the project life cycle (macro viewpoint) maintaining the users and stakeholders' level of satisfaction is the main success criteria.

According to Elattar (2009) hierarchical model for construction projects' success criteria from the owner's, designer's and contractor's perspective, executing projects within the estimated budget is a typical success factor for all stakeholders and might be the most important one. A contractor's perspective is more concerned about meeting the budget of the project or keeping below it to make a profit, which is logical as contractors are there to make a profit. Thus, cost performance is a primary concern of all participants in the construction industry, so it is frequently seen as a pivotal criterion to determine the success level of a project (Hwang et al., 2013).

However, studies from around the world show that construction projects are far from achieving that aim as Table 2 shows.

In the Saudi context, it should be noted that international contractors can also suffer cost overrun as well. China Railway Construction Corporation (CRCC), for example, lost over USD 640 million (nearly 40% cost overrun) in a single Saudi public project (Mecca light rail project) (Shih, 2010; Min, 2011; White, 2010).

Study	**Sample Characteristics**	**Region**	**% of cost overrun**
Merrow et al. (1988)	52 Megaprojects	Worldwide	88%
Morris (1990)	133 Public Projects	India	82%
Pickrell (1990; 1992)	Rail Projects	The US	61%
Flyvbjerg et al. (2003a)	258 Transport Projects	Worldwide	28%
(Merrow, 2003)	Offshore Projects	Worldwide	40%
Odeck (2004)	620 Road Projects	Norway	7.9%
McKenna et al. (2006)	Mega Offshore	Worldwide	10%
Dantata et al. (2006)	16 US Rail Projects	The US	30%
Omoregie and Radford (2006)	Construction Projects	Nigeria	14%
(Ellis Jr et al., 2007)	3130 Road Projects	The US	9%
(Moura et al., 2007)	Construction Projects	Portugal	12%
(Azhar et al., 2008a)	Construction Projects	Pakistan	10%
(Lee, 2008c)	161 Transport Projects	Korea	52%
(Seung Heon et al., 2009)	7 Megaprojects, 29 Medium sized projects	Korea	122.4%
(Singh, 2009b; Singh, 2010)	925 Infrastructure Projects	India	13.45%
(Cantarelli et al., 2012b)	78 Transport Projects	Netherlands	16.5%

Table 2: Cost overrun in different contexts.

Projects that suffer cost overrun lose economic competitiveness and cost efficiency (Baccarini and Love, 2013), which in turn reduce the return on investment, damage the corporate reputation of organisations involved in the projects, and impact upon organisational goodwill and market share value. Failure to address cost overruns in projects may put future projects and investments in jeopardy (Ford et al., 2014; Olaniran et al., 2015b). The negative impact could not only reflect on the project itself but also reach other projects. If the cost of a public project is overrun, it reduces the amount of money allocated for building, maintaining, and/or operating other projects

(Love et al., 2016) leading to financial deficiency, disrupting a public agency's future plans, and conflict with taxpayers (Bordat et al., 2004).

For contractors, cost overrun will seriously affect their profits, cash flow, liquidity, productivity, and damage their image and reputation (Wang et al., 2008; Love et al., 2016). It is not unusual that cost overrun seriously overextends a construction company (main contractor or subcontractor) financially, which may lead to unfinished projects or may even have to be abandoned by its contractor or leading to a contractor's bankruptcy.

In light of the above, it is apparent that different stakeholders of projects from different regions around the world are suffering from cost overrun. However, the magnitude of the cost overrun is different in each study, ranging from 10% to 105%. The variance in studies results raises the question of whether the cost overrun magnitude has improved over time or remains the same. Flyvbjerg et al. (2003a) and Lundman (2011), for example, argue that there has been no improvement in cost overrun in the past 70 years, despite improvements in technical aspects and knowledgeability and the technical explanation for cost overrun is explicitly rejected. On the other hand, studies by Dantata et al. (2006) and Singh (2010) suggest a reduction of cost overrun over the years.

Besides the variation in study samples, such as the type of projects, the variance of the cost overrun magnitude is mainly caused by the variance in perspective to cost. For example, Flyvbjerg et al. (2003b) include only construction costs (neglecting other costs such as maintenance). Moreover, the "base estimate" used to measure and define cost overrun ("…the degree to which the final cost of the project exceeds the 'base' estimate" (Himansu, 2011)) differs from one study to another as projects have more than one cost estimate during their life cycle (Figure 2). For example, some studies have used estimation at the initial planning stage as the base point (Flyvbjerg et al., 2003b; Cantarelli et al., 2012b), while others used the detailed planning stage (Odeck, 2004), full funds authorization (Merrow, 2011), or made no mention of where the base estimation lay. Thus, for a research studying cost overrun, defining what cost overrun is and what the cost contains are both crucial, as noted by Olaniran et al. (2015b) and Ahiaga-Dagbui et al. (2015) who believe that the "lack of consistency" in cost overrun definition caused the variance in cost overrun magnitude.

Frankly, the status of a project's maturity level could be different for a similar named point (stage) from one context to another, which reflects the lack of a standardised definition for each stage. To illustrate, the "Detailed planning" stage could mean a different stage from one country to another. Thus, exploring the project life cycle of a project is needed to gain a deep understanding of cost overrun.

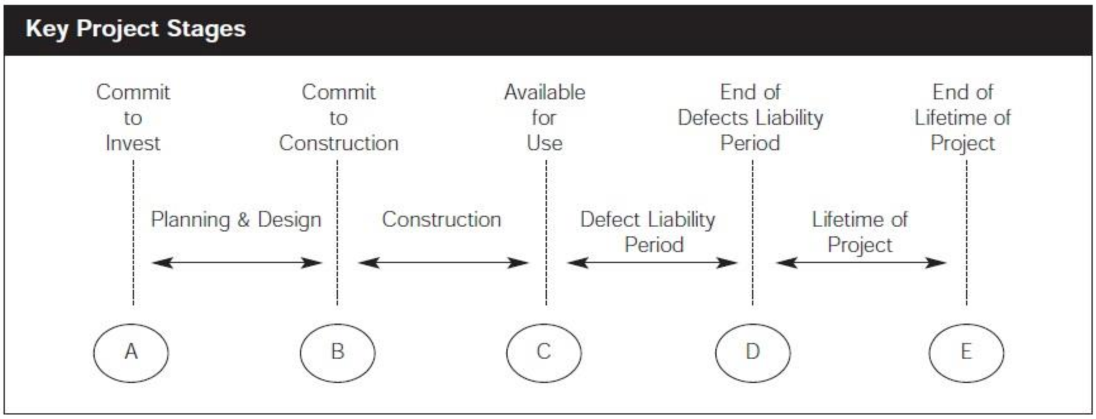

Figure 2: Key Project Stage.
Sources: (KPI working Group, 2000).

For contractors, the project delivery mechanism and contract document play significant roles in defining cost overrun and cost content. *Delivery mechanism*, for example, illustrates the contractors' involvement point (base point), while *contract document*, helps to define cost content by identifying contractors' responsibility as well as any risk apportioning. Thus, evaluating the project delivery mechanism and the contract for Saudi's public sector are needed to investigate the contractors' cost overrun accurately.

To explain the complexity in the differentiate cost overrun definitions, researchers have described cost overrun as a reflection of human imperfection in predicting future events and the effect of this imperfection on project cost, and then ask owners to be flexible in measuring projects' cost success (Ogunlana, 2010). This is supported by the lean management in construction projects that looks for the value that is created over the process, rather than the traditional measuring technique for the cost (Latham, 1994). In fact, some studies suggest that cost overrun is inevitable, and project owners should accept a certain amount of cost overrun (Enshassi et al., 2009). For example, some studies excluded projects with less than a certain percentage of overrun from their analysis, such as 10% (European Commission, 1998) and 30% (Lind and Brunes, 2015), which indicates that a certain percentage over the base cost should be accepted and not considered as a cost overrun. Moreover, according to expert opinion (in particular, expressed by J. Ots, manager of one of the world's largest construction companies, Sweden's Skanska), a cost overrun by about 20-30% is quite admissible for a large-scale project, and for the construction of, say, an underground or sunken-tube tunnel even a double overrun of the projected cost is “normal”. This gives a somewhat different perspective on what should be considered as a cost overrun.

The above suggestions are, however far from the reality in which public sectors in many countries are working within a limited budget and usually are chased financially by other agencies, offices and the taxpayers. Thus, risks are usually transferred to contractors to reduce the likelihood of cost overrun. However, contractors are less willing to accept cost overrun because their business aims to make profit, with the exception of some contractors who are willing to accept cost overrun for specific projects as these projects could gain them other non-financial benefits, with an example being the Mecca light rail project constructed by China Railway Construction Corporation (CRC). According to Zhao Guangfa, president of CRCC, within the company, this project was considered more a political mandate than a commercial project, and failure was therefore not an option (Xiangyang, 2010; Shih, 2010).

1.1.4 The effects of the context on the construction projects:

As section (1.1.3) and Table 2 show that projects’ performances vary between the countries. Some of the studies link the variation to the contexts that the projects are developed in such as Lee et al. (2015) who prove that the host countries’ characteristics such as political, economic, social, cultural, and business environments provide a context within which performance occurs.

This is not limited to the construction industry, as Pulaj and Kume (2013) stated that the context affects an organisation regardless of its being of any industry, any size, and any product or service provided. However, the degree of effect differs among the industries. Based on that, the literature places emphasis on considering the context effects for any organisation, as highlighted early by Child (1972) who stated that an organisational choice will be directly affected by context and the degree of change within that context. He further stated that the success of an organisation would mainly depend on responding to any change in its context that has a high degree of unpredictability and requires ongoing analysis and understanding of the mechanism causing effects. Moreover, Wood and Kennedy (1999) stated that events in the context (non-market environment) would cause financial, strategic or personal losses to a firm. For a construction organisation, as highlighted in section (1.1.1), there is the further problem that the organisation works in an industry which is characterised by high levels of complications, uncertainties, and unique risks (Hastak and Shaked, 2000).

For the construction industry, different studies have highlighted the importance of the context effects in construction projects' performance, such as in the Arabian Gulf region (Al-Sabah et al., 2014), Mexico (Fernandez-Dengo et al., 2012), and Russia (Zarkada-Fraser and Fraser, 2002). Moreover, it has been found that the country's (context) characteristics are considerably more complicated in terms of their effects than are the technical risks (Zarkada-Fraser and Fraser, 2002) in that they are linked to intangible continuous changes in the project context (Raiszadeh et al., 1995). The effects occur throughout the phases and stages of a project life cycle such as planning (Lee et al., 2015), development (Musa et al., 2015), procuring (Ratnasabapathy et al., 2008), construction (Wang and Yuan, 2011a).

For a construction firm such as contractors, context and technical factors play a significant role in the profitability of the organisation as well as the production and transaction costs (Makino et al., 2004). In fact, a study has analysed nearly 3000 construction projects completed by Korean contractors in 30 different countries and concludes that the host country affects the construction firms more indirectly (Lee et al., 2015). The study also concluded that effects are more visible and greater in developing countries compared to developed countries. With a specific focus on cost performance, a survey of top international construction firms based in Singapore shows that context affects contractors' cost performance and could lead to contractors' cost overrun (Chan and Tse, 2003).

The focuses of these studies during the context analysis was mainly from a foreign construction company point view rather than local ones. The literature shows that there are different outputs for the context (country/market) evaluation from the international and local construction companies' perspectives (Gunhan and Arditi, 2005). An evaluation for the context (country/ market) for a domestic company is less complicated and contains fewer profiles to analysis compared to international business.

The literature review evidences only minimal consideration of the effect of the context on a contractors' performance. Moreover, there is no study that has evaluated nor investigated the Saudi public sector context and its effect on contractor performance. Therefore, the study will consider the context when investigating the causality of the contractors' cost overrun.

Different methods, tools, and profiles have been considering during the context evaluation. For example, Al-Sabah et al. (2014) include the Political, Economic, Legal, and Social profiles, Fernandez-Dengo et al. (2012) include Operational, Political, and financial profiles, and El-Sayegh (2008) considers Political, Economic, Natural, and Social & Cultural profiles.

The difference in the method, tools, and profiles that are used for the context evaluation could be related to the observation of Dill (1962) and lately by other researchers (Pulaj and Kume, 2013) that there is no agreement on the profiles that could describe the context as it could comprise everything that surrounded the organisation or the project. The definition and the profiles that describe the context have been changed over time, which raises the question of what the profiles does an organisation need to be evaluated so as to measure the context effects and risks.

Although most of the previous studies focus on the effect of the host countries on international construction firms, they can be used to shed light on the way of investigating the effect of the Saudi public sector (the context) on the local construction industry. Moreover, the studies mentioned the effects of the context of the projects and organisations; however, these studies have not evaluated the context, nor do they establish a link between the context and poor performance. Thus, an investigation to identify and explain factors (weakness) that affect contractors' performance in general and cost performance specifically, as well as showing how they are linked to each other, is needed.

For the purpose of this study, and guided by the previous studies and research limitations, four profiles will be used to evaluate the context effects which are: Economic, Business Environment, Resources, and Regulation and Laws.

The profiles are formulated on the basis of two theories which are the Porter model (diamond) and institutional theory as Figure 3 shows. Porter model (Porter, 1995) is normally used to evaluate the external environment (context) using four determinants which are factor conditions, demand conditions, related and supporting industries, and firm strategy and rivalry. Porter and Kramer (2002) argued that the four determinants closely affect each other; consequently, they act as a unique system for a given country. The institutional theory, on the other hand, explains how the context environment of a country affects an organisational structure (DiMaggio and Powell, 1983; Meyer and Rowan, 1977; Scott, 2008). Although definitions vary across the academic disciplines, according to this theory, an organisation must conform to the institutional systems (e.g., laws, regulations, norms, and cultures) prevailing in a given environment to survive. The main reason that an organisation conforms to institutional pressures is to secure legitimacy in a given business environment, thereby expecting long-term survival. Scott (2008) classified institutions into three elements: (1) regulative, (2) normative, and (3) cultural-cognitive elements.

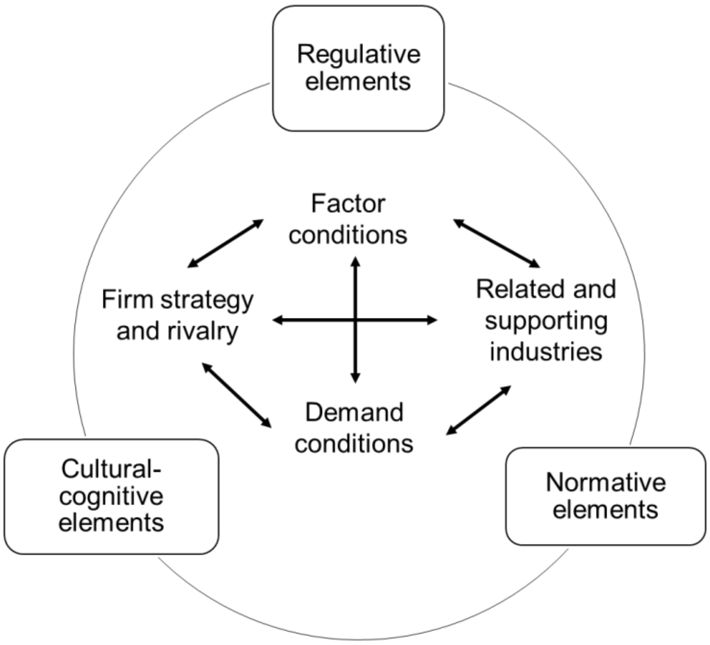

Figure 3: Porter model (diamond) and institutional theory.

Based on the above, the four profiles adopted for this research are defined as follows:

Economic profile: Economic factors have to do with the nature and direction of the economy in which the company operates (Fahey and Narayanan, 1986). This profile will focus mainly on the Saudi Arabian economy in general and how public sector projects are financed, any payments are delivered and how it would affect the contractor’s performance.

Business environment profile: this profile will include mainly the culture environment, Dispute Resolution and Litigation environments, and discuss corruption and fraud in the sector.

Regulation and Laws profile: Regulation and Laws have a considerable influence on the regulation of business activity, the purchasing power of consumers and other businesses. This profile mainly focuses on government regulations and laws that have an impact on the contractual agreements between the contractors and the public sector.

Resources profile: this profile will discuss the primary resources for construction projects which are Finance, Labour, Material, and Plant.

1.2 Problem Statement:

The size of investments in construction worldwide is considered to be as large as 10% of the world economy (Hampson et al., 2014). Meeting the project cost estimates has been found as the prime success factor by all project stakeholders (Baloi and Price, 2003; Meeampol and Ogunlan, 2006). However, it is not unusual to see projects, owners, and contractors suffer cost overrun (Azhar et al., 2008a). The negative impacts of a stakeholder's cost overrun will reach other stakeholders beside that stakeholder who suffer cost overrun. For instance, a contractor's cost overrun may lead to contractors' bankruptcy and project abandonment and thereby affecting the owner financially and reinforcing the construction industry's poor performance reputation, in turn resulting in decreased investment for new projects (Mbachu and Nkado, 2004).

Literature shows that cost overrun is a common problem in construction projects and still exists despite the problem having been investigated for over 30 years (Love et al., 2016), thus suggesting that further research is needed to alleviate cost overrun (Abderisak et al., 2017). Moreover, the literature shows that the cost overrun magnitude differs between studies. The variation of this magnitude could be related to different factors such as project size (Singh, 2009b; Singh, 2010; Odeck, 2004), project type (Odeck, 2004) and project location (Cantarelli, 2011; Cantarelli et al., 2012a; Cantarelli et al., 2012b; Cantarelli et al., 2012c). Equally, the studies support the claim that worldwide findings are not always applicable for individual countries.

The apparent lack of consistency regarding the causes of the cost overrun, in spite of having been investigated for over 30 years, and that the cost overrun problem still exists, indicate that the current literature does not identify the true root causes. Providing solutions to the problem cannot be achieved by investigating cost overrun from the wrong angle. Thus, the current cost overrun literature is, in this thesis, evaluated so as to identify limitations in identifying the real causes. Moreover, as a result of the illustration in section (1.1.4) of the effects arising from the context of the construction industry, projects, and organisation, the evaluation will also consider whether the previous studies consider the effects of the context as well as the process of developing the construction projects.

As the background review has shown, the studies that identify the cause(s) of cost overrun suffer from a limitation regarding the way of looking at the causality of the cost overrun. The results of the evaluation suggest a rethinking in the method of identifying the causes of cost overrun. The analysis shows a need to move from listing individual (standalone) causes and attendant ranking, to develop a model that illustrates the complexity and dynamic connection between those causes and cost overrun. Moreover, identifying and measuring the effect of individual causes does not reflect the reality in which overrun occurs, so leading to inadequate assessing and managing of the causes leading to cost overrun.

This research investigates the cost overrun problem from a different perspective by including effects flowing from the context that the construction projects are developed in. As illustrated in sections 1.1.3 and 1.1.4, different contexts (laws, regulation, industry's environment, and project's lifecycle) usually mean different cost overrun magnitude. Moreover, researchers have highlighted the importance of studying cost overrun at the level of individual countries (rather than seeking a global ‘solution’) as the causes could be related to the institutional structure of that country (Cantarelli et al., 2010; Cantarelli et al., 2012b; Cantarelli et al., 2012c; Odeck, 2017). Also it has been illustrated in section 1.1.4 that context affects the operation of a construction industry, its projects, and organisations and it is not unusual for this to lead to cost overrun and bankruptcy. As a result, investigating the context first is essential to gain an in-depth understanding of the issue of cost overrun. The argument thus follows that to fully understand the causal nature of cost overruns in construction projects, the context and environment of the project must be clearly articulated, and the methods used for their investigation need careful consideration. Nevertheless, as literature shows different points of view regarding any context investigation, this research has developed four profiles (lenses) that will be used to investigate the context (see section 1.1.4) which are: Economic, Business environment, Resources, and Regulations and laws. Moreover, links between the possible weakness of the context, process of developing construction projects and the cost overrun need to be established and evaluated.

The Saudi Construction Industry is a part of the global construction context. Despite being the most significant construction industry in the region, studies investigating the construction industry are limited (Mitra and Wee Kwan Tan, 2012). The Saudi construction industry is unique compared to other construction industries around the world. This uniqueness is partly inherited by the country's regulation, culture, and work environment as shown in Chapter Two and the results of Objective One. As was argued in section 1.1.3, regarding the importance and mutual effect of the context that a construction project is developed in, the systematic literature review shows that the context of the Saudi public sector’s components has not been investigated regarding the effect(s) on the construction industry in general, and on contractors’ cost performance specifically. Based on that, and as this study’s context is the Saudi public sector, in order to understand the contractors’ cost overrun in-depth, the context of the Saudi public sector and the process that are used to develop a construction project need to be explored, evluated and understood through the four lenses explained earlier.

Moreover, to deeply understand the causal nature of cost overrun, researchers have emphasised investigation of the project's context and environment to help to understand the inheritance of cost overrun from the very early stages of the project's lifecycle (Ahiaga-Dagbui et al., 2017; Jennings, 2012). Thus, gaining insight into the mechanism (interaction) of the context and any process effects that occur during the projects’ development is the next step in order to more fully understand the contractors’ cost overrun. Based on the results of the evaluation, possible weakness that could lead to the cost overrun will be identified and links to the outcome of cost overrun will be established. As a result, causality paths will be developed which will be used to build the causality model.

It is argued that exploring the local context, mechanisms, and process benefits expands the value of this research and the contribution it offers to more fully understanding the causal nature of context with regard to cost overrun. In particular, this contribution will benefit other research that targets improving the Saudi public sector’s projects’ performance, mechanism, or process.

1.3 Research questions:

Based on the research justification, the following questions are raised:

- What are the nature of the environment around the construction industry and construction project processes and practices that the Saudi public sector use to deliver a construction project? Related to this, how the environment, processes, and practices lead to contractors' cost overrun?
- What are the main causality paths of contractors' cost overruns? How are the causes interacting within the context of the Saudi public sector to lead to contractors cost overrun?

1.4 Aim and objectives of the research:

This study aims to develop contractors' cost overrun causality model in the Saudi public sector that considers the effects of context, the practices, and processes of developing construction projects.

1.4.1 Research objectives:

To achieve the aim of the research, the following objectives will be addressed under the umbrella of the four lenses of Business environment, Economic, Regulation, and Resources lenses:

Objective 1: To explore the commercial context of the Saudi public construction projects procurement.

Objective 2: To establish the link between the commercial context of the Saudi public construction projects procurement and contractors' performance.

Objective 3: To critically review and establish the causalities of cost overrun in Saud Arabian construction projects.

Objective 4: To classify and evaluate the possible causalities of cost overrun in Saud Arabian construction projects.

Objective 5: To develop a causality model that illustrates the interdependency between the causes of the contractors’ cost overrun within the Saudi construction public projects based on the evaluation of the context and process.

1.5 The scope of the study:

This study concentrated on Saudi public building construction projects. The reasons behind choosing public projects is that the primary owner (public sector) controls over two thirds of the country’s projects. Regarding choosing the building projects, a project’s type analysis of approved public projects in 2013 shows that the majority of projects are building followed by road projects. Moreover, construction project multi tasks projects where tasks included electrical, mechanical ...etc. works. Nevertheless, the Saudi classification system shows that most of the Saudi contractors are classified under the “building”, the classification system is explained thoroughly in analysing objective two. Thus, focusing on the building projects will be beneficial for the whole industry and all parties.

This study will also be limited exploring identifying evaluating to cost overrun causes as it has been found that time has fewer implications on cost compared to cost on time. Therefore, if a project has the right financial resources time overrun will not be an issue. A number of studies which studies both cost and time overrun shows that cost overrun occur more often than time overrun (Kaming et al., 1997a; Cox et al., 1999; Radujkovic, 1999). This makes the problem of cost overruns one of great significance.

This study focused on contractors who work in Saudi public projects. Although the research does not specify their focus on the nationality of the contractors, the majority of classified contractors (over 99%) are local contractors (Saudi contractors). Moreover, all the interviewees are working for local contractors. Thus, the outputs are more related to local contractors rather than international contractors.

Post-contractor's involvement phases are a significant focus in this study. This is because the study focuses on contractors' cost overrun. However, the paths development goes beyond this focus. This is because construction projects are developed in subsequent processes. Thus, the root causes usually are in the early stages.

Moreover, this study is limited to the public projects that are delivered using the standard process explained in the STP.

1.6 Limitations of the study:

The research was limited to investigate the Meso Level of the Saudi public practices and process of developing a construction project. This because of the lack of a unified system on the technical level (low level) for all the Saudi public organisation. It is more likely that because there are no general regulations at such level. Therefore, the work can only reliably be applied to the Meso Level of management of construction project processes in the Saudi public sector.

Despite other contexts' profiles also affecting the construction industry, however, this study was limited to investigate Business, Economic, Regulation, and Resources profiles. This because of this study concentrated on looking into the cost overrun issue from the contractor’s perspective and it was discovered these four profiles have the major effects on the contractors' cost performance.

This study is tailored (limited) into the current process and practised in developing a construction project in the Saudi public sector. However, the lack of unified practices and processes for developing a public construction project also created a challenge during weaknesses points identification (objective two) activity.

Regarding data, the lack of research outputs on the context of Saudi Arabia as well as the problem of ready-made data (and difficulty to explicate data) forced the study in some objectives to rely on secondary data rather than primary data. Moreover, it also forces the research investigation to be on broader contexts, such as exploring the whole process and practices of developing a construction project as well as the overall project life cycle (to identify the weaknesses), rather than addressing a specific phase, process, or practice in detail. The data collected forced the researcher to eliminate the planning phase; the document data was limited, and the interviewees were not involved in the planning phase.

1.7 Structure of the thesis:

This thesis is divided into five chapters that interact to reach the study's aim and objectives, with Figure 4 showing the interaction between chapter contents. The research design figure (Figure 22), presented in Chapter Three, shows how the each of the data collection methods serve the research aim and objectives.

1.7.1 Chapter One:

In Chapter One, the research highlights the background of the study. The nature and characteristics of the construction industry in general, and in Saudi Arabia specifically, have been illustrated, along with the problem of cost overrun in the construction industry. Moreover, the importance of the of the context and its effects on the construction industry, projects, and organisations involved were discussed and four lenses has been developed (based on Porter's model and relevant institutional theory). Following that, the problem statement was discussed and followed by the research questions, aim, and objectives. Finally, the research scope and limitations were discussed and illustrated.

1.7.2 Chapter Two:

In the second chapter, the researcher explored the context of the Saudi public sector. Based on four profiles (lenses): Business, Economic, Regulation, and Resources, the public sector context is explained. Moreover, the chapter explained how these profiles affect the construction industry, projects, contractor as well as the development of public projects. The results of the chapter will be used later in Objective Two where the explanation assists in identifying the possible weakness that could lead to cost overrun. In this chapter Objective One is resolved and the research/literature gaps that need to be further investigated are identified.

1.7.3 Chapter Three:

In this chapter, the research systematically illustrated and justified the research paradigms, methodologies and techniques which are applied to achieve the research aim and objectives. Research design is developed, which shows how each objective will be achieved and which research approaches, data gathering, and analysis techniques are used.

1.7.4 Chapter Four:

In this chapter, the data collected analyses and discussion for the five objectives were presented. In the beginning, descriptions of the process and practises of developing a construction project in the Saudi public sector and identifying their weaknesses are presented. At this point, links between the weaknesses and the possible causes of cost overrun were established, showing how the context and process lead to cost overrun. Other possible causes of the cost overrun which are not related to the context and process, were identified in the critical analysis of the cost overrun causes literature. As a result, causes from the context, process, and literature were comprehensively identified and classified. Based on that, causality paths were built and evluated for use in building the cost overrun model. In this chapter, Objectives Two, Three, Four, and Five have been resolved and achieved.

1.7.5 Chapter Five:

In this chapter, the general conclusion of the study and the major findings of the study were presented. Research questions and objectives were revisited and linked, where appropriate, to the findings of the research. The chapter also discussed the contribution to and implications for the study for the construction project management body of knowledge and practise whilst also, the chapter presenting the limitations of the research and recommendations for future study.

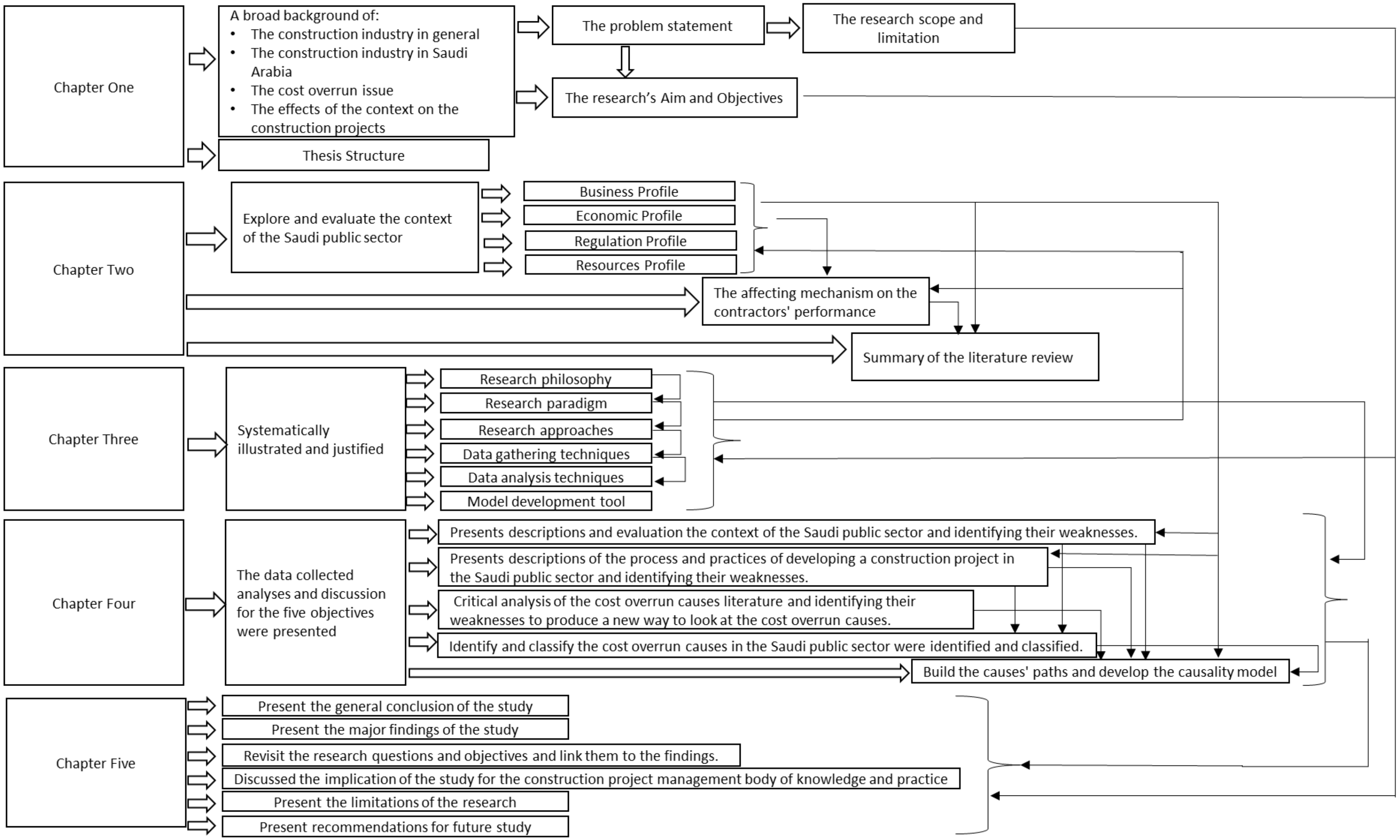

Figure 4: Research structure.

Chapter 2: Literature Review:

2.1 Introduction:

The first section of this chapter illustrates and evaluates the current literature on the construction industry in Saudi Arabia and other relevant aspects, such as the business environment and construction resources. Besides that, the chapter provides literature review for the other Objectives Two, Three, and Four.

The amount of the literature is limited for the subjects under investigation which are the Saudi Public sector context, the process and techniques for developing the Saudi public sector, and the cost overrun causes. Thus, the chapter mainly fulfils the first objective of the research which aims to explore and explains the Saudi context based on Business, Economic, Regulation, and Resources profiles, identify their weakness, and explain their effects on contractors cost performance. The second part introduces the cost overrun literature and illustrates the extent of the cost overrun issue while also investigating attempts to solve the problem. The publications on the major contemporary issues and factors of the construction industry in Saudi Arabia were reviewed. This was considered essential in order to build up the background of the origin of the current conditions affecting the environment of the government construction sector. These characteristics and conditions are well defined and explained in this chapter. However, the chapter was less focused on Objectives Two, Three, and Four.

As the previous chapter mentioned, understanding the internal and external projects' environment in Saudi Arabia is essential to understand the real causes of the cost overrun in that context. As the resources about the Saudi construction industry are limited, a systematic literature review and interviews were carried out to understand the context. The literature in this context is limited in quantity; gaps in the literature will be identified so as to allow them to be possibly addressed at the data collecting stage. By the end a summary of the literature review where the gaps in the literature are presented and linked them to the research aim and objectives.

2.2 Economic Profile for Saudi Arabia and construction:

The Saudi economy is the largest economy in the Middle East and North Africa area (Akoum, 2009) and the biggest oil producer globally with, on average, 10 million barrels per day (bpd). The income from oil expanded the country's GDP 180 times from the 1968 level and reduced the country debt to be one of the lowest in the world (Clyde & Co and Blanksby, 2011). Figure 5 shows the Saudi Arabian GDP over the last 50 years. The GDP composition in 2014, for example, is 12% government, 43% oil, 45% other. The ministry of planning publication shows that construction contributes on average 7% to the total GDP and 35% of the non-oil productive sectors. The country's currency is the Saudi Riyal (SAR) which is fixed-linked to the US Dollar (1 USD=3.75 SAR) (SAMA, 2017).

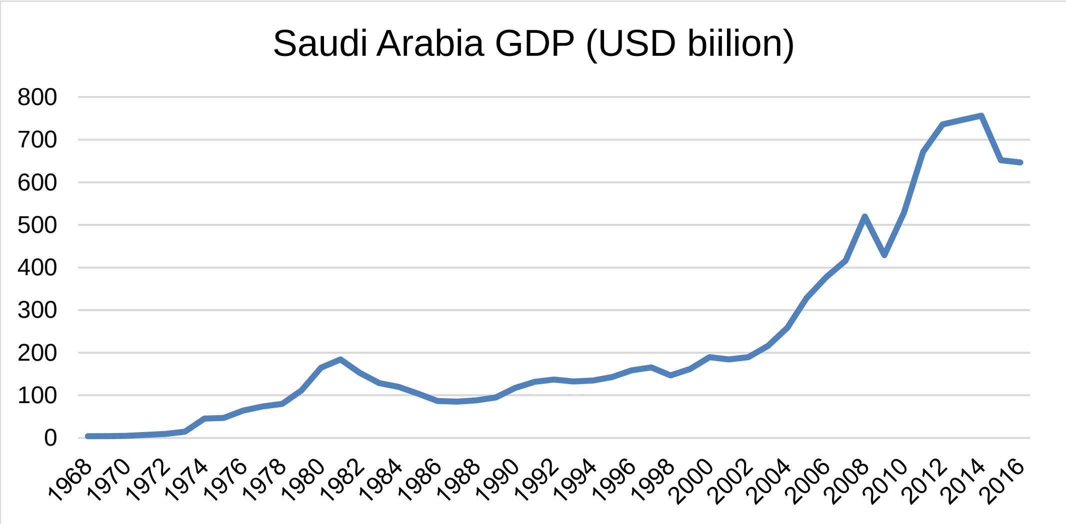

Figure 5: Saudi Arabia (KSA) GDP (USD billion) between 1968 and 2016.
Source: (World Bank, 2018a).

The fundamental contribution of the oil sector, which in 2015, for example, was 80% of total budget revenue, enables the government to invest in massive public spending programs without the need for taxation, falling into balance-of-payments deficits or inflationary difficulties, which other developing countries suffer from (Vohra, 2017). However, Figure 6 shows that KSA has failed to mitigate its dependency on oil ever since it was discovered, as shown by the high correlation between the Saudi economy and oil prices. The figure demonstrates the similarity between the country's GDP and the average oil price fluctuation over the last 45 years, which is something not seen in the United Kingdom and the United States' economies (Figure 7 and Figure 8) because their economies are multi-source economies (IMF, 2018; IMF, 2017).

The current KSA system has developed a strong economy -at least in the short-term- making the construction industry less affected by the fluctuation of international currencies, which is vital for the stability of the construction industry particularly in a country where most of the construction materials and technologies are imported (OBG, 2018). Despite that, the Saudi government has admitted that the current economy is not sustainable and will not cope with the long-term plans for the country (MOF, 2017). Moreover, the high revenue achieved from one source only worsens the macroeconomic instability and results in adverse effects on growth and the stability of non-oil sectors while also maximising international investors' hesitation to invest in long-term projects in the country (Vohra, 2017). Nevertheless, oil price instability creates an economic event referred to as oil shock - when the revenue of the country maximises followed by high spending of the country especially on major megaprojects, followed by a sudden sharp drop of oil price resulting in a deficit of the budget (Algahtani, 2016).

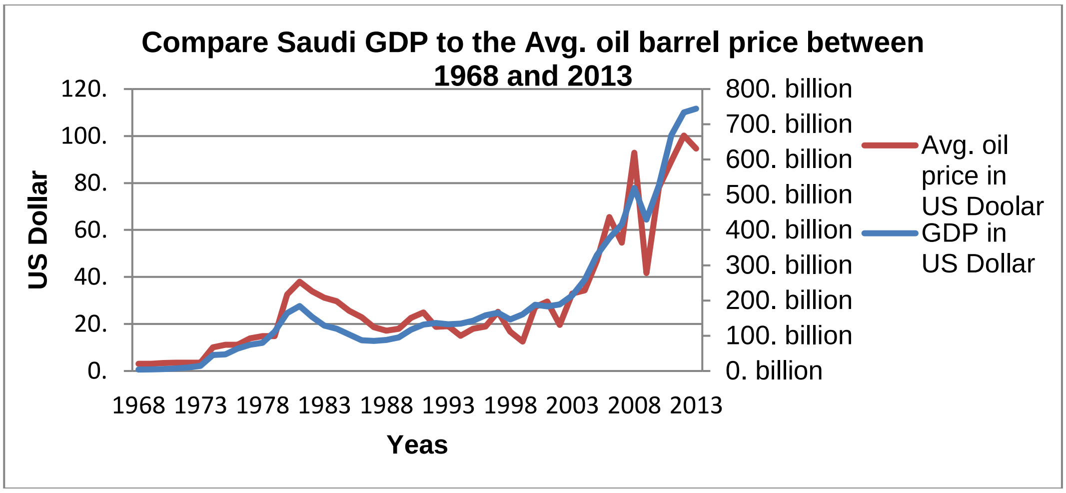

Figure 6: A comparison between Saudi GDP and the avg. Oil barrel price between 1968 and 2013.

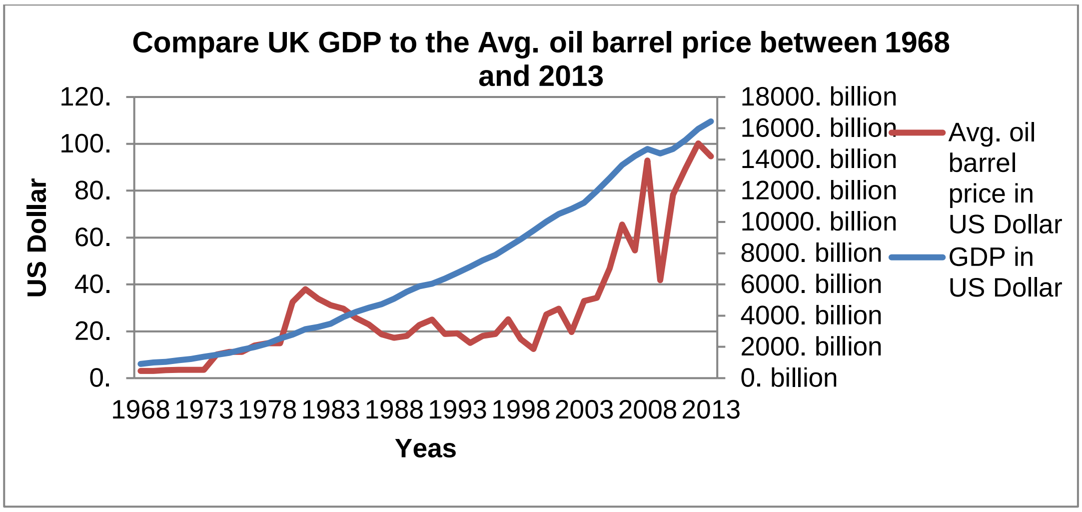

Figure 7: A comparison between UK GDP and the avg. Oil barrel price between 1968 and 2013.

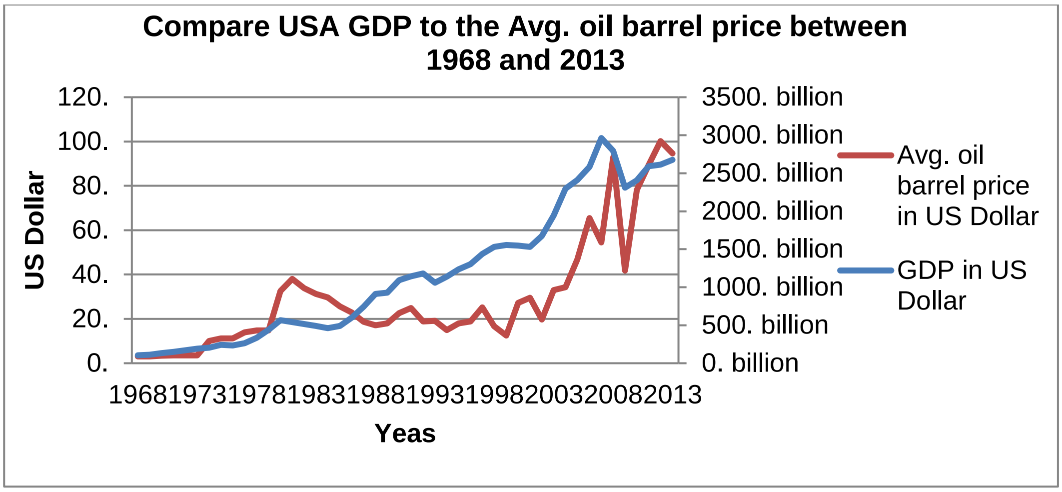

Figure 8: A comparison between USA GDP and the avg. Oil barrel price between 1968 and 2013.

Within the Saudi economy history, a peak-to-trough event had occurred four times (1982–86, 1998–99, 2008–09, and 2014-now) when oil revenues decreased by 50% either because oil prices fell, oil output fell, or a combination of both. According to the International Monetary Fund (IMF) report, the macroeconomic reaction to the low oil revenue during these events is almost the same. The declined oil revenue is also combined with a deficit of the country's budget to result in a decrease of Saudi government spending, slowing of money and credit growth, decreased export receipts, and minimised financial reserves if any (IMF, 2015). For example, the last oil price drop in late 2014 resulted in 20% reduction of the Saudi government budget in 2016, and the IMF predicted that this defect would continue till 2020 if the oil price per barrel stays under USD 50 (IMF, 2015; IMF, 2016a; IMF, 2016b).

The KSA's political system shaped in a traditional way where the government is responsible for creating public jobs for the population which gives the government little space to cut or reduce the spending on public employees' salaries during the low government revenues. Thus, it should not be a surprise that construction projects arguably are the first and the most affected sector by any government spending cut as Ministry of Finance (MoF) annual reports show (IMF, 2016a; Arnold and Torchia, 2016). This is because of the short sight of the finical decision makers in looking into public construction projects as unnecessary expenditures rather than as investment vehicles. Such sudden financial cuts result in adversarial behavioural patterns that worsen the economic difficulty, such as contractor's margin erosion, adversarial contract negotiations, and cash flow issues (Hughes, 2016).

To illustrate the impact on the construction industry of an oil price drop, the oil price drop in late 2014 was followed by signs that the government had started slowing and postponing some of its infrastructure projects to save money. In July 2015, the

Spanish manufacturer Talgo reported that Saudi Arabia had cancelled a USD 201 million contract for six high-speed trains (Rashad, 2015). Moreover, in September 2015 the Saudi finance minister announced that the government would cut "unnecessary" expenditures and delay some projects to cope with the low oil prices (Torchia, 2015). In the same month, the High Commission for the Development of Riyadh, which owns the most significant project in Saudi Arabia – the Riyadh Metro (USD 22 billion), reported that the Saudi government had moved to cut spending on the Riyadh Metro while also investigating other expenditure reduction options (MEED, 2015).

2.3 The business environment for Saudi Arabia and construction:

In Saudi Arabia, the government is the leading player in the economy and is backed by oil revenue (Mhamed et al., 2018). In the construction industry, for instance, two-thirds of construction projects are owned by the government as a result of the rapid development of the country (Al-Jarallah, 1983). The Saudi government has been responsible for providing services in the last 50 years, and the private sector either was not able to cope with the rate of development or barely existed at the time. As a result of private sector immaturity, the public-sector agencies established their own companies – so as to be less controlled by public regulations and be more flexible- in sectors such as Power, Telecommunication, Petrol, and Chemicals. Despite reports by the Saudi Arabian Monetary Authority (SAMA) and IMF showing that private sector participation is fundamental for macroeconomic stability, especially in the non-oil sectors, by improving labour regulations and access to finance, and attracting foreign direct investment (IMF, 2016b; Sommer et al., 2016), the private sector mainly depended on government contracts. This resulting inability for the Saudi private sector to create real financial participation in the economy, delaying the development of a profitable private sector and slowed the growth of the financial and labour markets (Mhamed et al., 2018; Biygautane, 2017a; AGSIW, 2014; IMF, 2016b). In other words, public spending is the primary driver for the country economic growth. Nevertheless, the private sector still faces a challenge to compete with the public sector or create any real growth within the economy.

The Saudi government announced an ambitious "2030 vision" in April 2016 by investing USD 4 trillion in programmes aiming to double GDP by 2030 so as to repeat the doubling between 2003 and 2013 (Vision 2030, 2018; McKinsey & Company, 2015). The country, therefore, reduced public spending by 11% in 2016 and planned to also increase the non-oil revenue from USD 43.5 billion to USD160 billion by 2020. Moreover, another focus of the country is direct internal and external investments in government services under the “Privatisation programme” (Khan, 2016; Nurunnabi, 2017). Such a change needs a fundamental change within the regulation and laws of Saudi Arabia. Thus, the Saudi Economy and Planning Minister said that part of the 2030 vision was the rehabilitation of the Saudi business environment to be business-friendly (Al-Harthi et al., 2015).

Arguably it is easy to establish a business company in Saudi Arabia. A construction company, for example, could be regulated online within the same day without any experience or professional certificate required (Presley and Westaway, 2017). However, around 80% of Saudi private companies are controlled by a small number of family businesses (Hertog, 2013). The biggest construction companies in the country are owned and controlled by a few families (Zendera, 2014).

The construction sector is less affected by competition with government companies as the government agencies frequently use a third party (private sector) to perform design, consultant, and construction projects rather than construct it themselves. However, construction companies compete with each other, and the ones awarded a contract are generally among the lowest bidders and with a probability to fail. The high competitive could explain partly the meagre rate of 50% of project success in Saudi Arabia identified by international and local contractors (Mosley and Bubshait, 2015).

Construction is described as a “sensitive business” (Medallah, 2015) as all project components and the surrounding environment contribute to the risk, which is irregular. As a result, an exploration within the business environment components is needed.

2.3.1 Governance and Regulatory Environment:

One of the main challenges that faced the Saudi government when attracting direct external investments was the lack of a governance system, laws, and regulation capacities (OECD, 2014). Table 1 (page 4) shows the country has scored low in regulatory quality and government effectiveness over the years and this could be one of the higher risks for investors as it gives the impression that regulatory reform performance is prolonged. These low scores have negative consequences for attracting foreign businesses and direct investments (Alter, 2015). The other regulation-related factor that makes the business environment extremely risky is the sudden changes in laws and regulations without prior notice (Assaf et al., 2015).

The effects of such regulation changes reach contractors even when it is not applied to contractors; however, the effects of these risks are more significant on contractors' main resources (Finance, Material, and Labour) which are regulated by the country solely. The press is full of examples of regulation changes which mainly relate to the labour and material which are the backbone of the industry and sensitive subjects, as will be explained in sections (2.4.2 and 2.4.3).

For the construction industry (a risky industry by its nature), the absence of good governance and the rule of law as well as sudden changes in laws and regulations without prior notice exaggerates the Saudi construction industry risks leading to poor performance in terms of time and cost for both local and international contractors (Assaf et al., 2015).

2.3.2 Culture:

The early work of Hofstede described culture as "the collective programming of the mind which distinguishes the members of one human group from another" (Hofstede, 1980). Culture is one of the aspects that usually changes based on location (Kendra and Taplin, 2004). Understanding the national culture (unconsciously acquired the culture of early life), and the organisational culture (shared values and beliefs held by a certain segment of society) (Igo and Skitmore, 2006), is critical to understand any business environment (Pheng and Leong, 2000; Shore and Cross, 2005). Different researchers pointed out that culture impacts aspects of business such as: decision making and bureaucracy (Müller et al., 2009; Wang and Liu, 2007), teamwork (Mead, 2004),leadership and empowerment (Turner and Müller, 2005), business relationships (Zigang and Fan, 2004), risk management (Mihet, 2012), conflict resolution (Mulcahy, 2005), project failure (Muriithi and Crawford, 2003), and management control (Amy and Pulatov, 2008; Van der Stede, 2003). An example illustrating the influence of national culture is behaviours towards risks and implementing new strategies. In China, it has been found that Chinese project managers tend to be less prudent in risk management and so utilise higher risk strategies that maximise profits (Tan, 2016). Furthermore, it is more difficult to implement some management strategies because the Chinese are less interested in rule structures compared to other cultures (Pheng and Leong, 2000; Fan and Zigang, 2004; Wang and Liu, 2007).

Studies such as Pant et al. (1996), Pheng and Leong (2000), Chen and Partington (2004), and Wang and Liu (2007) have shown that the cultural difference between Asia and the West have affected the project process and by the end project performance in the relevant regions. One of the main reasons for the differences displayed is related to the varying political and social ideas, such as bureaucracy, social consciousness, and communications. Although there is some evidence that culture influences management styles, decisions, and behaviours, as well as employees' expectation on how to be managed (Tsai, 2011; Adeyemi-Bello and Kincaid, 2012), the influence of culture on the project management aspects have not been widely investigated (Hoole and Du Plessis, 2002). Additionally, Amy and Pulatov (2008) have highlighted how project management bodies, such as APM, PMI and IPMA have not recognised the importance of culture, particularly national culture, and its effect on project management.

In Saudi Arabia, one of the elements that form the culture is the religion (Islam), which influences every aspect of life and business and influences the business environment (Rees and Althakhri, 2008; Alsaif, 2013). Rice (2004) described the business environment in Saudi Arabia as conservative, with its policy and decision-making influenced by Islam. Another element that forms the Saudi national culture is the "tribal heritage". The implications of such influencing touch the whole environment, resulting in a business environment that is very detail oriented, emphasising expected social behaviours, ethics, and the organisational structure. In a more recent study by Al-Rasheedi (2012) focused on culture through implementing Hofstede and Bond (1984) cross-cultural dimensions, shows that in Saudi Arabia the national culture affects the performance of the project in three different themes:

1. Low commitment to project control through deadlines.
2. Distant relationships with project managers.
3. Change is perceived as negative.

Kerzner (2004) recognised collaboration and teamwork as bases for project management. However, collaboration and teamwork could be less active within the Saudi construction industry. The culture affects the positions of a public organisation compared to a contractor organisation. The state organisation is always in a higher position than the private sector, resulting in contractors being the weakest link in that the first one feels he is not obligated to collaborate or negotiate with the second. Thus, it should be no surprise in such a culture that contractors hold most of the project risks, are expected to obey all contract conditions, and try his best to keep the states' representatives happy.

Teamwork and collaboration could be less effective in Saudi Arabia as individuals adhere to strict divisions between members of society based on several factors such as tribal affiliations, age, and gender. This could be the opposite of the western views of social relationship; every team member is playing an equal role (Chen and Partington, 2004). Moreover, the culture difference between the team members could affect their performance. As will be illustrated later (section 2.4.3), the private sector in Saudi Arabia is heavily dependent on a foreign workforce from different countries, and contractors are no exception as they usually contain multinational teams. Cultural distance between contractors' team members could affect knowledge exchange and learn within the team, managerial conflicts, conflict resolution, and individual capabilities (Nielsen et al., 2007; Park and Ungson, 1997).

Also, a typical organisational structure in Saudi Arabia (public or private) comprises strong hierarchical lines by placing the highest power at the top with each subsequent step down the chain of command having a drastic decline in authority. Familial ties, gender and age heavily influence positions of power. Moreover, Saudi national culture scored high in the power distance dimension (Hofstede-insights, 2018), which indicates that people are more likely to accept the difference in power and expect a definite hierarchy. These two facts cast a dark shadow over communication between the top management and lower levels, resulting in less effective teamwork and collaboration.

Within the communication distance, Saudis are close to Asian culture where Chinese and Japanese tend to be more reserved in confrontations (social or business), rather than western countries where project managers are more open and direct in their communication and style of management (Chen and Partington, 2004; Gobeli et al., 1998; Pinto and Kharbanda, 1995). On the other hand, Saudi decision-making behaviour is closer to the individualised methods of North American project managers, rather than Japanese and Chinese cultures tend to see the importance of teamwork as a way of making important decisions (Kerzner, 2004).

The Saudi national culture encourages some sorts of corruption as the tribal heritage of the country holds that “loyalty [is first] to the family, then the clan, the tribe, and the nation” (Rice, 2004). Researchers have reported that as individuals are more loyal to the family and the tribe over the country, they usually look for ways to overcome rules and regulations so as to award services to their friends, extended family, or tribal members (Jabbra and Jabbra, 2005). These services range from awarding government contracts to unsuitable contractors to facilitating bureaucratic processes (Ali, 2010). In non-tribal societies (usually developed countries) this is seen as corruption, nepotism, or patronage. However, it is seen in

Saudi Arabia as an obligation (House et al., 2013). Similar behaviour has been found in some Asian countries such as China, Nepal, and Japan where family loyalty and respect influence decision-making processes (Pant et al., 1996; Pheng and Leong, 2000; Wang and Liu, 2007).

Nevertheless, Alseghayer (2013) mentioned that national culture encourages two behaviours that affect a project performance: low productivity and punctuality. Alseghayer (2013) emphasised that the Saudi national culture does not give timeliness, nor tight schedules, a high priority.

The difficulty of measuring the effects of national and organisational culture on any project's aspect performance could be a reason for the limited published research on this issue. In addition, participants in such research may not realise that culture is influencing their behaviour, as seen in research applied to Saudi Arabia where cultural differences are emphatically denied as causes of conflict in the Saudi construction industry (Al-Sedairy, 1994). The author suggests that the data is not reflecting the real picture and confirms that culture in itself is a “highly sensitive issue” and suggested that denial by participants means any direct approach to measure the impact of culture will not work.

2.3.3 The Dispute, Dispute Resolution, and Litigation environments:

One of the characteristics of the construction industry is being highly adversarial, typically deemed to be due to each stakeholder having different definitions and parameters for success as well as fragmentation of projects' development process and the team involved in each stage. As a result, construction industries have long been linked with dispute occurrences (Keil, 1999). Although disputes are inevitable in some cases, they could destroy both sides financially (Mahamid, 2016), and changes in a project’s scope and variations are actually the root source for most of the disputes in construction projects worldwide (Jaffar et al., 2011). In the Saudi Arabian case the leading causes in addition to scope change and variations are: delay in progress payment by the owner; unrealistic contract duration; poor quality of completed works, and labour inefficiencies (Mahamid, 2016).

To avoid financial loss, a dispute’s parties usually avoid going to court and use other methods such as arbitration whenever possible. However, in the Saudi public sector government agencies are prohibited from engaging in arbitration, although a Saudi arbitration law exists (Royal Decree No. M/34, 2012). As a result, arbitration will not be covered as it is considered out of the research context of public construction projects. It should not, therefore, be a surprise that the most commonly used dispute resolution method in Saudi Arabia is litigation (Al-Ghamdi et al., 2012). Disputes that are related to Saudi public projects should be settled at a special court ("Grievance Board"), which is an Islamic court fully authorised to settle public sector's agencies' disputes (Council of Ministers Resolution No. 190, 1989).

The legal system of Saudi Arabia is based on Sharia or Islamic law. The king of Saudi Arabia appoints Sharia-trained judges who maintain Islamic jurisdiction within the court system. Such a system is less familiar to international investors who could act as a hindrance to such investment. The interpretation of documents - especially in the absence of legal precedent case - in the current legal system has been criticised as similar cases could reach very different results. Moreover, the system has been described as very a slow legal system. Al-Reshed (2002) examined 77 dispute cases between government agents (public owners) and main contractors and found that approximately 92% of cases took more than a year to hear, and some lasted up to eight years. The absence of using arbitration in resolving disputes and the limited number of courts contribute to the slowness and also contribute to Saudi Arabia being ranked last in the "Resolving Insolvency" indicator of the World Bank Doing Business ranking and indicates that risk could arise from such an environment. This undoubtedly increases the damages on the harmed party who resorted to the judiciary.

Jannadia et al. (2000) indicated that severe disputes concerning construction contracts have become increasingly common over the last two decades. In 2006, 45% of the litigation cases within the Board of Grievances were concerned with construction disputes or projects (Al-Rabiah, 2013; Al-Rabiah, 2006). It goes without saying that the number and value of disputes in a contract are inversely proportional to the clarity of contract documents.

In a case of loss and expense, the general principle (in Sharia law) is that a party may receive damages equivalent to the loss incurred and caused by the other party. However, the weaknesses of the mechanism of compensation applied by the judiciary, and that, in many disputes, the judiciary refuses compensation for not proving the damage or compensation awarded is at a negligible level, are problems affecting dispute resolution. In addition, the damage that may be compensated includes the actual losses such as the financial damage, the actual loss suffered by the injured person, but does not include moral damages nor punitive damages. There is also a weaknesses and lack of expertise in the judicial or arbitration courts to provide expert technical opinion on the issues of dispute in specialised construction contracts (Almutairi, 2015).

In the Saudi public context, different factors, which some have been explained earlier such as culture and others will be explained later, make it difficult for contractors to prove the damages and losses. For example, in the case of the absence of proof additional works, being the weakest link among other stakeholders, contractors accept additional work without the assignment being adequately agreed upon in the contract or issued by a non-authorised person. Thus, contractors are more vulnerable not to be adequately compensated for the actual damages and losses.

Penalty clauses in a contract are nonetheless permissible unless contracts in which the original commitment is in the form of credit (debt) (Islam Q&A, 2015). However, some conditions have been raised regarding compensation, such as that it should be a reasonable amount, should be fair and impartial, and based on the actual harm (not including intangible harm).

Furthermore, there are two cases in which the compensation penalty is not payable: 1. The one on whom it was stipulated was unable to comply due to reasons beyond his control 2. The one in whose favour it was stipulated was not harmed by the failure to fulfil the contract (Ali, 2013; Enazi, 2016; Al-Munajjid, 2011; Othman, 2009).

2.3.4 Corruption and fraud:

The potential for fraud and corruption to occur exists throughout the business world, and construction projects are no exception. The lack of governance and control, as well as the cultural acceptance in which some actions are not categorised as fraud or corruption, enhance the chances of corruption exists. Indeed, there are more opportunities to commit fraud on a construction project than there are in business operations, where usually corporate policies and procedures are well enforced, and internal or external audit is an ongoing requirement. One example of corruption caused by a lack of governance and legislation and effective litigation systems is that contractors in Saudi public projects are working under unbalanced risk appropriation contract that put the state representative in a position of unlimited authority, are accepting additional work without the assignment being issued in the proper manner agreed upon in the contract, or issued by a non-specialist.

The tribal and strong family links in Saudi Arabia, which is one of the themes that influence the national culture, encourages some sorts of corruption. The tribal heritage ranked the loyalty as follow: at first to the family, then the clan, the tribe, and the nation (Rice, 2004). One of the corruption actions is that individuals often look for ways to manoeuvre around bureaucratic rules and legal regulations to grant favours to their friends, extended family, or fellow tribal members. These favours range from granting government contracts to unsuitable contractors (Ali, 2010), to facilitating bureaucratic transitions (Jabbra and Jabbra, 2005). Although the west perceives this as nepotism, corruption, or patronage, in Saudi Arabia, it is considered a duty to prioritise one's family in business deals before evaluating technical competency or financial competitiveness (House et al., 2013). Such behaviour has been found in some Asian countries such as China, Nepal, and Japan; family loyalty and respect influence decision-making in project management to become bureaucratic and more prolonged (Pant et al., 1996; Pheng and Leong, 2000; Wang and Liu, 2007).

Other cost-related actions within the construction industry that could be labelled as corruption and fraud are: Increasing the attractiveness for approving the project (Consultant); 'Unbalanced bids' (contractors); Overestimated change orders (Contractors); Unsubstantiated change orders (Owner representative); Delayed and/or improper approvals by the appointed project consultant, Over-reported project performance to either over-invoice for work on-site or hide project delays (Sohail and Cavill, 2006; Gunduz and Önder, 2013).

2.4 Resources availability and construction:

The construction industries in the developing countries face significant challenges with the resources such as management and shortages. In the following sections, the four primary resources will be discussed.

2.4.1 Finance:

For a construction project, the main finance types needed are development finance to cover the cost of initial stages, construction finance to cover the cost of the project implementation, and contingency finance to cover cost overruns and delays (Zainudeen et al., 2010). Saudi public projects usually have one major financer (normally Ministry of Finance (MoF)) who control funding for all public projects. However, under the solo financer, the whole public projects are affected by any negative financial capability of that financer resulting in threatening the whole industry in that country.

In the case of public projects in Saudi Arabia, there is a lack of law or regulation for funding construction public projects. However, the literature indicates two ways to fund public construction projects. First, directly by the Saudi government in that Saudi Arabia is a rich country and the government can fund the majority of public projects through the MoF (MEP, 2010b; MEP, 2010a). Second, the country has opened public projects to the private sector to part-fund projects using contracts such as BOT and PPP (Al-madina, 2012).

From a financier perspective, construction projects frequently exceed cost and time limits. Moreover, the time usually needed for a construction project to be finished is relatively long. A financer needs to be financially stable to finance such projects, avoid any claims, and finish projects on time. For Saudi MoF, as the country depends on a single source of income (oil), any drastic changes in the value of that resource affect the value of projects that can be funded. As the main owner financier, this profoundly affects the industry as a whole, especially contractors, which could be reflected in their account statements (Argaam, 2016) and the worst cases lead to contractors’ bankruptcy as with Saudi-Ojer which was the second major contractor in the country (Dey, 2016).

To gain more in-depth understanding of the public sector construction industry the manner in which public projects are funded need to be investigated and evaluated, particularly the process of payment for completed work as it has been found as the primary reason for poor performance (Althuniain, 2012; Almahmoud et al., 2012; Al-Kharashi and Skitmore, 2009; Assaf and Al-Hejji, 2006).

2.4.1.1 Contractors' financing mode:

Access to credit is essential for a construction company to gain working capital, provide a financial guarantee to clients, and balance the cash flow curve (Palliyaguru et al., 2006). Similar to most services providers, a contractor provides services (part of the project) then will be paid for them. In the short term, a wide variety of financing options exist including overdraft facilities, loan facilities, trade credit, construction guarantee fund, and private sources. Among these, the familiar source of finance for unexpected cash flow deficits is bank overdrafts.

For Saudi construction contractors, Islamic finance is the preferred source for financing (Jamal, 2009; Alriyadh Trading, 2014). All banks in Saudi Arabia provide financial services which include but are not limited to advance progress payments, progress payment certificates and short-term loans (Alfransi, 2018; Bank Albalad, 2018; Riyadh Bank, 2018). According to Saudi Arabian Monetary Authority (SAMA) speaker, direct loans provided to contractors are 8% of the total Saudi bank financing portfolio (USD 30 billion), and more than that if indirect loans (financial guarantee, …etc.) is included (Hafiz, 2016). Banks usually secure their loans against the assignment of proceeds, however, in the case of a severe delay by MoF paying contractors, which generally happens when there is a decrease in the oil price, banks stop financing contractors more new loans. Moreover, banks increase the risk ratio/category for the construction industry, resulting in a higher interest rate and reluctant to finance contractors (Habtoor, 2016; Al-Busaily, 2016). The consequences could be worse in the case of an unplanned capital incident; banks charge a higher interest percentage.

2.4.2 Material:

For the construction industry, the building materials sector is crucial. It serves as both a barometer of the broader health of the construction industry and as a critical factor in the bottom line of local contractors. This because materials are a primary component for construction projects (Gulghane and Khandve, 2015) through consuming typically between 50% to 70% of a project's cost (Gulghane and Khandve, 2015; Patil and Pataskar, 2013). The price of material in a country affects building cost, for example, a building in Saudi Arabia costs 42% to 85% of the UK cost, with access and availability of building materials being key reasons of the difference (Colliers International, 2016).

In Saudi Arabia, basic construction materials such as cement, steel, and paint are produced locally, and most of the electromechanical, IT, Safety, control systems are imported (EDRT, 2010; Alhzaha, 2013; Assaf et al., 2013). In their aim to stabilise and nationalise the construction materials market, the government provides direct financial support to local producers such as free-interest loans and subsidised fuel (OBG, 2018). Moreover, the government controls the construction materials' importing and exporting limits in exchange for this financial support (Tomalieh, 2015). For example, cement plants are not allowed to export their product outside the country unless they pay back the amount of difference in fuel price that was provided at a lower price by the government.

The Saudi construction industry suffers from oversupply and undersupply of construction materials caused by the differences in the projects' number over the years which linked to oil price as mentioned earlier. The supply fluctuation results in price fluctuations, for example, material costs increased by 12% from 2012 to 2014 (oil price high) and decreased in demand since 2015 (oil price low) resulted in a 17% reduction in cement price (OBG, 2015).

Although the Saudi government have regulations to stabilise material prices, these regulations affect the local basic materials, but the current development in projects' design usually needs complex, advanced technology, and innovative construction materials which are mostly produced elsewhere.

2.4.3 Labour:

Labour play an essential role in the success of construction projects (Proverbs et al., 1999). Moreover, the construction industry workforce ranges from 6 to 14% of the total workforce (Figure 11) for a country, and providing an experienced workforce is an important factor for attracting direct foreign investments. In the case of Saudi Arabia, the top two problematic factors for doing business in the country are labour-related factors which are: inadequately educated workforce, and restrictive labour regulations (World Bank, 2016) which partly explains the difficulty of securing foreign investment.

Saudi Arabia is a young and newly developed country which was founded in 1932. Since oil was first produced commercially, a significant portion of national income has been spent on building the country's infrastructure. In the early days, there was a tiny percentage of skilled and educated locals, resulting in skilled workforce shortages to cope with the boom in construction activities. Dependency on foreign labour continues today and partly explains the large number of foreign workers in Saudi Arabia compared to other countries (Figure 9). Foreigners constitute more than half of the workforce and more than a third of the population, which is very high compared to other countries (see Figure 9).

It worth highlighting that the majority of foreign workers in Saudi Arabia are male, with less than 30% female, which is a very high percentage compared to the UK or Saudi nationals (Figure 10).

As Figure 11 shows, the construction industry in Saudi Arabia occupies 14% of the workforce which comes second after service industries (Assaf et al., 1996). The percentage is relatively high compared to the other countries, demonstrating the importance and the size of the construction industry in the Saudi context. Most construction workers, skilled, semiskilled, and unskilled, are imported from far Eastern and Middle Eastern countries; a process that takes almost six months (Donaghy, 2016).

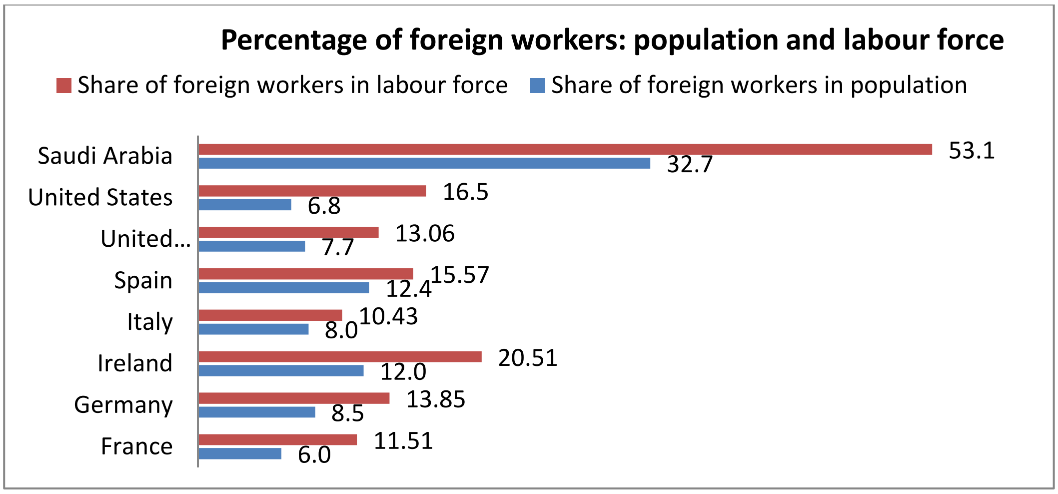

Figure 9: Percentage of foreign workers in the population and labour force.
Sources: (OECD, 2015a; OECD, 2015b; SAMA, 2015).

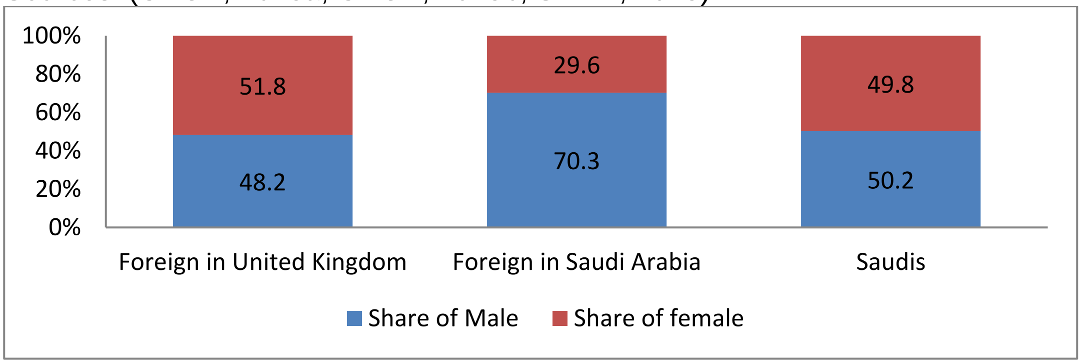

Figure 10: Male and female percentages in the UK and Saudi Arabia.
Sources: (CDSI, 2014; OECD, 2015a; OECD, 2015b).

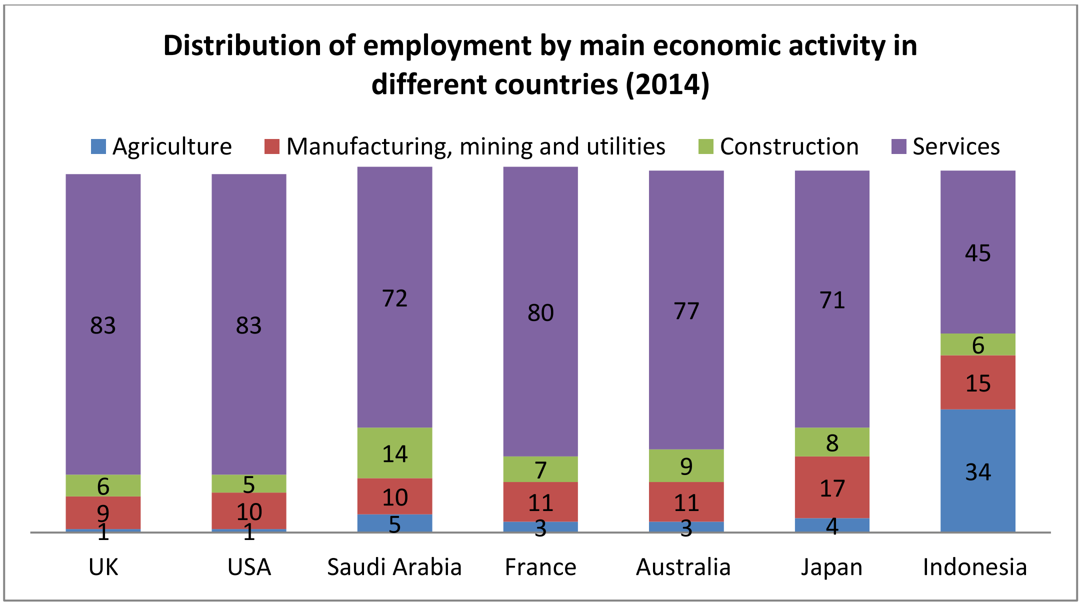

Figure 11: Distribution of employment by main economic activity in different countries (2014).
Source: (ILO, 2015).

For Saudis, the building and construction sector is the least attractive sector regarding employment (Alyom newspaper, 2011). Local workers constitute 10% of the construction industry workforce (Figure 12), with one reason being the low salary offered by the private sector. Moreover, there is no minimum wage for expatriates in Saudi Arabia which makes it harder for Saudis to gain a position within the private sector in general and within the construction industry in particular (Ministry of Labor, 2005).

Reliance on foreign labour is the standard feature of the private sector in Saudi Arabia; the construction industry is the only industry in which reliance on expatriates' labour has never been less than 90% (Figure 12). The over-reliance and preference of the Saudi private sector for expatriates has been discussed by (Ramady, 2010), and he points out that factors such as cost, culture and control play significant roles.

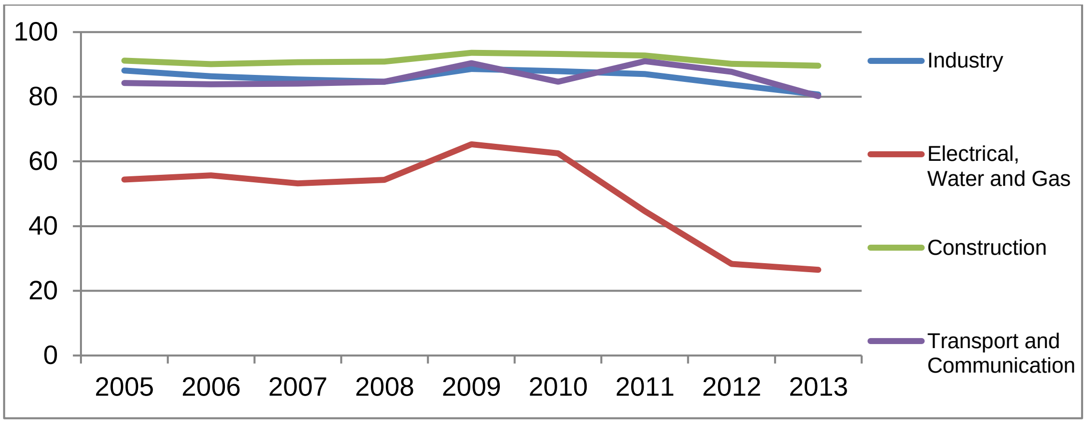

Figure 12: Expatriates percentage in different Saudi sector.
Source: (SAMA, 2015).

Moreover, statistics show that the private sector and the education system in Saudi Arabia are incompatible which contributes to the preference for expatriates. As Figure 13 shows, almost two-thirds of the labour force's education in Saudi Arabia is at a low educated level, which is very high compared to the UK where only 29% of the workforce has a low level of education. By contrast, Figure 14 illustrates that universities annually produce a substantial number of graduates with a high level of education that are not employed by the private sector.

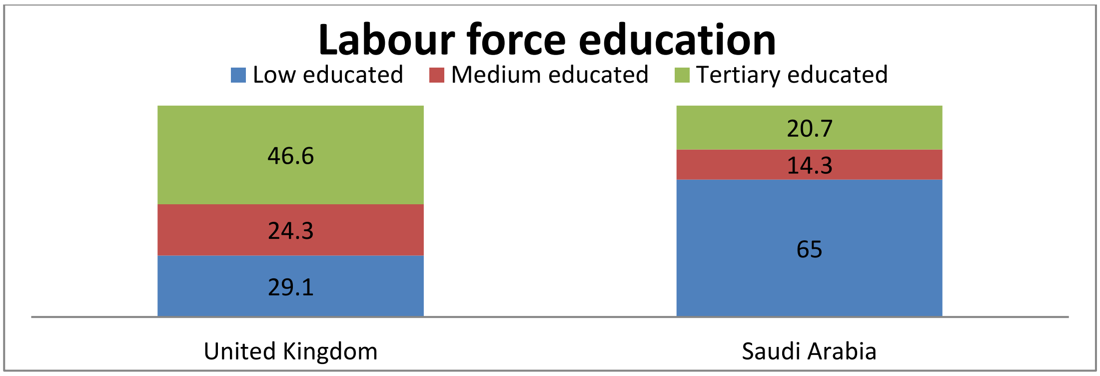

Figure 13: Labour force education in Saudi Arabia and the UK.
Source: (OECD, 2015b; SAMA, 2015).

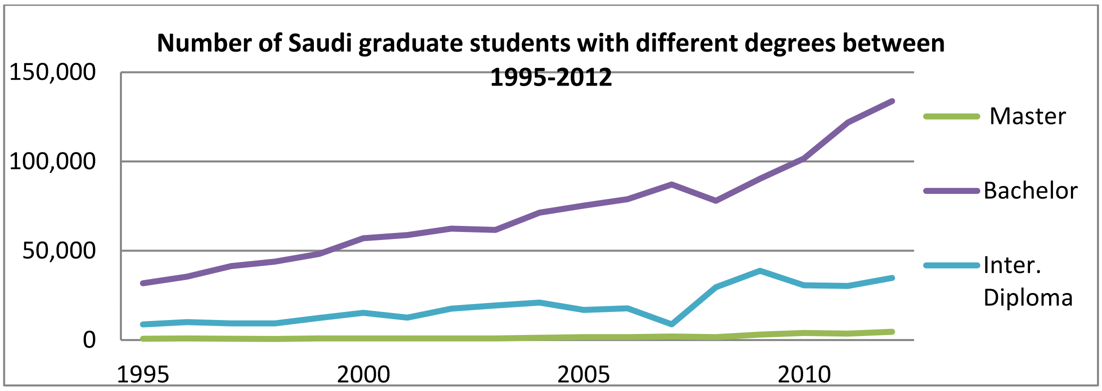

Figure 14: Number of Saudi graduate students with different degrees between 1995-2012.
Sources: (SAMA, 2015).

With 93% of jobs in the public sector occupied by Saudis, compared to 22% in the private sector, Saudis always prefer to work for the public sector (IMF, 2016a). One of the reasons is job security, which is prioritised over a high salary. Moreover, in general, salary, working hours, job requirements and description, and work conditions in the public sector are much better especially for the fresh employees, and an increase in wage is guaranteed yearly. Public sector wage policies reduce the incentive for individuals to look for private sector jobs or launch their own businesses.

A report by the Ministry of Planning and Economy stressed that the private sector is unable to resolve the unemployment problem because the majority of the jobs it provides are unskilled and do not require a high level of education (MEP, 2010b). According to the report, this situation makes the replacement of foreign workers by national workers difficult as the majority of the national labour force is skilled labour, and most of the unemployed have a university degree.

Moreover, statistics show that the private sector and the education system in Saudi Arabia are incompatible which contributes to the preference for expatriates. As

Figure 13 and Figure 14 shows that the private sector focuses on cheap professional labour while most of the graduates are high-educated and the smallest are professional labour. The figures suggested the decision-makers should look more into the privates' sector requirements and focus more on the professionals who will increase the value of the money that spent on the high-education which was confirmed by other studies (Al-Qarni, 1990; Al-Nemer, 1993; Al-Jabr, 1994). According to one of the studies that communication is missing between higher education institutions and the private sector (Jeffrey, 1997).

In the construction industry, contracting companies are usually owned by Saudis, but most of the employees, from the top level to labour level, are imported from abroad; in 2013 alone, more than 432,000 work visas were issued for the construction and building sector (Figure 15) (CDSI, 2014). With 61% of the population who are in the working-age (15-64 years old), it must be pointed out that over-reliance of the private sector on expatriates has economic, social and political outcomes (Al-Dosary and Rahman, 2005). For example, the extent of Saudi unemployment has increased especially amongst young people and reached 11.7% (male) and 32.8% (female) in 2014 (Table 3).

The employment situation has put pressure on government decision-makers to introduce the Saudization programme (translates in Arabic as "Nationalisation of the Saudi labour market"). According to Looney (2004), the Saudization program focusses on three primary goals:

1. Increase employment for Saudi nationals.
2. Reduce and reverse over-reliance on foreign workers.
3. Recapture and reinvest foreign income that otherwise would have gone overseas.

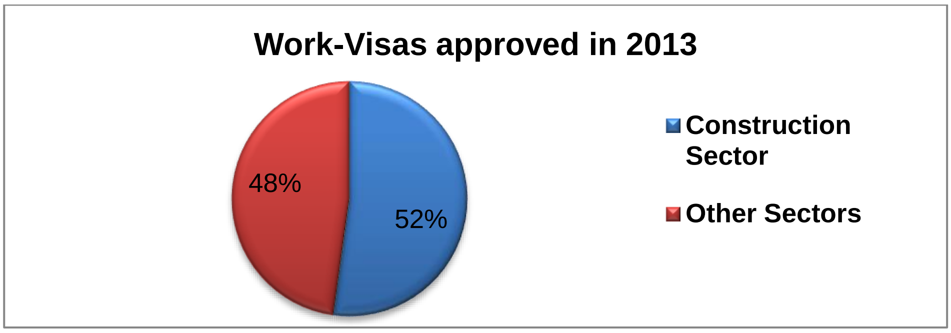

Figure 15: Work-Visas approved in 2013.
Source: (CDSI, 2014).

Unemployment Rate for Citizens	11.7
Male	5.9
Female	32.8

Table 3: Unemployment Rate for Citizens.
Source: (CDSI, 2014).

The programme will be a new challenge for contracting companies, especially the ones already involved with large projects. Such a significant replacement of the workforce in a company takes time. However, contractors were tasked to deal with the new situation over two years, and the Saudi Arabian General Investment Authority (SAGIA) cancelled dozens of business licenses where entities failed to meet the Saudi hiring requirements (The Economist, 2014), and has delayed issuing residency visa requests for businesses to obtain employees from other countries (US Department of State, 2015). Another problem that could hit the construction industry is poor labour productivity. Figures show that construction labour could not cope with increased complexity and innovation (Khan et al., 2013). The lack of trust and socio-economic changes among workers has been identified for reasons for the decrease in labour productivity (Radosavljević and Horner, 2002).

In short, expatriates occupy more than 90% of the construction industry jobs, which is a very high percentage as the industry failed to reduce this rate and replace them by locals. The over-reliance on expatriates will be a new challenge for all Saudi contractors in terms of the new nationalisation scheme. Foreigner labours' regulation, law, and enforcing them are all very changeable and hardly predictable. The Saudi government are affected by the situation where a good number of young Saudis are unemployed in a country where 1/3 of its population are foreigners.

2.4.4 Plant:

The third important component of project resources is construction plant. To achieve project goals (finish on time and reach high-quality standards with an effective cost), mechanisation of previously manual work needs to be done. This highlights the importance of plant (the machinery and equipment used in construction) (DBW, 2018). Construction machinery is not cheap and is normally considered as a major component of a construction company’s assets. The cost of equipment constitutes a significant investment for most construction contractors in Saudi Arabia (Shash, 2012). Maintaining heavy machinery is also expensive, so hiring plant is an option but mainly for light use task-specific machinery. In the UK, for example, plant hire is well established and worth over £4 billion, while the Saudi machine hire market has annual revenue of USD 66 million, so is not significant as in the UK, partly as Saudi contractors own 83% of the machinery required (Shash, 2012). Because of the shortage of a permanent labour force in Saudi Arabia, construction equipment is used to the maximum possible extent.

The country's harsh weather can result in damage to machinery, and this should be considered as part of the maintaining of the plant, with its associated risks. If the equipment was to fail during a project, the firm could face heavy financial losses, delayed schedules, and additional funds would be required to either quickly repair the equipment or purchase a new one.

In a Saudi construction project, the equipment cost ranges from 10 to 12 % of the project cost. In addition, a skilful operator is needed to get the full optimisation of that machine. Small mistakes by the operator could cause damage leading to financial loss. A good example is the carne crash in Makkah city that killed 111 and injured 394 pilgrims in 2015 (BBC, 2015). The incident led to the suspension of all the company contracts with the government which was worth billions as the company was the most prominent contractor in the country and held most of the major project contracts (Reuters, 2015).

Despite the importance of construction machinery in the country, the researcher faced insufficient numbers of studies covering construction plant in Saudi Arabia.

2.5 Saudi Public Projects:

The Saudi public sector is that part of the country's economy owned and supported financially by the Saudi government. Thus, Saudi public construction projects are those owned and supported financially by the Saudi government. The public usually has high expectations of the output of "their" public projects, resulting in high pressure to finish on time and within budget cost.

Saudi Arabia's government takes the responsibility to provide free infrastructure for the citizens based on 5 year development plans that started in 1970 (MEP, 2010a; MEP, 2015; MEP, 2005; MEP, 2000; MEP, 1995; MEP, 1990; MEP, 1985; MEP, 1980; MEP, 1975; MEP, 1970). Switching this responsibility to the private sector has been seen by the public as "selling the country" (Biygautane et al., 2018). Despite the downturn of the Saudi economy in some periods, the government has continued its obligation to provide the required infrastructure (Dew, 2003).

The effect of oil prices on the construction industry became more pronounced between 2004 and 2015. During this period, the average oil price rose dramatically from almost USD 34 per barrel to reach just over USD 110 per barrel. At the same time, the Saudi economy started benefiting from increased total income; USD 250 billion in 2004 to a new income peak in Saudi history in 2013 with almost USD 750 billion. Focusing on this period, Figure 16 shows the total approved budget by the government of Saudi Arabia quintupled from USD 10 billion in 2004 to reach its peak in 2010 with almost USD 50 billion.

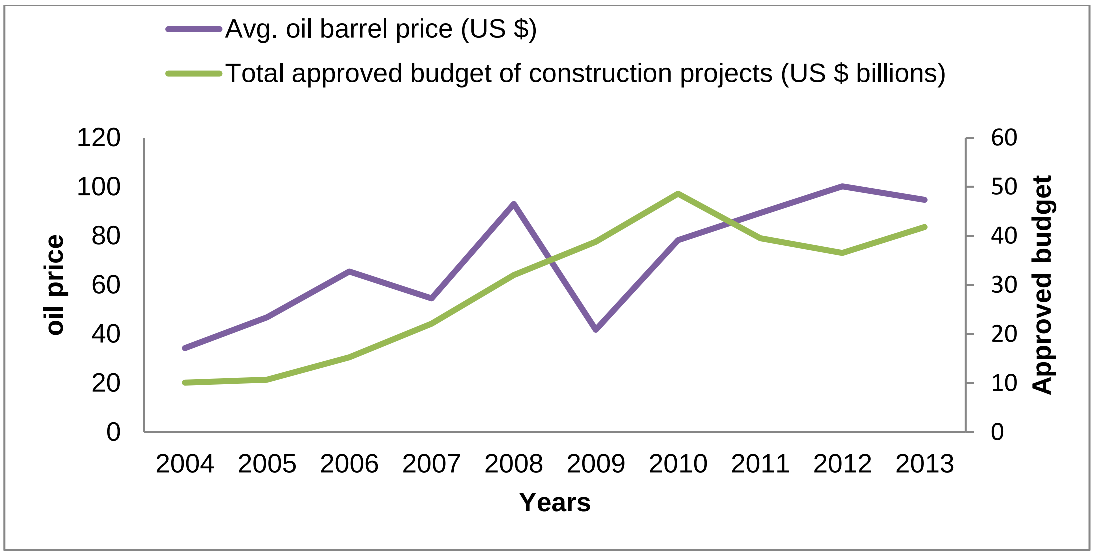

Figure 16: A comparison of the total approved budget for construction projects with the avg. Oil barrel price between 2004 and 2013.
Source: (MOF, 2005; MOF, 2006; MOF, 2007; MOF, 2008; MOF, 2009; MOF, 2010; MOF, 2011; MOF, 2012; MOF, 2013).

2.6 Regulation and Project Development:

The regulations and laws applied to the Saudi public construction project are shown in Figure 17. The higher ranking in the pyramid should not conflict with the lower one. According to Article 1 in the Government Tenders and Procurement Law (STPL), the law aims to regulate procedures of “tenders and procurements carried out by government authorities”. Moreover, Article 6 cited that “all government works and procurements shall be put up for public tender” under the STPL regulations and procedures, “except those exempted under the provisions of this Law” (Royal-Decree-No.M/58, 2006; BECM, 2009). However, applying the below law pyramid is not always the case for public construction projects, some of the public projects are exempt from the STPL and PWC which should be delegated by Royal Decrees.

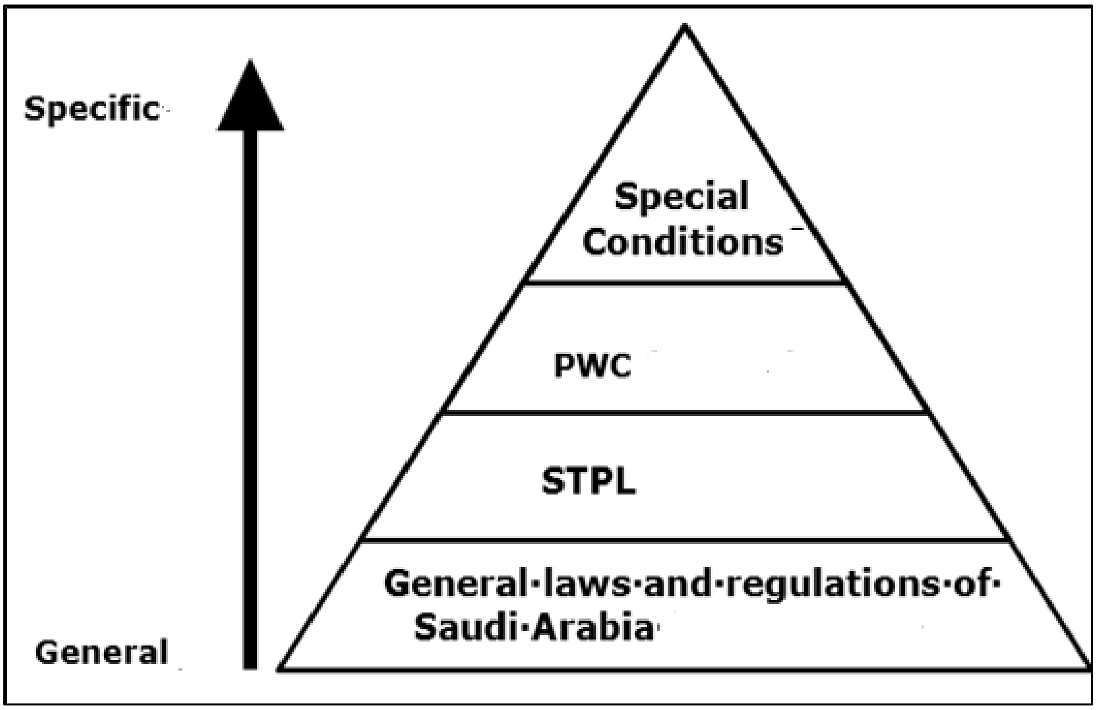

Figure 17: Regulation order from general to specific.

In the case of an exemption, the governmental laws and regulations, such as STPL and PWC, are not applied, and affected projects are usually undertaken by leading international contractors who do not accept the current projects' procurement and risk apportioning. The exemption could be in response to public pressure, such as when the Jeddah flooding crises resulted in 83 dead (Ghabiri, 2017). The government has spent billions on anti-flooding systems in the city that seem not to be working, with one result being the opening of corruption investigation cases and arresting of hundreds of previous officials. Several Royal orders followed the crisis, instructing Saudi Aramco (an oil company owned by the government) to construct the flooding system for Jeddah city. Also, other projects have followed such as King Abdullah University of Science and Technology (KAUST), King Abdullah Petroleum Studies and Research Centre (KAPSARC), and King Abdullah Sports City (KASC) (Dahlan, 2014).

Another trigger for exemption is to attract world-class contractors required for complex high-tech projects, which have been found to do a better job compared to the local competition (Medallah, 2015; Al-Otaibi and Nawab, 2016) such as in the railway projects constructed using the Engineering-Procurement-Construction (EPC) procurement vehicle.

The third trigger for exemption has been introduced recently and is attracting the private sector direct investment using different of delivering methods such as PPP and BOT. This is supported by Biygautane (2017b) who argues that a new procurement method involving a third party, such as the private sector, should be used more in Saudi Arabia as it benefits the country through:

1. overcoming large financing project that government cannot support anymore, especially with the low oil price (overcoming a government's financial constraints),
2. overcoming the lack of owner experience with complex projects,
3. avoiding the problem of cost overrun and delay (Hodge and Greve, 2005).

Figure 18 and Table 4 show that Saudi public construction projects are using different types of contracts during their project lifecycle, but the awarding method is still the same - lowest price wins. Moreover, the contracts that are used between Saudi public agencies and each of designer, consultant, and contractor, are contracts of adhesion ("take it or leave it") that gives the designer, consultant, and contractor no ability to negotiate (Council of Ministers, 1988). The project will hand over to the client after the construction project is finished.

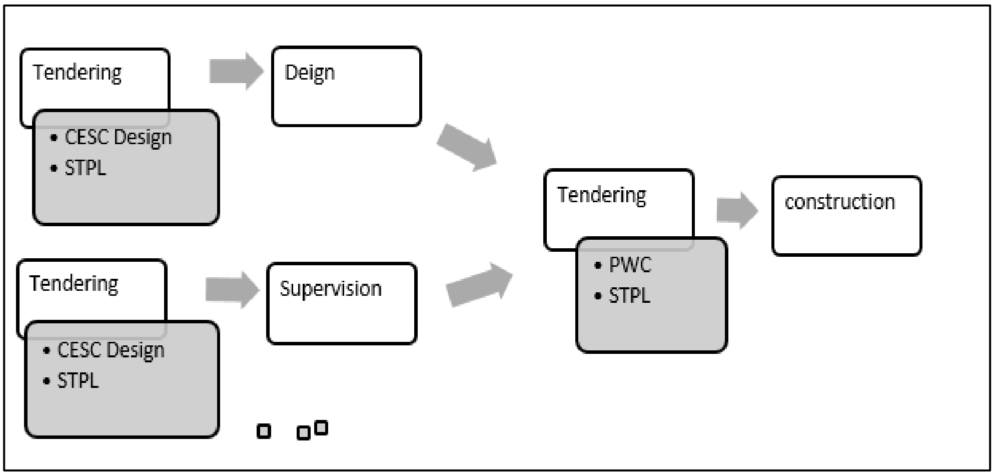

Figure 18: Contract and procurement laws used for each stakeholder.

Although the government has used different types of delivering methods, such as PPP and BOT, these are not the norms according to the law and need approval by the highest authority. Thus, the focus of the study will include projects appointed under normal circumstances, which means using the STPL and PWC. As the scope of the study includes focusing on construction projects in the Saudi public sector and contractors' cost performance, the regulation that is used for appointing the contractors will be investigated further.

Between	And	Contract name	Tender Form	Awarding Method
Public Agencies	Designer	Consulting engineering services contract (Design) (CESC Design)	Close/Selective Tender	According to the STPL Lowest Price
	Consultant	Consulting engineering services contract (Supervision) (CESC Supervision)	Close/Selective Tender	
	Main contractor	Public Work Contract (PWC)	Open Tender	
	Sub-Contractor	N/A	N/A	N/A

Table 4: Type of contracts in Saudi Public Sector.
Source: (Council of Ministers Decision No. (259), 2011).

Although studies investigating the Saudi public projects performance have identified that the procurement regulations lead to poor performance, the why and how questions have never been addressed. Thus, the STPL and PWC limitations need to be identified, and the path that could lead to poor performance be explored. The research will face a limitation regarding the number of publications that discuss PWC conditions, which results in using primary data. To create more value during the evaluation, an investigation and comparison between the current PWC and FIDIC building and engineering works, designed by the employer (Red book) and what hinders implementing FIDIC. This is because there is a widespread belief in the Saudi construction industry that applying FIDIC is going to solve three-quarters of the issues related to the Saudi public sectors performance. Nevertheless, STPL shows that public projects are adopting a traditional procurement strategy. However, it is not clear how a public project is developed and what are the phases in their project lifecycle. Thus, the project development strategy needs investigation.

2.6.1 Performance:

Some studies claim that nine out of ten projects are suffering from poor performance (Flyvbjerg et al., 2003a) and the Saudi construction sector, which is the most significant construction industry in the region (EDRT, 2010), is not out of the norm and suffers from serious problems leading to poor performance (Almahmoud et al., 2012; Assaf and Al-Hejji, 2006; Falqi, 2004). Cost and time performance is considered to be one of the most severe and frequent problems in the Saudi Arabian construction industry (Faridi and El-Sayegh, 2006).

Some websites have been monitoring public project performance (in specific areas) such as Medina area (MDA, 2017) and Jeddah (3adad.net, 2015). However, the websites' data at the time of writing are outdated so their performance data cannot be used. In this respect, several local studies have cited that over the four decades, public projects suffered from frequent and lengthy delays. In the 80s, two studies by Zain Al-Abidien (1983) and Al-Sultan (1987) studied different types of projects and mentioned that 70% of public projects are delayed. 76 water and sewage projects, which were built in the late 80s and early 90s, have been studied by Al-Khalil and Al-Ghafly (1999), who found 60% of them were delayed. In 2004, a study reported that 952 (40%) out of 2379 projects in Saudi Arabia were delayed (Falqi, 2004). Poor time performance continued, as a study in 2006 found that only 30% of construction projects in Saudi Arabia were completed within the specified cost and schedule (Assaf and Al-Hejji, 2006). Saudi construction projects built between 1992 and 2009 scored little success, as 82% failed to meet their baseline time, cost and quality objectives with an average cost overrun of 40% (KPMG, 2010), and only 25% of Saudi infrastructure projects were delivered at the estimated cost and time, according to Alguwaihes (2011). The Saudi national anti-corruption commission (2013) updated these figures and painted a worse picture: in 2013 over 3000 Saudi public projects were delayed.

For cost overrun, comparing to delay, data about the cost overrun in Saudi public projects are insufficient, which is likely for privacy-related reasons as finance data are ordinarily sensitive for public and private sectors. However, newspaper and government reports mentioned that Saudi infrastructure projects are not immune from cost overruns. Studies reported that 41%-50% of infrastructure projects in Saudi Arabia overrun their budget (Althunian, 2010; Alguwaihes, 2011). Although the causes of cost overrun have not been studied thoroughly for the Saudi construction projects, Al-Khaldi (1990) examined factors contributing to poor cost estimation, and Bubshait and Al-Juwairah (2002) studied causes contributing to construction costs.

Such poor performance has harsh consequences on the projects and all parties involved; project delay is considered to be one of the most severe and frequent problems in the Saudi Arabian construction industry (Faridi and El-Sayegh, 2006). The consequences that result are beyond project failures and escalating costs which was reported by different authors (Al-Kharashi and Skitmore, 2009; Fahad et al., 2012; Almajed and Mayhew, 2013; Ali et al., 2013). Besides the financial loss, other negative impacts of delay in the public sector are: confusion regarding public development plans; disturbance of the budget execution plan of the government authority involved, and public inconvenience. From the contractor's viewpoint, delay merely is an additional liability as the construction period becomes longer; the more extended period results in higher overhead costs and expenses; the entire contractor’s working capital may become trapped in one project. Delays also mean a loss of output and revenues, since the contractor cannot become involved in other projects (O'Brien et al., 2004).

Assaf et al. (1995) identified and ranked the causes of delay in Saudi building projects. Out of the 56 causes, the financing causes score the highest, and environmental causes score the lowest. According to the contractors, preparation and approval of shop drawings, delays in contractors' progress payment by owners, and design changes by owners are the most important causes for delay. A study by Al-Khalil and Al-Ghafly (1999) followed and identified the most important causes for the delay as: delay in payment for the client; financial difficulties by the contractors; difficulties in obtaining permits; and selecting the lowest bidder regardless of capabilities. Answering the question of who is responsible for the project delay, owners and consultants blame the contractor, and the latter blame the owner. Another study by Assaf and Al-Hejji (2006) identified the causes of delay in Saudi construction projects from different point views. As with the previous study, the results show the exchange of accusations between project parties. Owners specified that causes of delay are related to contractor and labours. The contractors on the other hand score owner-related causes the highest.

Lately, a study by Al-Kharashi and Skitmore (2009) summarised the causes of delay which are: lack of qualified and skilled staff; lack of coordination; communication gaps between contractor and designer; shortage of human resources in the design firms; lack of knowledge of the designers about the available materials and equipment; insufficient details in the working drawings, and incomplete drawings and specifications. It could be concluded that the most influential cause of delay in the Saudi Public Construction Sector is the lack of experts and qualified team members, especially those who can deal with developed portfolios (Al-Nuaim, 2011; Al-Kharashi and Skitmore, 2009).

Research in the previous studies used a survey research method to identify leading causes and measuring. One feature that is shared by Saudi public project performance studies is the disagreement between the primary stakeholders of the main poor performance causes as well as who is responsible. This could be a result of industry and national cultures, unclear contract boundaries and responsibilities, lack of experience of all parties, unclear identification of the phenomena and form which party’s point view, and the lack of a single system of measurement (Aziz, 2013b). Such features could raise questions regarding the quality outputs as well as benefits of investigating poor performance causes from different points of view if the disagreement is always appearing. Moreover, to decrease the effect of disagreement between the parties, it is appropriate to identify the system of measurement of progress or quality of work and compares it to the modern management methods so as to measure the range of intangible issues involved.

To overcome the performance issue conferences, symposiums, and workshops about defaulted projects were held in Saudi Arabia. Although there was no clear definition of defaulted projects by the government and how they differ from delayed projects (Hanfi, 2012), a study by Brahmin (2012) shows that 13% of Saudi projects are defaulted projects. Improvements have been suggested, such as by Zain Al-Abidien (1983) that different parties should work as a team to improve the regulations and contract.

Considering the above, the majority of public projects in Saudi Arabia suffer from severe delay. For over 30 years, the portion of public projects suffering poor performance stayed the same, possibly indicating that the problem is rooted within the system, regulation, and method of public projects delivery. This is supported by the fact that regulation has not changed during those 30 years.

Although some of the studies show that problems are accrued during the project development, it is not clear how a public project is developed, and what are the main triggers for these problems. Thus, an in-depth investigation within the project lifecycle is needed. Saudi Contractors' performance will be discussed in section 2.7.2.

2.7 Contractors in the Saudi construction industry:

In Saudi Arabia, contractors engage in public construction projects after the detailed design is finished. During the tender stage, contractors purchase tender documents, price BOQs, and the main contractor will be chosen based on the lowest price. Because of the high uncertainty nature of construction projects, main contractors face risks that could affect time and cost (Alfredo del and Cruz, 2002). Moreover, choosing a project's contractors based on lowest price maximises the nature of risks in the industry (Creedy et al., 2010a) as the construction industry is generally more competitive than most other economic sectors (Enshassi et al., 2006). Nevertheless, the country's economy also increases the cost situation for contractors as it is affected by oil price shocks resulting in the construction industry have a boom-bust cycle (Table 5), as shown by the Saudi construction industry during 2004 to 2014 when the oil price significantly increased. A boom in the Saudi construction industry is created and supported by a high oil price and the government's subsequent approval for hundreds of infrastructure projects (Al-Sedairy, 2001; Shash and Al-Amir, 1997). Simultaneously, the annual statistical reports show that the number of contractors doubled over the same period (Figure 19). The rapid increase in contractors' number is a sign of the urgent need for contractors, and there is a high demand for construction works that potentially makes the construction industry more profitable.

A bust in the construction industry is typically followed a boom, such as those in 1982 and 2014, which was resulted from the decrease in oil price and government cuts in construction projects (Shash and Al-Amir, 1997). Cutting or reducing spending on construction projects is the usual response taken by the Saudi government as most of the new income will be barely enough to spend on public employees' wages and essentials as well as the regulation supporting such action. At this period, contractor companies start to show losses in their annual statements, such as for the Al-Khodari company (Alkhodari, 2011; Alkhodari, 2012; Alkhodari, 2013; Alkhodari, 2014; Alkhodari, 2015; Alkhodari, 2016). With a high number of contractors and the small amount of work available, the Saudi construction environment becomes very competitive and less profitable, pushing contractors towards suicide bidding for survival (Al-Harbi et al., 1994; Shash and Zamel, 1993). As a result, small and medium contractors are more likely to announce bankruptcy within five years of starting the business (Grosskopf, 2004).

Contractors who start and complete a project within a boom or bust phase can usually predict the types of problems they might face. However, it is not unusual that contractors submit their bid in one phase and construct the project in another phase. In such circumstances, contractors are more likely to face issues that did not exist in the industry when they made their estimation. To illustrate the differences between the two economic phases, Table 5 shows some aspects, characteristics, and risks that exist in each phase. For example, contractors who start their projects before an oil boom and construct part of the projects at the boom phase will face an increase in resources prices (material, labour, etc.) which could reduce the contractors' profitability or lead to cost overrun. Although there are benefits that could appear in that situation those benefits do not cover the losses. To illustrate, contractors who start their project during the boom phase and construct their projects at the bust phase benefit from the low resources prices, however, the losses because of the payment delay overcome the benefits of low prices for resources (Al-Khudari, 2016).

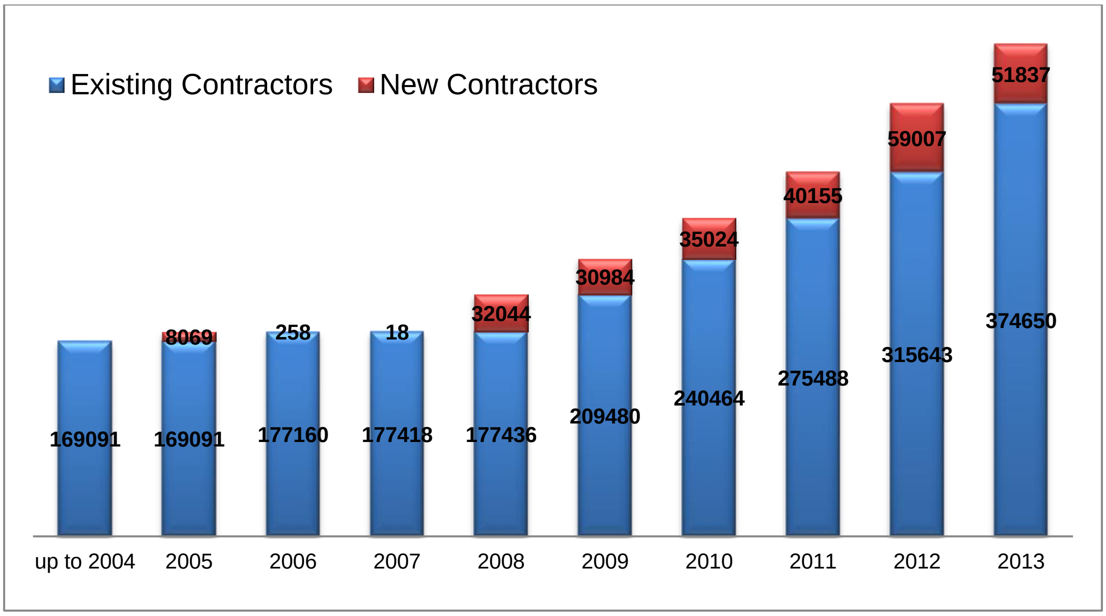

Figure 19: Existing Commercial Register of contractors between 2004 and 2013. Source: (CDSI, 2014).

Saudi contractors usually work only within the country and most likely within the public sector. This phenomenon is a result of there being an acceptable amount of work generally in the country as well as a Saudi contractor normally growing up under parental care from the state and government concessions (Abbas, 2016). For example, government regulation prefers local contractors and products over non-local and, as a result, the experience that Saudi contractors gained is limited as they are not exposed to the external environment and therefore cannot mitigate the uniqueness of the Saudi construction industry where they usually work in by becoming familiar with other types of contracts. Thus, this diminishes their ability to compete outside their geographical area and means they rely on themselves (Abbas, 2016). Experts criticised the dependency of Saudi contractors on the country and their susceptibility to unexpected risks if they want to develop and grow to stay in the market (Bhatia, 2016).

In general, the construction industry is behind other industries in using accepted approaches to assess and manage risks (Mulholland and Christian, 1999). Contractors rarely rely on statistical techniques and tools to make decisions that are risk-related, instead of individual knowledge and experience, and intuitive judgement is normally used by contractors. Such an approach has been found lacking by being neither prescriptive nor normative (Laryea and Hughes, 2009). Saudi contractors are not different from the norm, and the lack of use for modern risk assessment methods is accompanied by the lack of a sold data bank.

Transferring risks to insurance companies is not a popular option in Saudi Arabia, as the Saudi based insurance company is not providing options to the local contractors. The government as well seems not in favour of that option as is not enforcing insurance requirements to the Saudi contractors. According to Medallah (2015), the lack of legal regulation and technical ability are the main reasons behind the insurance companies not providing many options for contractors. Thus, contractors add risks generally to the price which could be challenged in a highly competitive environment.

Characteristics	Boom (Oil price high)	Bust After Boom (Oil price low)
Country emphasis Government focus	Focus on new building contracts.	Focus on operation and maintenance contracts.
Regulation implied Enforcement of existing laws	Easier on enforcement of laws.	Insist on enforcement laws such as competitive tendering (lowest price).
Contractor financing	Large advance payments provided by the government. Up to 20%. Less dependent on commercial banks.	Small or no. up to 5%. Against financial guarantee. No financial assistance resulting in short-term loans with fee-bearing loans provided by commercial banks.
Contractors Works availability	Operating at full capacity	Operating at low capacity
Owner financial capability	A significant portion of the annual budget on new buildings.	Deferment / Cancelled / Suspended new projects.
Payment	No payments delay	Payments delay
Project consideration Process	Lack of thoroughly planning. No consideration to life-cycle cost (operation and maintenance cost), the quality, and standards that fit the local environment.	The design phase is less rush resulting in consideration to life-cycle cost (operation and maintenance cost), the quality, and standards that fit the local environment.
Return on Investment (ROI) for contractor and Profit margins	Due to the low competition: high ROIs and high-profit margins.	Due to the high competition: low ROIs and low-profit margins.
Trust	Moderate trust environment	Low trust environment
Environment	Contractor-friendly Enough projects for most contractors	Aggressive competition among contractors (the purpose of survival and profitability).
Resources (Material, Labour, and Equipment)	High competition on resources by contractors. Low availability and high prices.	No competition on resources by contractors. High availability and low prices.
Fund Availability	High because of high advance payment and payment on time	Low because of no advance payment and payment delay.
Access to loans	High, banks consider the construction industry is not high risk	Low, banks consider the construction industry is high risk
Government expertise	Very low due to the construction boom.	Very high to construction bust.
Labour Skilled labour Availability/Price	Low availability High prices (Higher wages).	High availability Low prices (lowering wages).

Table 5: Boom- Bust cycle characteristics.

2.7.1 Contractors' Cost Estimation:

The client’s financial capacity has been found to be the most important factor affecting a Saudi contractors' decision to bid or not on a project (Bageis and Fortune, 2009) which could partly explain why contractors' still working with the government despite the harsh contract terms and payment delay. However, the study by Bageis and Fortune (2009) shows that the rest of other factors that affects bid/no bid decision differs depending on the contractors' size, classification status of the contractor and the primary client type.

In a Saudi public project, a contractor's bid is the accumulation of items provided in the project’s BOQ, with a contractor estimating a unit price for each item. The total cost of each item is the multiplication of an items' unit price and some units (Table 6).

Item (Items’ specification and description)	Number of Units (Provided by Owner)	Unit Price (Provided by Contractor)	Total Price (No. of item * Unit Price)
Item 1	*Integer number*	*In SAR*	*In SAR*
Item 2			
Item N			
Total Bid			In SAR

Table 6: Contractors’ cost estimation contents.

For contractors, cost estimating is the process of estimating the cost of resources needed to finish a project according to its plans and specifications (Yum, 2007). Contractors normally reach their estimation by accumulating base price, overhead, markup and contingency, and profit. Function-based cost estimating is an important element in the contractors bidding process, and provides a basis for the contractor to submit a tender price for a project (Akintoye and Fitzgerald, 2000). Base price is the cost of an item without including other surcharges such as an administering cost which includes the provision of general plant, site staff and site-based services. To mitigate projects’ risks and uncertainty, contractors add a contingency as the third component of the bid price.

In competitive bid environments (contractors chose based on lowest price), such as Saudi Arabia, a contractor's estimation needs to be low enough to allow the contractor to become the lowest bidder and profitable at the same time (Kim et al., 2008). In coping with this dilemma, the contractor will normally ensure that an appropriate cost estimate is determined with a fair markup. However, winning a project bid under such conditions is very difficult. Including the cost of all likely risk events in the tender will take contractors out of the competition. Thus, it is not unusual for contractors to underestimate their bid price to win the competition (Flyvbjerg et al., 2002). Beside tough competition, estimators are facing other issues such as unclear contract period, incomplete drawings and specifications, incomplete project scope definition, and unforeseeable change in material prices (Enshassi et al., 2005; T. et al., 2018). During the boom periods, it has been found that for Saudi contractors, providing detailed cost estimating is less critical compared to bust periods, as the high bid mark-up protects them against sensible estimate errors and misjudgements (Al-Harbi et al., 1994).

Although an item base price is the main component of accurate estimation, neglecting other surcharges could lead contractors out of business. Thus, an accurate estimation of a bid's markup, contingency, and overhead are essential for any contractors as they serve as a profit centre for the contractor (Chan and Pasquire, 2002). Contractors usually calculate markup cost and contingency costs relying on their experience and as a percentage of the base project cost. This does not reflect the possible ranges of cost variations in cost estimation (Molenaar, 2005; Nabil and El-Riyati, 2015). Furthermore, the unstable construction environment contributes to the difficulty that a contractor faces when deciding on the optimum level of these costs. However, different factors could define this percentage, such as payment regularity, number of on-going projects, inflation and regulation. This could explain why, in Saudi Arabia, contractors' markup and contingency (greater than 10%) are slightly higher compared to other countries (Assaf et al., 2001).

2.7.2 Contractors' performance:

For Saudi contractors, profitability is the most important factor that measures contractors' performance (Ali et al., 2013). In any construction industry, irresponsible and unqualified contractors are part of the industry. However, in Saudi's construction industry, the number of them could be higher, with one of the main reasons being that becoming a contractor is so easy with minimal financial requirements and no technical qualification or experience required, which could explain why less than 1% of contractors are classified. The absence of owners' evaluating of contractors whom they are going to work with, rather than choosing contractors on the lowest price, is another reason for poor contractor performance (Brahmin, 2012; Hanfi, 2012).

Mosley and Bubshait (2015) compared cost growth between local and international contractors in Saudi's construction industry and found that performance varies with project size. In projects costing less than USD 15 million, local contractors performed better by almost 3%, whereas in medium projects costing between USD 15-50 million both contractors performed almost the same, and in over USD 50 million projects international contractors performed 50% better compared to local contractors. Such a difference could be related to the low number of international contractors who are involved in small and medium contractor because of the level of competition. Lack of experience among local contractors could be another reason for the poor performance in large projects which are normally unique and complex. The study also shows that although the Saudi construction environment is unique, international contractors have delivered projects successfully.

Causes behind Saudi contractors' poor performance have been studied by Mosley and Bubshait (2015) who found that causes are more related to: management, poor cash flow, poor accounting systems and records, difficulties in attracting good personnel, dependency on a very limited customer base and lack of effective business plans. Similar results have been found by prior studies (Al-Barrak, 1993) and (Kivrak and Arslan, 2008).

2.8 Summary of literature review:

The Chapter highlighted and investigated the cost overrun issue and its causes. The literature shows that although the cost overrun has been investigated for over 30 years, the problem still exists. The research also highlighted that the current causes identification studies and articulated some of their general limitations. Based on that the research suggested to include the effects of the contexts that a construction project developed in (External Environment) and the process of developing a construction project which was neglected in the previous studies.

Although the construction industry considers being the second largest industry in Saudi Arabia financially after oil and the number of projects that are approved every year, the construction industry faces challenges in the Saudi public sector. Construction projects' performance in the Saudi public sector is inadequate. Research shows that 70% of the projects are delayed.

As the Saudi public sector is context of this study and guided by the four profiles (lenses) – Business, Economic, Laws and Regulation, and Resources -, this chapter also investigated and evaluated the Saudi public sector as a context of construction projects development and their effects on the construction industry in general and the contractor in specific. Moreover, and because of the limitation of the literature, the chapter also identified the gaps in these four profiles which need more investigation and their effects also need more investigation. This is a fundamental requirement for the new approach of investigating the causes of cost overrun. The literature shows that the Saudi public projects' poor performance seems to be a tag and not improved over the years. Although the contractors' capacity and capability have improved over the years as a result of the thousands of projects that they have been involved in, almost 70% of the projects are delivered delayed causing contractors' cost overrun.

Moreover, illustrating and evaluating the process and steps that are used to develop a construction project is another fundamental reequipment for the new way to investigate the cost. Bothe investigation will illustrate the weakness in the context and the process which generally are the trigger for, contribute to, or/and leading to a cause of contractors’ cost overrun.

Understanding the contractors' cost overrun in the Saudi public construction industry could also provide insights into other studies in another context similar to Saudi Arabia. The research will enrich the cost overrun and Saudi construction literature. However, the currently limited literature means investigating the limitation of the Saudi public context. Moreover, besides the benefits that contractors will gain from exploring the contractors’ cost overrun causes, the public sector will also benefit from such research. Reducing the number of abandoned projects is one of the examples of an area in which the public sector will benefit. As it has been found that one of the leading causes for projects abandoned in a study by Mac-Baranga (2017) is the bankruptcy of contractors, which is a result of cost increased from the contractor side.

Based on this literature, the following gaps have been identified:

- The current cost overrun causes literature need to be evaluated, and the primary schools of thoughts need to be articulated.
- Cost overrun causes have been investigated for over 30 years of research, however, the problem still existing which suggesting that: first, the current literature does not articulate and investigate the cost overrun causes properly, second, the global findings of an investigation of the cost overrun cannot be used of specific country, and third, further research is needed to alleviate and avoid cost overrun causes.
- A rethinking of the method of the identification of the causes of cost overrun id needed to overcome the current investigation of the causes of cost overrun such as:

    - Methodology: move from listing individual (standalone) causes list and ranking to develop. Identifying and measuring the effect of individual causes are not reflecting the reality, which leads to inadequate assessing and managing causes leading to cost overrun.
    - Context: the lack of including the effect of the context, and the process of developing the project during the identification of cost overrun.
    - Stakeholders: cost overrun problem commonly investigated from the owner viewpoints instead from other stakeholders such as contractor.
- To include the effect of the context and the process of developing the construction project, an investigation and deep understanding of the context and process is needed.
- The Saudi public sector and its effect on contractors' performance have been investigated neither understood.
- The process of developing a construction project in the Saudi public sector and its effect on contractors' performance have not been investigated.
- The lack of a developed model that illustrates the complexity and dynamic connection between those causes and cost overrun.

As the gaps have been identified the need for a new way into investigating the contractors' cost overrun and its causes, the next chapter will illustrate, discuss, and justify the research methodology that has been adopted for this research.

Chapter 3: Research Methodology:

3.1 Introduction:

In this chapter the research methods used to achieve the stated aims and objectives are discussed, justified, and presented. This includes research methods in construction projects in general, research philosophies, strategies, techniques and the procedure for data collection, research time horizon, research validity and reliability, and relevant research ethics.

3.2 Research and research methodology:

Research has been defined as a systematic technique of knowledge-finding that aims to answer questions and explore an issue and its practice (Tayie, 2005). Therefore, any research should focus on problems needing to be solved, knowledge and conclusions that can be reached, and how the research is to be conducted (the methodologies) (Fellows and Liu, 2015). Research methods is therefore defined as a combination of techniques which are used to investigate the research problem as well as reach a conclusion (Easterby-Smith et al., 2018).

To provide the best outputs, research needs to be guided by systematically designed processes that feed into each other (Yilmaz, 2013) which mainly depend on selecting the most appropriate research methods.

To achieve the aim of the research and to provide solid and high-quality research outputs, choosing an appropriate research method(s) is fundamental, and this requires a suitable research processes design. According to Frankfort-Nachmias et al. (2014), research design is considered as a roadmap for researchers that guides them in the process of collecting, analysing, and interpreting their research data and allows them, in most cases, to build inferences and causal relations among variables under investigation. Yin (2009) described it as a logical model which links research questions to the data that needs to be collected and ultimately to the research conclusion by identifying research questions and relevant data, informing data collection and data analysing mechanisms, and collecting and analysing the data to reach conclusions.

A number of research frameworks that could be followed to achieve the research aim and objectives include the nested model by Kagioglou et al. (1998) and the research onion by Saunders et al. (2009). In this research, the research onion (Figure 20) is most relevant and comprises the following layers: research philosophy, research approach, research strategy, research strategy choice, research time horizons and finally research techniques and procedures, where each step feeds into the next one. In this research, the same order will be used to clarify how the research questions will be answered. Saunders et al. (2009) framework has been chosen as it provides comprehensive instruction regarding research design and is a popular framework for construction projects management research.

To follow the same steps and with the research problem explained in chapter one, the following section provides a justification for the chosen research philosophy.

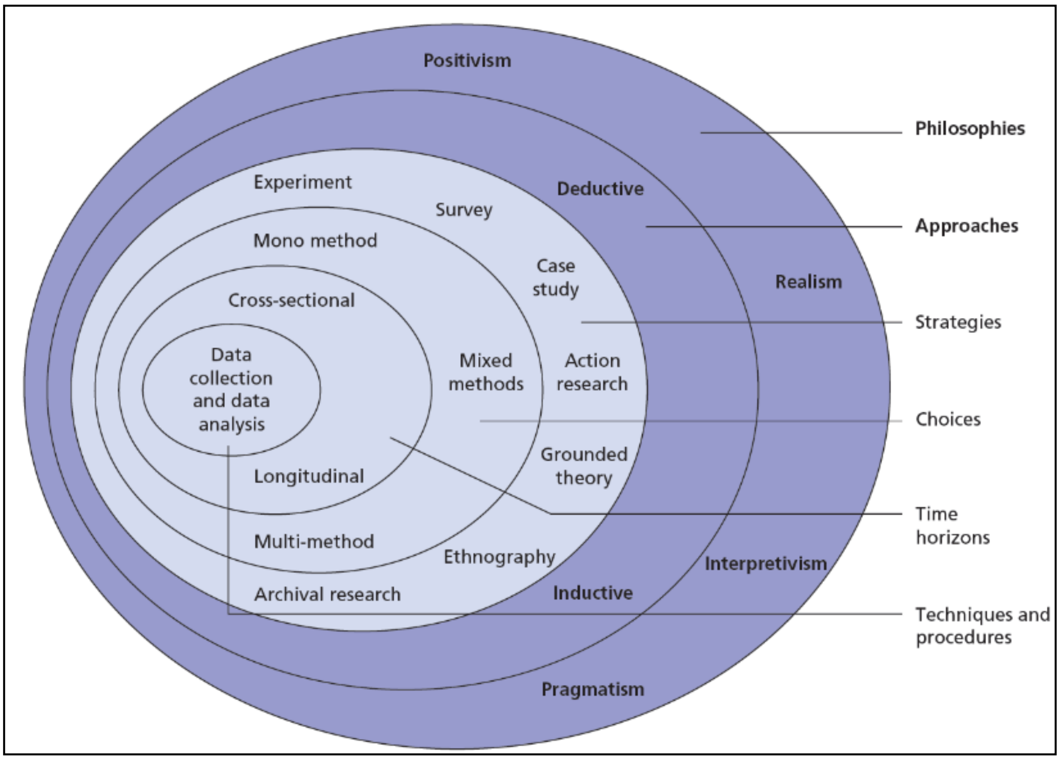

Figure 20: Research Onion.
Source: (Saunders et al., 2009).

3.3 Research Philosophy:

Selecting the appropriate research philosophy is essential for any study as the way of looking into reality, and the nature of the problem should guide the research methods (Johnson and Clark, 2006). In other words, a research philosophy dictates the relationship between a researcher and the research problem (Bryman, 1988) and will help clarify research designs and the making of best decisions about the research approach, strategy, data collection techniques and procedures to achieve the research aim and objectives. According to Saunders et al. (2009), different research philosophies comprise assumptions about the way that the researcher sees the world, including:

- the nature of reality, being and truth (ontology), how it can be understood (epistemology),
- the role of values in the enquiry (axiology), and
- the process that will be used for studying it (Lincoln and Guba, 1985).

Thus, initially, relevant terminology needs to be clarified.

Terminology	**Explanation**
Ontology	Ontology is a part of the research philosophy that concerns about the of nature reality (Tashakkori and Teddlie, 2003). The research objectives have a significant effect on choosing the reality form. The school of the thought that is adopted by a researcher has profound effects on any knowledge created from the research. Researchers are divided about nature reality into two main schools of thoughts. There are the objectivists who recognise the reality as it is driven by unchallengeable natural laws, on the other hand, there are the subjectivists who recognise the reality is driven by the actions and interactions of social actors.
Epistemology	Epistemology is a part of the research philosophy that concerns about whether and how valid contribution knowledge about reality is achieved (Bryman, 2012; Scheurich, 1997; Willis, 2007; Lincoln and Guba, 2000; Tashakkori and Teddlie, 1998). There are two main views about epistemology which are: positivist and interpretivist. For positivism researchers, the reality is illustrated by objects that are considered to be "real", for instance, the following objects considered to be real objects: computers and machines. Interpretivism describes the social phenomena as they have "no external reality", in their point view they cannot be seen, measured or modified like other objects such as computers and machines. They believe that the social world of business and management is far too complex to lend itself to theorising by definite 'laws' in the same way as the physical sciences.
Axiology	Axiology is the part of research philosophy which is related to how researchers see the value. Research could be value-free or value-laden research. In value-free research, the researcher and/or the research's respondent's feelings and past experiences have no contribution to the research (Hill, 1984). In value-laden research, the researcher and/or the research's respondent's feelings and past experiences have contributions to the research.

Table 7: Ontology, Epistemology, and Axiology explanations.
Sources: (Runeson and Skitmore, 2008; Saunders et al., 2009; Halloway, 1997; Khazanchi and Munkvold, 2003; Bryman, 2012; Scheurich, 1997; Willis, 2007; Lincoln and Guba, 2000; Tashakkori and Teddlie, 1998).

As Table 8 shows, three philosophical schools of thought have been identified; positivistic, post-positivistic (relativistic), and constructivist. In the next section, the research will select the research philosophy for each objective.

	Positivism/ post-positivism (relativism)	**Interpretivism/ constructivism**	**Pragmatism**
Ontology: *the researcher's view of the nature of reality or being*	External and objective (independent of social actors).	Socially constructed, subjective, multiple	Diverse viewpoints regarding reality. (Chosen to enable answering of research question best).
Epistemology: *the researcher's view regarding what constitutes acceptable knowledge*	The objective point of view. Focus on causality and law like generalisations.	The subjective point of view. Focus on the reality behind details situations.	Either or both objective and subjective viewpoints can provide adequate knowledge dependent upon the research question and stage of the research cycle.
Axiology: *the researcher's view of the role of values in research*	Value-free stand (researcher is independent of the data).	Value-Laden stand (researcher is part of what is being researched)	Values are essential in interpreting results (researcher adopting both objective and subjective points of view)
Research Approach	Deduction	Induction	Both deduction and induction
Data collection techniques most often used	Highly structured, large samples, measurement, quantitative, but can use qualitative	Small samples, in-depth investigations, qualitative	Mixed or multiple method designs, quantitative and qualitative

Table 8: Comparison of three research philosophies in management research. Source: (Saunders et al., 2009; Teddlie and Johnson, 2009; Johnson and Onwuegbuzie, 2004; Easterby-Smith et al., 2018).

In construction project management research, there is a debate regarding the most appropriate research philosophy and paradigm, with the primary debate being between Interpretivism/Constructivism supporters and Pragmatism supporters.

Key for the interpretivism supporters is that people are considered a fundamental part of construction management and therefore, aside from the researcher, affect the meaning of the research issue. Interpretivists believe the main focus should be towards the understanding of meaning and context, rather than Positivism's focus on establishing causal relationships and explanations (Rooke et al., 1997). Interpretivists support their argument by asserting that the main aim of construction management research is practitioner performance improvement through the developing of normative guides. This cannot be done without explicating the meaning to practitioners and developing performance improvement models that are more likely to be accepted first by practitioners.

Key for Pragmatism's supporters is that construction management research involves other knowledge areas such as law, economy, and engineering. Thus, such multi-disciplinary research needs combined Positivism and Interpretivism philosophies. Furthermore, the nature of construction management research makes the Pragmatism philosophy the most appropriate basis for construction management research as different philosophies serve different objects and disciplines. However, this philosophy has been criticised by Positivists and Interpretivists who believe that Pragmatism could lead to a degeneration of rigour through its opening of space for "evading definable standards" (Runeson and Skitmore, 2008; Rooke et al., 1997).

Regarding the investigating of the causality of cost overrun, previous studies such as Al-Agele and Al-Hassan (2016) adopt the positivism philosophical standpoint. In these studies, researchers believe that the problem under investigation (cost overrun) is not constructed within the realm of the context. By adopting objective points view, studies try to link (build a relationship) between the stand-alone causes and cost overrun using quantitative data and correlational analysis. In these studies, research does not differentiate between the correlation and causality which is, according to Ahiaga-Dagbui et al. (2015), a common misunderstanding and misuse by researchers in the mistaken belief that because data shows a correlation there is necessarily an underlying causal relationship. This misunderstanding could be one reason behind the lack of improvement in understanding cost performance, even though the problem has been investigated for over 30 years. As the previous studies show poor understanding of project systematicity and lack of demonstrable causality of cost overrun, it is argued here that a positivism philosophy is not the optimum choice to achieve the aim of this research.

Although the ontological, epistemological, and axiological stands for this research lean towards the Interpretivism/constructivism philosophy, the research will adopt the pragmatism research philosophy. The reason that a pragmatism research sidesteps the contentious issues of truth and reality and focuses instead on what works as the truth regarding the research questions under investigation. In that sense, pragmatism rejects a position between the two opposing viewpoints. As it has mentioned earlier that the research aim and objectives are the main factors that affect choosing the research philosophy for any research besides other factors such as the type(s) of data and its availability. For this research, it aims to develop contractors' cost overrun causality model in the Saudi public sector that considers the effects of context and the practices and processes of developing construction projects. Such an aim needs to investigate different aspects of the context (in this research four profiles are used) and identify their weakness (factors) that could lead to contractors' cost overrun. The evaluation and identification cross different knowledge areas such as social, law, and economy. Moreover, the management and business knowledge areas as the practices and processes will be evaluated which mainly based on management theories. Nevertheless, as this research adopts the contractors' point of view and considers it as an organisation that contracts with another organisation (public sector), there is a need to consider relevant organisation theories. The multi-disciplinary research needs the Pragmatism philosophy which combines Positivism and Interpretivism philosophies as different philosophies serve different objects and disciplines. The research will also develop causality paths that are contain different causes that originated from different disciplines such as: economy, social, human behaviour and technical.

Researchers propose that the science of project management differs from the natural and social sciences such as biology and sociology (Shehu and Akintoye, 2009). Briefly, a researcher contend that project management is not only a scientific discipline; it is also a professional discipline (practice). In this perspective, theories of project management should in some way be relevant to professional practice. Like other scientific disciplines, such as engineering, clinical psychology, the nursing sciences, education, and architecture, which are fuelled by professional practice, the project management field attempts to develop a body of knowledge that is transferable to management skills, thereby advancing the practice.

The researcher has concluded that the Pragmatism philosophy, due to being between the positivism and interpretivism philosophies and adopting both the subjective and objective points' of views, fits this research more than other research philosophies. In addition, it provides a framework that focuses on different aspects which are human-related; construction project management is a multi-disciplinary field, and the research aims to improve that field by developing a framework (Korte and Mercurio, 2017). The philosophy allows a researcher to use the most suitable philosophy for researching an objective; another philosophy can be adopted if its use is justified (Jabareen, 2009) and use a triangulation data mechanism will be used to achieve some of the objectives, which will need multi-analysis techniques; only pragmatism provides that (Morgan, 2014).

3.4 The research approach:

Figure 20 shows the research approach as being the second layer of the research onion which is defined by Walliman (2005) as "a method of coming to conclusions by the use of logical argument”. Three approaches are recognised: deduction, induction, and abductive. The deductive approach concerns designing a research strategy to test a theory or hypothesis, while the inductive approach concerns are collecting data and analysis leading to the development of a theory. Table 9 shows the differences between deductive and inductive approaches, in addition to which it can be argued that “deduction owes more to positivism and induction to interpretivism” (Saunders et al., 2009).

Research projects that adopt an induction approach are considered generally to be better at providing understanding of the problem. Thus, a small sample of subjects might be more appropriate than a large number, as with the deductive approach. According to Easterby-Smith et al. (2008b) research projects that adopt the induction approach are more likely to work with qualitative data and to use a variety of methods to collect these data in order to establish different views of phenomena and build a hypothesis. On the other hand, the deductive approach commonly uses quantitative data in order to test and validate a hypothesis (Bryman, 1988).

Both approaches have negatives:

- The deductive approach can handle only particular types of statement and is separated from observation and experience; hence, it can be limiting. Moreover, it was criticised for the lack of clarity in terms of how to select theory to be tested via formulating hypotheses
- The inductive approach has been described as unmanageable and haphazard. Hence, it is rarely applied in practice. Also, it was criticised because no amount of empirical data will necessarily enable theory-building.

Integrating both approaches (so as to be abductive) is set to address the limitations of inductive and deductive approaches and this is normally adopted with the pragmatism philosophy which forms a strong base for knowledge progress from Walliman (2005) perspective. Figure 21 below illustrates the reasoning differences between the main three approaches.

When selecting the type of research philosophy to adopt, investigation nature and data availability are the main factors that affect the choice, but it is also essential that the problem under investigation, any concepts, assumptions and limitations are also clearly defined.

Deduction emphasises	Induction emphasises
• Scientific principles • Moving from theory to data • The need to explain causal relationships between variables • The collection of quantitative data • The application of controls to ensure the validity of data • The operationalisation of concepts to ensure clarity of definition • A highly structured approach • Researcher independence of what is being researched • The necessity to select samples of sufficient size	• Gaining an understanding of the meaning's humans attach to events • A close understanding of the research context • The collection of qualitative data • A more flexible structure to permit changes of research emphasis as the research progresses • A realisation that the researcher is part of the research process • Less concern with the need to generalise

Table 9: Major differences between deductive and inductive approaches.

For the problem under investigation (cost overrun causality), previous studies Adafin et al. (2016); and Al-Agele and Al-Hassan (2016) typically have adopted a deductive approach. The studies first create a list of causes using literature reviews and/or interviews and then measure the correlation of theses causes to the cost overrun before ranking them based on their correlation. Researchers in these studies seek to test their theories (hypothesis) quantitatively. However, such an approach has been criticised by recent studies as it is not the optimum approach to investigate the nature of cost overrun causality. According to Ahiaga-Dagbui et al. (2015) merely identifying and listing factors that may contribute to a cost overrun and testing their correlation does not provide evidence of causation and the ability to draw conclusions about the underlying dynamics that lead to their occurrence. Moreover, literature reviewed lacks a model that investigates the cost overrun and considers the effects of the context and process of developing construction projects (see section 1.2). Thus, a new model needs to be built to consider previous studies, which is the aim of this research. Based on that, a deductive approach is not the optimum research approach to achieve the research aim and objectives.

This research adopts an abductive approach, as the study aims to build a causality model that represents the contractors' cost overrun in the Saudi Arabian public projects context. The resultant model will provide explanation of the nature of causality; current theories do not explain the nature of this causality nor recognise the effects of the context, or the practices of developing construction projects. As the research scope is limited to four profiles (lenses) only (Economic, Business Environment, Resources, and Regulation) which are not claimed to represent the entirety of context profiles, and so are considered incomplete observations representing only the external environment part of context. Moreover, the model is the best explanation of the contractors’ cost overrun causality rather than a full complete theory. The limitations of the study are related to the data availability as explained in sections (1.5 and 1.6).

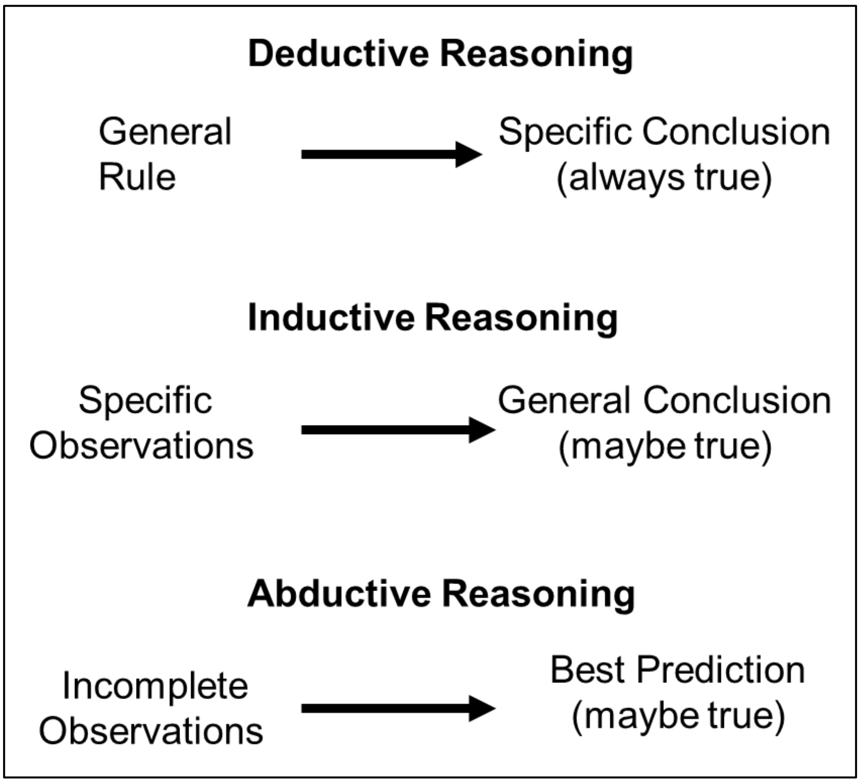

Figure 21: Reasoning difference between the three approaches.

To build the model, an understanding of contractors' cost overrun cause mechanisms and how these develop from a very early stage of projects is needed. As such, any investigation requires to understand the context that a project is developed in, as well as the causes of contractors' cost overrun in other contexts. The research process starts with observations of the context (based on the four profiles) and of the practises used to develop projects. Links between the observations and the problem under investigation have been conducted which result in building of causality paths. These paths are considered the backbone of the model explaining the contractors’ cost overrun in the Saudi Arabian public projects context. The research approach decision then leads to the next layer of the research onion, which is the research strategy.

3.5 The research strategy:

The research strategy is a part of the research design which can be defined as a general plan including how the researcher will answer the research questions (Saunders et al., 2009). It is related to the fundamental process of collecting and analysing data. The academic literature shows different types of research strategies; for construction project management research, the following types are typically used:

- Experiments.
- Surveys.
- Ethnography.
- Action Research.
- Case Studies.
- Literature Review.

3.5.1 Experiment:

The experiment was defined by Jupp (2006) as "a research design used to draw causal inferences regarding the impact of a treatment variable on an outcome". The experiment is used to study causal links; in other words, it studies the possibility of a change in an independent variable creating a change in another dependent variable (Creswell, 2009). Such a strategy requires a controlled environment; therefore it is not considered the most suitable strategy for management and business studies (Creswell, 2009).

3.5.2 Surveys:

The survey is a research strategy that can test a social phenomenon for large populations using a sample of that population so as to justify a reasonable inference and then draw a general conclusion about some characteristic(s) or behaviour(s) of a large population. It should be mentioned that a survey strategy needs a relatively large representative sample (Babbie, 2011; Fellows and Liu, 2008) of the targeted population, and uses questionnaires or interviews to draw general results to the larger population (targeted population) (Crabtree and Miller, 1999; Creswell, 2009; Fellows and Liu, 2008). Quantitative and qualitative data can be collected when using a survey as the research strategy (De Vaus, 2002) therefore allowing quantitative data, for example, to be used to measure relationships between variables and to test models of these relationships. According to Saunders et al. (2009), the survey strategy is widely used in management and business research. Additionally, it is usually used to answer *how much, how many, who, where,* and *what* types of questions.

3.5.3 Action Research:

Action research can be defined as the process of finding solutions for an organisation's problem by the organisation's members (Eden and Huxham, 1996; Punch, 2005; Fellows and Liu, 2008). McCutcheon and Jung (1990) describe action research as “systematic inquiry that is collective, collaborative, self-reflective, critical and undertaken by the participants of the inquiry”, whose aim to understand and articulate the practice to improve it. Bryman and Bell (2007) believe that researchers should be a part of the contributing organisation to understand the problem and the process being studied fully. Additionally, generalisation is another limitation as this strategy is focused on a single organisation.

3.5.4 Case Study:

The case study is a strategy focused on a single or more ‘case’ (Tesch, 1990). As with other strategies, it could be conducted alone or in combination with another strategy to give it strength (Yin, 2003; Stake, 1995).

Case studies are valuable in determining a knowledge base of different individual, organisational, social and political phenomena, often with a real-life context (Yin, 2009), and are particularly helpful in any research related to human aspects (Gillham, 2000). In case studies, the researcher explores in depth a programme, event, activity, process (Creswell, 2009) and multiple sources of evidence are often utilised, allowing the researcher to examine a wide body of knowledge. Case study research also has the benefit of providing a tool for description and explanation of a variety of real-life phenomenon (Fellows and Liu, 2008; Yin, 2009) and can be quantitative or qualitative in nature. This form of research seeks to generate answers to questions such as ‘*what*’, ‘*why*’ and ‘*how*’ (Yin, 2009).

3.5.5 Literature review:

The literature review is established as an essential research strategy and a vital step for any research. It comprises the reviewing of available material relating a specific topic or field, typically carried out by other researchers, and usually containing evidence that could be used to develop the current research (Hart, 2018). To improve the quality of the strategy outputs, different guides have been developed to be followed by researchers (Cooper, 1998).

A general purpose literature review is used to identify the knowledge gap(s) as well as a research aim, objectives, and questions (Eisenhardt and Graebner, 2007). Additionally, it is used to develop new ideas for the existing literature, assess and evaluate the literature, and develop concepts and frameworks (Saunders et al., 2015; Whittemore and Knafl, 2005).

There are different types of literature review:

- Background literature review,

- Integrated literature review,
- Systematic review,
- Meta-analysis, and
- Qualitative reviews (Whittemore and Knafl, 2005).

Although all types need a clear research statement before starting, the width and depth of the target literature are some of the factors that differentiate between the types. For example, the target literature of the integrated literature review is broad and less deep compared to the systematic review, which reviews a more specific topic in-depth.

Systematic reviews, meta-analyses (for quantitative data), and meta-synthesis (for qualitative data) are combining the outputs of multiple resources after these resources had been evaluated (Whittemore and Knafl, 2005). Thus, the results of these literature review types are beyond reporting only as it allows comparison and synthesis of the results and conclusions of different resources.

In contrast to the integrated review, the systematic reviews and meta-analyses synthesise results from studies that use similar variables and methodologies. Such methods have been found useful to improve the generalisation of qualitative research (Whittemore and Knafl, 2005).

3.5.6 Ethnography:

Ethnography is two Greek words combined ‘ethnos’ meaning people and ‘graph’ meaning describe (Punch, 2005). It is the process of making notes and writing up about daily life group activities as part of studying people’s lives or culture (Patton, 2002; Bryman and Bell, 2007). This requires the involvement of the researcher in the daily process of the contributing organisation to get full insights (Bryman and Bell, 2007; Fellows and Liu, 2008) which might not suit an outsider researcher.

3.5.7 Adopted research strategy:

It has previously been noted that the research aim, objectives and questions all affect the choice of research philosophy, and have a strong effect on choosing a research strategy. Thus, the clarity of a research problem is vital in choosing the most appropriate research strategies as they underpin the nature of the enquiry.

As presented in Chapter One, the major objectives of this research are exploring and evaluating the commercial context of the Saudi public construction projects procurement, establishing the link between the commercial context of the Saudi public construction projects procurement and contractors' performance, with the aim of developing a causal model to explain contractors’ cost overrun. These objectives, at a general level, call for descriptive explorations and an explanatory investigation of the nature of the Saudi construction industry environment, as well as of the public project delivery practice to establish interdependency and causal links leading to contractor cost overrun.

All of the above research strategies have been analysed for appropriateness to achieve the research objectives, as some of the strategies are more suitable than others. The sensitivity of the research strategies to the research objectives also has been analysed, with one key factor being that the strategy artefacts do not hinder phenomenon trait reflection on the research output, as suggested by Jick (1979).

As a result, experiment, action research, survey, and ethnography have been eliminated as appropriate research strategies on the basis of:

- **Experiment**. The nature of the construction project management field, which involves people, as well as the project environment which does not allow the control of only one variable within the construction industry so as to measure its effect(s) on other variables.
- **Action research**. The study must be conducted on more than one contractor for the sake of generalisation. Furthermore, the researcher is not a part of any of the construction contractor organisations working with the Saudi public sectors.
- **Ethnography.** The researcher will not be able to be involved in any of the contractor’s daily processes.

Table 10 shows methodologies that have been used by previous studies seeking to identify the cost overrun causality. As discussed earlier (research philosophy and approach), previous studies mainly tr to build a theoretical model then test its correlation to cost overrun using quantitative data. As such a research design needs a large population and the main research strategy that has been used is the survey. Such a strategy is usually used to answer how much, how many, who, and where types of questions which are not related to the research question, objectives, nor aim. As explained earlier, previous studies do not tackle the aspect of cost overrun causality and suggesting a rethinking in the method of identifying the causes of cost overrun by using a new research strategy that seeks to measure the correlation with stand-alone causes cannot give a deep understanding to the cost overrun causality problem and does not illustrate the complexity and dynamic connection between those causes and cost overrun. For the Saudi public context in specific, survey strategy has been used to investigate the causality of project delay in (Shash and Abdul-Hadi, 1992) and (Assaf and Al-Hejji, 2006). Researchers measures the correlation between the causes and projects delay. However, the studies do not achieve their goal in identifying the real and root causes of delay and projects in the Saudi public sector still suffer lengthy delay (Mhamed et al., 2018).

Study	**Country**	**Methodology**
(Memon et al., 2012)	Malaysia	Preliminary study (interview). Analysis 97 questionnaire survey.
(Ameh et al., 2010)	Nigeria	Identified factors from the existing literature. Analysis 53 questionnaire survey.
(Durdyev et al., 2012)	Turkey	Identified factors from the existing literature. Analysis 79 questionnaire survey.
(Azhar et al., 2008b)	Pakistan	Identified factors from the existing literature. Analysis 24 questionnaire survey.
(Rosenfeld, 2013)	Israel	Identified root factors from the existing literature and from local experts. Analysis 195 questionnaire survey.
(Allahaim and Liu, 2015)	Saudi Arabia	Identified factors from the existing literature. Analysis 160 questionnaire survey.
(Koushki et al., 2005)	Kuwait	Identified factors from the existing literature. Analysis 450 personal interview survey.
(Enshassi et al., 2009)	Gaza Strip	Identified factors from literature review, personal interviews. Analysis 66 questionnaire survey.
(Jackson, 2002)	UK	Analysis 141 open-ended questionnaire.
(Kaming et al., 1997a)	Indonesia	Identified factors from literature review. Analysis 31 questionnaire survey.
(Alinaitwe et al., 2013)	Uganda	Identified factors using interviews. Analysis 247 questionnaire survey.
(Baloyi and Bekker, 2011)	South Africa	Identified factors from the existing literature. Analysis 22 questionnaire survey.
(Mansfield et al., 1994)	Nigeria	Identified factors from the existing literature. Analysis 37 questionnaire survey.
(Frimpong et al., 2003)	Ghana	Identified factors from the existing literature. Analysis 72 questionnaire survey.

Table 10: Previous studies research strategies.

As it has been explained earlier in this section, case study is considered one of the best strategies to investigate deeply and provide a deep understanding of the cost overrun causality, so as to allow the researcher to examine a wide body of knowledge (required for this study). Moreover, case study has the benefit of providing for description and explanation of a variety of mechanisms of the causality, and also establishing the links between the context and process in one hand and the cost overrun in the other hand. The strategy also captures the complexity and dynamism within the process of delivering Saudi public-sector projects and provides analytical generalisation. Nevertheless, another reason to choose this strategy is its ability to be tailored to context (Yin, 2003). Thus, the strategy will enable contextualisation of the construction processes adopted, and the weaknesses of the process under which they are experienced.

As not all the causes are context and process related, the research needs to include other possible causes to the causes pool and link them to the context and eventually to cost overrun. For this, a systematic literature review is considered the best strategy as it allows the researcher to include all the previous studies that have investigated cost overrun causality. Based on that, the main strategies which have been selected are systematic literature review and case study. One of the main advantages of the systematic literature review is its flexibility; it could be used to report only and/or go beyond reporting and allows for synthesising the outputs and conclusions of multiple resources.

3.6 Research Design:

In this research, the main idea behind developing a research design is to clarify the rationale and logical tie between the research's problem, questions, and adopted data collecting and analysis tools (Checkland and Holwell, 1998). Moreover, the research design will help the researcher to collect and analyse the important data that is related to the research problem and avoid any irrelevant data. In other words, the research design is an assuredness tool that the data (evidence) collected are related to the research questions and link between the research problem, findings, and conclusions. It goes without saying that in order to collect the right data the right questions must be asked which could reflect the importance of the research design on the reliability and validity of the research. Regardless of the adopted research strategy, the research design will increase quality and the trustworthiness of the research outputs. In this section, the research design for the SLR and case study will be presented a general view are presented in Figure 22.

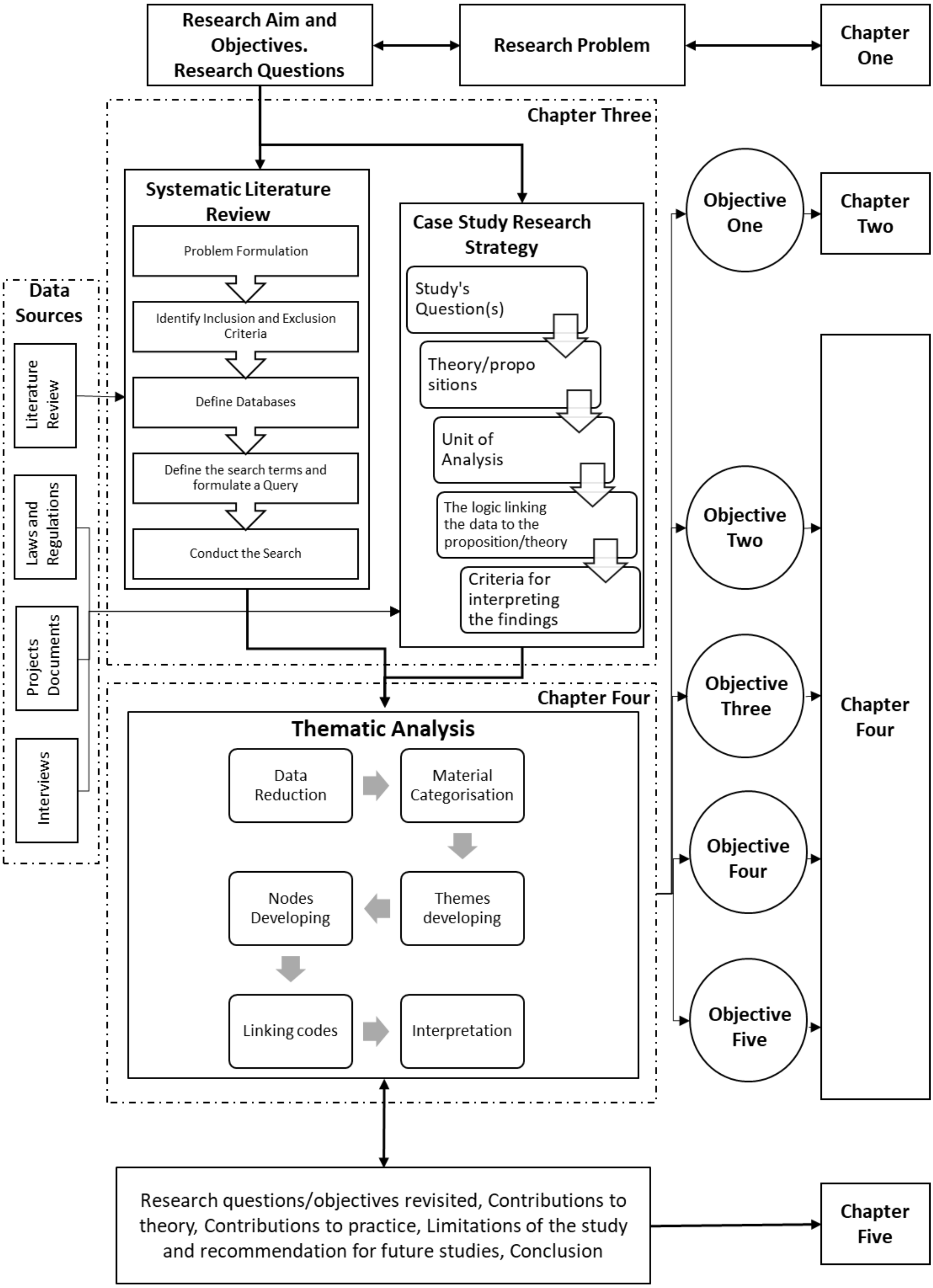

Figure 22: Research Design.

3.6.1 Systematic Literature Review Research Design:

According to Okoli and Schabram (2010) reviews of research literature are conducted for a variety of purposes:

- Providing a theoretical background for subsequent research;
- Learning the breadth of research on a topic of interest;
- Answering practical questions by understanding what existing research has to say on the matter.

Different types of literature review have been identified (Kitchenham et al., 2009; Hart, 2018; Brereton et al., 2007; Okoli and Schabram, 2010), with the degree of rigour being one the main features differentiating them. This also links to the depth and breadth of the literature review. For example, two types of literature review were used in this research; *narrative* or simple literature review (generally used to build a background about the subject being investigated), and the *Systematic Literature Review* (SLR), defined by Fink (2005) as "a systematic, explicit, and reproducible method for identifying, evaluating, and synthesising the existing body of completed and recorded work produced by researchers, scholars, and practitioners". The first type was used for each objective during the early stage of research where a context is needed (less depth, more breadth). As a research objective was found to need more in-depth investigation, SLR is used (more depth, less breadth). It is worth mentioning that the research objective clarity affects the breadth of the literature review.

At the beginning of the research, a narrative literature review was conducted regarding the context of Saudi public projects and cost overrun. After the research statement and purpose became clearer, the literature search was directed by keywords in relevant databases and other sources using inclusion and exclusion criteria to maintain the focus of the search. This evidences the importance of the narrative literature review and its difference from SLR; it allows the inclusion of multiple methodologies to capture the context, processes, and subjective elements of studies addressing a problem (Whittemore and Knafl, 2005).

Systematic Literature Review (SLR) is the second data gathering technique for this research which was used with other techniques to achieve mainly Objectives One, Two, Three, and Four. In this method, a researcher collects data from resources authored by others. Gill and Johnson (2010) criticise the focus of such technique on the descriptive aspect of the previous literature rather than assessing the narrative’s quality, strength and source of data. To overcome these drawbacks and enhance the scientific process of the reviews (Evans, 2002), the researcher identified inclusion and exclusion criteria to assess the quality of data. A variety of guides relevant to this are available (Davis and Parker, 1997; Rowley and Slack, 2004; Fink, 2005). Planning, Selection, Extraction, and Execution are the main heading steps followed in all guides, although there are slight differences between the guidance in the number and naming of the sub-steps. Generally, the main steps are presented in Table 11.

Step No.	**Name**	**Description**
First step	*Formulating the problem*:	The researcher needs to identify the purpose of the review and the problem under investigation.
Second step	*Building a detailed protocol*:	The protocol will be built which includes defining the search terms, defining Inclusion and Exclusion Criteria, and identifying the databases that the research will utilise.
Third Step	*Perform the search*:	The search will be conducted on the databases using the terms which have been identified in the previous step.
Fourth Step	*Evaluate* (Quality appraisal):	The researcher will use the Inclusion and Exclusion Criteria, which are identified in Step Two, to identify the resources needed for the next step. The final resources normally will be analysed based on different factors such as the year of publication, type of the study, methodology ...etc.
Fifth Step	*Extraction and Analyses*:	The applicable information will be identified for the resources required, and then analysed and combined using different techniques depending on the type of data.
Sixth Step	*Writing the review*:	The output of the previous steps will be written-up and documented following research standard principles and including enough details that the SLR process can be independently reproduced.

Table 11: SLR steps.

In SLR, the qualitative data are normally evaluated using approaches that code studies and data based on factors such as the methods of studies, theoretical basis, and relevance of the data reported (Fisch and Block, 2018). SLR has been used successfully in construction project management research, e.g.(Viana et al., 2012; Chai et al., 2013); (Sun and Meng, 2009), and (Roehrich et al., 2014). However, none of the databases provided evidence that SLR has been used in the context of Objectives One, Two, Three, and Four.

Reasons for choosing literature review as a research method and SLR as a data collecting technique for achieving (fully or partly) Objective One, Two, Three, and Four, which were originated from either the nature of the method itself or from the nature of the objectives, were:

- To expand knowledge of a search on practices of delivering projects and contractors' cost overrun in Saudi Arabia which allows the researcher to identify and analyse the current state of knowledge on a topic.
- Less bias within a literature review: SLR resources are selected depending on a scientific selection process.
- Providing a deep understanding and yielding truths: The analysing of and combining between outputs of different resources will provide a deep understanding of the issue under investigation. Moreover, the different research methods, samples, and outputs across studies will expand the understanding of the researcher about the issue under investigation and identify the theoretical background of the current research.
- Less severe constraints: the issues that constrain other research methods, which generally relate to sample, time and money, are less severe for SLR.
- The complex nature of the topics under investigation, which are: practices of delivering projects and contractors' cost overrun.
- The nature of the current researches on practices of delivering projects and contractors' cost overrun are repetitive of, rather than built on, previous work.

3.6.1.1 Step One: Formulating a problem:

In order to identify data which will be used in SLR analysis, primary research on a topic must exist before synthesis can be conducted. This could be done by formulating review questions using the following factors: Population, Interest, and Context (PIC). Table 12 shows the first step for the objectives.

PIC feature	**Objective One and Two**	**Objectives Three and Four**
Population	Nature and weaknesses	Nature and Causes
Phenomena of interest	Process and practices of project delivery	Contractors' cost overrun
Context	Saudi public projects	Construction projects
The research question	What are the process and practices that are used to deliver a project in the Saudi public sector?	What is the nature and causes of contractors' cost overrun in construction projects?

Table 12: Formulating a problem for objectives.

3.6.1.2 Step Two: Building a detailed protocol:

To build a SLR protocol, the inclusion and exclusion criteria, databases, and the search terms and query need to be identified. The research identified the three requirements discussed under three sub-heading below.

Identify Inclusion and Exclusion Criteria:

Table 13 and Table 14 explain and identify the exclusion and inclusion criteria to be conducted on the two reviews relevant to Objectives One, Two, Three, and Four.

Criteria	**Explanation**
Source Type	Academic Journal and conference proceedings - a good representation of the breadth and depth of research achievements and they usually have been scrutinised through a peer-review process.
Published	Wither it is primary, secondary, reference, or literature materials.
Peer-reviewed	A peer-reviewed published study normally means that the study is: A research's question(s), method(s) are clearly stated. A research's approach, data collection, sampling, and analysing method are appropriate and have been described. Research claims are supported by sufficient evidence.
Sources location	In recent years, most academic journals began to provide online access. The emergence of some publication index databases has dramatically assisted the literature search task. As for the date of publication, no explicit restriction was set. However, a small number of pre-90s publications are covered by online databases. Thus, the number of papers could be small compared to recent years.
Language	In English or Arabic Languages; the researcher is fluent in these languages. It would be beyond the researcher's ability to include resources in other languages. Moreover, technical translation such as Google translation is limited and not accurate.
Aim	Cost overrun issue is well known in the construction industry and could be a result of other issues within the industry such as change order, labour, or financial issues. Thus, the researcher decided to include only the studies that aim to investigate, identify, or understand the causes of cost overrun. Some of the studies focus on the effect(s) of cost overrun. Such a decision excluded papers on cost management systems, methods, and techniques from the review.
Project type	As this study focuses on construction projects, the study of cost overrun in construction projects will be included.
Owner type	The owner could be public or private.
Project lifecycle level	Project lifecycle level only, as the contractor is generally involved in the late stage of the project life cycle. There is a large body of literature on cost overrun at a business or organisational level. These are also excluded unless they also discuss implications at the project level.

Table 13: Explanation of the inclusion and exclusion criteria.

Criteria	Included	Excluded
Type	Academic Journal and conference proceedings.	Other types of resources.
Published	Published resources.	Unpublished resources.
Peer-reviewed	Peer-reviewed resources only.	Not Peer-reviewed resources.
Sources location	Online.	Offline.
Language	Resources in Arabic and English Languages.	Resources in other languages.
Geographical location (Objective 1 and 2)	Saudi Arabia	Other geographical location
Research aim (Objective 1 and 2)	Resources that aim to evaluate, investigate the process and practices of developing a public construction project.	Resources that not aim to evaluate, investigate the process and practices of developing a public construction project.
Research aim (Objective 3 and 4)	Resources that aim to investigate, identify, understand the causes of cost overrun. Some of the studies effect of cost overrun.	Resources that are not aiming to identify, understand the causes of cost overrun.
Projects type	Construction projects only.	Other types of projects.
Procurement type	Traditional (Design-Bid-Build) (DBB).	Other types of procurements.
Owner type	Public projects, governmental owner.	Other owner's types.
Project life cycle level	Project level.	Business and Organisational levels.

Table 14: Inclusion and exclusion criteria.

Some of the criteria have been excluded,and the reasons are given in Table 15:

Criteria	Explanation
Geographical location (Objective 3 and 4)	No restriction was set. It has been found from other studies that the causes of cost overrun are different from a region to another. If the location was set as a criterion, then the causes identified will be limited to that geographical location.
Duration	No restriction was set. However, a small number of publications are allowing search on pre-90s sources on their online databases which is going to effect on the number of papers identified for that period is very small.
Rating	The quality of the studies is varied. However, the criteria that are used to rate the quality is more subjective, especially for qualitative study. There is a lack of guidance that could be used to build quality criteria within the construction project management research. Thus, the researcher decided not excluded the less quality studies as long as they are empirical studies and been peer-reviewed. The main reasons to include these studies that they are from a different context (country, type or/and size of the project, and data sources) which usually results in different outputs from other studies. Thus, excluding this type of studies will decrease the number of causes, classification, and the understanding of cost overrun.

Table 15: Excluded criteria.

Define Databases:

Literature sources search engine can be divided into a journal search engine and a database search engine. Journal search engines usually are limited to one or a few numbers of journals which generally share the same field, while a database search engine searches within a more significant number of journals. Although several systematic review studies in the field of construction project management identify a specific number of journals to search within (the studies), the researcher decided to search within relevant databases rather than use a journal-specific search engine. This decision was taken to reduce the bias within a chosen literature review, as well as gain access to other resources outside these journals. The following databases (Table 16) have been recommended by library staff at the Robert Gordon University and been recommended by other educational bodies that provide construction project management courses:

Database	**Years Access**	**Limitations**
ABI Complete (ABI Global)	All Years	No Limitations.
Business Source Premier	All Years	No Limitations.
Science Direct – Elsevier	All Years	No Limitations.
SAGE journals	All Years	No Limitations.
Emerald	All Years	No Limitations.
Wiley online library	All Years	No Limitations.
Scopus – Elsevier	All Years	No Limitations.
Institution of Civil Engineers Digital Library	All Years	Limited support to advance search.
IEEE EXplorer Digital Library	All Years	Limited support to advance search.
Springer Link	All Years	Limited support to advance search.
Taylor and Francis Online	All Years	Limited support to advance search.
Engineering Village	None	No access to the database.
Construction information service	None	No access to the database.

Table 16: SLR Databases.

Multiple index databases were used to ensure that no significant sources were missed, even though there are considerable overlaps between different databases.

Define the search terms and formulate a Query:

After the process has been investigated and illustrated (as a result of achieving Objective One), Objective Two adopted SLR alongside interviews as data gathering techniques. The literature review regarding Saudi construction projects and the nature of the Saudi construction industry has been gathered. Achieving the first objective produces indicators for the selection of keywords for the primary key weaknesses of the current practices in delivering public construction projects in Saudi Arabia. However, because of the limited number of publications about Saudi construction project delivering practices, the researcher decided to use general keywords to cover more publications about Saudi construction projects. The keywords used are “construction projects in Saudi Arabia”.

As the researcher is attempting to identify all or most of the relevant literature, a search query needed to be constructed/formulated based on the aim of the systematic literature review using the keyword terms. The sources of the keyword terms are: Contractor, Causes, Cost, Overrun, and Construction. Using both an English language dictionary and a specialised dictionary (online Oxford dictionary of construction, surveying and civil engineering).

The keywords’ synonyms identified from the main question are in Table 17. Moreover, the related terms and words are identified (Table 18) by using one of the oldest controlled vocabularies which is provided by the United States Library of Congress (Library of Congress, 2019).

It should be mentioned that some of the controlled vocabularies/thesauri do not recognise the term *cost overrun* such as the UK Archival Thesaurus (UKAT) (UKAT, 2019). However, using the hierarchy browsing, the only controlled word(s) that have been identified which relate to cost under the Main Thesaurus (civil, military and mining engineering) are "Building costs".

Keywords	Synonyms
Contractor	Contractor OR Main contractor OR Constructor
Causes	Cause, root cause, factor, reason, Source, Root, origin plural phrases will be much less competitive
Cost	cost OR budget OR price OR tender OR bid
Overrun	over-run OR overrun OR increase OR performance OR exceed OR run over
Construction	construction OR infrastructure OR building OR project

Table 17: Keywords' Synonyms.
Sources: (Gorse et al., 2012), (Dictionary, 1997), and (Harris, 2006).

Controlled Vocabularies/Thesauri	**Related Terms/ Narrower Term**
Cost overrun	Construction costs, Contracts, Cost accounting, Cost effectiveness, and Production control
Contractors	Government contractors, Subcontractors, and Employee leasing
Construction	Building construction, and Engineering

Table 18: Controlled Vocabularies and Related Terms.

3.6.1.3 Step Three. Conduct the Search:

First attempt:

As a result of step two, the first search enquiry attempt is:

((Contractor OR Main contractor OR Constructor) AND (Causes OR cause OR root causes OR factor OR reason OR Source OR Root OR origin) AND (cost OR budget OR price OR tender OR bid) AND (over-run OR overrun OR increase OR performance OR exceed OR run over) AND (construction OR infrastructure OR building OR project))

Use of more than one database or resource (including the Web) as illustrated in Table 19.

Database	**Number of search results (Basic search) (Anywhere)**	**Number of search results (Advance Search)**
ABI Complete (ABI Global)	20,817 (Peer-reviewed inactivated). 4,516 (Peer-reviewed activated).	5 (in abstract) (Peer-reviewed activated). 0 (in title) (Peer-reviewed activated).
Science Direct - Elsevier	29,206 (Peer-reviewed activated).	51 (in abstract) (Peer-reviewed activated). 0 (in title) (Peer-reviewed activated).
Business Source Premier	1105 (Peer-reviewed inactivated).	79 (in abstract) (Peer-reviewed activated). 0 (in title) (Peer-reviewed activated).

Table 19: Results of the first search enquiry attempt.

While there is no absolute right or wrong on building a search enquiry, a trial search enquiry was conducted to 'test' the process and this made use of three databases. The results show three contrasting findings:

- A search of entire documents produces result in the thousands of 'hits' for the search terms.
- A search only of the abstract section of documents produces a more limited number of "hits".
- A search of the title only produces zero "hits".

A large number of results when using a basic search is beyond the researcher's ability to review without adding to the duration of the research project. The researcher, therefore, reviewed the smaller number of results of the advanced search and found that none of the studies aims to identify contractors. It could be seen clearly that the search enquiry needs to be improved because of the limitation of the sources (empty syntheses), and a systematic review cannot be performed without data. The following steps were taken:

- Remove the keywords that are related to the contractors. It worth knowing that the results will include some causes which are for owners' and/or projects' cost overrun, although this research aims to identify the causes of contractors' cost overrun only. However, the nature of the construction industry (complexity and aggregated) means that causes affect or are affected by other causes (strong links), thus studying the causes of projects' cost overrun will build a deep knowledge and understanding of the causes of cost overrun in general and contractors' cost overrun specifically.
- New Synonyms were identified while reviewing the abstract of sources from the previous search which are presented in Table 20.
- New Keywords: Cost escalation.

Keywords	New Synonyms
Causes	Risk
Cost	Estimation OR costing
Overrun	Escalation OR Variation OR Change OR deficiency
Construction	Structure

Table 20: New keywords' synonyms.

Thus, the new search query is:

(Causes OR cause OR root causes OR factor OR reason OR Source OR Root OR origin OR Risk) AND (cost OR budget OR price OR tender OR bid OR costing OR estimation) AND (over-run OR overrun OR increase OR performance OR exceed OR run over OR Escalation OR Variation OR Change OR deficiency) AND (construction OR infrastructure OR building OR structure OR project))

Second attempt:

The second search query was applied to two search engine databases identified earlier:

Database	Number of search results (Advance Search)
ABI Complete (ABI Global)	5,966 (in abstract) (Peer-reviewed activated). 25 (in title) (Peer-reviewed activated).
Business Source Premier	5,537 (in abstract) (Peer-reviewed activated). 20 (in title) (Peer-reviewed activated).

Table 21: Number of results for the second search enquiry attempt.

The researcher assessed the results of the search (focused only on the title) then decided whether the query needed to be changed.

Database	Assessment
ABI Complete (ABI Global)	15 resources aim to identify the causes of cost overrun in projects. 2 resources aim to evaluate and to manage the cost overrun in construction projects. 8 resources investigation other issues in the construction industry.
Business Source Premier	13 resources aim to identify the causes of cost overrun in projects. 3 resources aim to evaluate and to manage the cost overrun in construction projects. 4 resources investigated other issues in the construction industry.

Table 22: Assessment of the result of the second search enquiry attempt.

As it can be seen (Table 22) the number of resources when a search focuses on the abstract is higher than when focused on the title. Ignoring the resources from the abstract would lead to missing some of the important articles. So, the researcher sought to reduce the resources results when a search is focused on the abstract by:

- Using the truncation technique: Truncation is a technique that allows researchers to search for different forms of a keyword in their search queries by adding a truncation symbol (normally "*") to the end, beginning, or middle of the keyword.
- Limiting the search to articles that contain the keywords “Cost” and “overrun” and their synonyms in resources title: It has been found from the previous easements that all the resources titles that aim to identify the causes of cost overrun have these keywords in their titles.

Thus, the new search query is:

Condition in Title: ((cost* OR budget* OR pric* OR tender* OR bid* OR estimat*) AND (over-run OR overrun OR increas* OR perform* OR exceed OR run over OR escalat* OR Var* OR Change OR deficien*))

Condition in Abstract: ((caus* OR root* caus* OR factor* OR reason* OR Source OR Root OR origin OR Risk) AND (cost* OR budget* OR pric* OR tender* OR bid* OR estimat*) AND (over-run OR overrun OR increas* OR perform* OR exceed OR run over OR escalat* OR Var* OR Change OR deficien*) AND (construction OR infrastructure OR building OR structure OR project))

Third Attempt:

Table 23 shows that the number of results for the first database is relatively high. However, for the ABI and Business source databases, the combined number of results is within the researcher's ability to apply the inclusion and exclusion criteria. For the Science Direct database, the number of results is beyond the researcher's ability to process within the research time frame.

Database	Number of search results
ABI Complete (ABI Global)	1037
Business Source Premier	436
Science Direct – Elsevier	25,092

Table 23: Result of the third search enquiry attempt.

Thus, a new keyword needed to be added to the search query. As one of the criteria is including only the sources that aim to identify the causes of the cost overrun, the new keyword that will be added is:

Keyword	Synonyms
Identify	Identif* OR understand OR analyz* OR analys* OR classif* OR describ* OR diagnos*

Table 24: New Keywords Synonyms.

Thus, the new search query is:

Condition in Title: ((cost* OR budget* OR pric* OR tender* OR bid* OR estimat*) AND (over-run OR overrun OR increas* OR perform* OR exceed OR run over OR escalat* OR Var* OR Change OR deficien*))

Condition in Abstract: ((caus* OR "root causes" OR factor* OR reason* OR Source OR Root OR origin OR Risk) AND (cost* OR budget* OR pric* OR tender* OR bid* OR estimat*) AND (Identif* OR understand OR analyz* OR analys* OR classif* OR describ* OR diagnos*) AND (over-run OR overrun OR increas* OR perform* OR exceed OR "run over" OR escalat* OR Var* OR Change OR deficien*) AND (construction OR infrastructure OR building OR structure OR project))

Fourth Attempt:

Table 25 shows the results of applying the third search query on the recommended search engines databases.

Some of the databases identified earlier were excluded from the search for the reasons in Table 26:

Database	Number of search results	General Information
ABI Complete (ABI Global)	324	Duration (1967 - 2017)
Business Source Premier	235	Duration (1973 - 2017)
Science Direct – Elsevier	3,290	Duration (1978 - 2017)
SAGE journals	62	Duration (1983 - 2017)
Emerald	42	Duration (1995 - 2017)
Wiley online library	106	Duration (1978 – 2017)
Scopus – Elsevier	887	Duration (2008 – 2017)
Institution of Civil Engineers Digital Library (1)	233	Duration (1847 – 2017)
Total	5179	Oldest: 1847 Newest: 2017

Table 25: Result of the final search enquiry attempt.

(1) Although there is limited support to advance a search provided by ICE Library, the researcher decided to use the basic search with one keyword "cost overrun", as the ICE is a specialised institute and is not covered by general search engines.

Database	Reasons
IEEE Xplorer Digital Library	Limited support to truncation technique. The total number of wildcards that is supported in a search query is 5. The last search query contains "*" symbol is 27 keywords.
Springer Link	Limited support to advance search. The Advance search does not support search in a specific location of sources.
Taylor and Francis Online	Limited support to advance search. No advanced search is available on the database website.
Engineering Village	No access to the database.
Construction information service	No access to the database.

Table 26: Excluded Databases.

Although there are some limitations for the databases identified earlier, a second source for the data will mitigate this. Moreover, adding a second source for the literature will add more accuracy and value to the output of the literature review as any primary source that has been missed by the first method will be identified in the second source. The second source relies on finding new sources through reference lists of the papers that were identified from the databases identified previously.

The rest of the steps are illustrated thoroughly in data analysis (Chapter Four section 4.4.1).

3.6.2 Case study research design:

For the research case study design, the research adopted the instrument that has been expressed by Yin (2018) as being well known in reflecting the case study research design and has been adopted by other researchers such as: (Muya et al., 2013) and (Okeyo et al., 2015). According to Yin, five components need to be illustrated in order to establish a case:

First: study's question(s),

Second: propositions, if any,

Third: unit of analysis,

Fourth. logic linking the data to the propositions, and

Fifth: criteria for interpreting the findings.

The research will present each of the five points individually so as to increase the trustworthiness and rigour of the research process. Moreover, the section will be used to be used as a map to conduct the research process as well as the data that will be needed to collect and analyse (Yin, 2009). Besides the five points that have presented by Yin, case selection and sampling are other important parts of the research design which also important for the design process and establishing the trustworthiness of the research.

3.6.2.1 The study’s question(s):

As it has been explained in section (3.5.4), case study is more suited to research of an explanatory nature and could be used in exploratory and descriptive nature researches.

Regarding this point and as presented in section (1.4), this study’s aim is to build a causal path that is extracted from the weaknesses in the context and the process and practices so as to develop a construction project tailored to the Saudi Arabian public sector projects, and develop a causal model that illustrates the connection between all identified causes.

Based on that, a case study research approach, guided by the four profiles (Economic, Business, Resources, and Regulation) international best practises and appropriate selection of the cases, creation of unit of analysis, data collecting and analysis techniques, is the most suitable strategy to achieve the research aim and objectives.

For this study, and influenced by the question in section (1.3), the research questions are:

01: How the context and the process of developing a construction project affects the contractors' cost performance leading to contractors' cost overrun?

02: How the causes of the contractors' cost overrun interact within the context of the Saudi public sector leading to the cost overrun?

The explanatory nature of the central questions for this study is one of the triggers for choosing the case study as the main research strategy. It is useful in the process of developing the research design to review the questions as they are considered the basis of developing the research design.

3.6.2.2 The qualitative study's proposition:

Identifying the research proposition for this qualitative study is very important for the research design in order to direct the design process and identify the data (variables) that research will focus on. In other words, if the proposition is correctly formulated, it will guide the researcher by narrowing his focus onto the specific problem and reduce the temptation to cover everything about a phenomenon. Moreover, the proposition will work as a blueprint in guiding the research during the data collecting process (Leiringer, 2003).

For this research, the previous studies on cost overrun causation are argued to have ignored the effect of the context and the process and practises of developing construction projects leading to cost overrun. Thus, guided by the fours profiles (Economic, Business Environment, Resources, and Regulation), the research proposition is "*Establishing the cost overrun causality links and mechanism of the effect between the Saudi public sector context, the process and practises of developing construction projects, and the contractors' cost overrun*".

The proposition will help this research to design the research and analysis and interpret the data. The proposition also has been used to develop the themes which have been used to obtain the evidence and build the model by the end of the research.

3.6.2.3 Unit of analysis:

The third point that needs to be illustrated for the case study research design is the Unit of analysis which is directly linked to the study's question(s) and proposition/theory. According to Yin (2018), it will be used as an instrument where the research output will be applicable and data is collected from. Moreover, the unit of analysis also identifies what the case is about, as well as draw the borders of the research, which is very important for any research.

As a rule of thumb, identifying the unit of analysis should not be difficult if the previous two steps (research's question and proposition) are cleared. For this study, given the fact that the research focuses on explaining the effect of the context and the process of developing a construction project on the contractors' cost performance as well as the interacting between the causes of the contracts' cost overrun, it is believed that *project* is the most appropriate unit of analysis. Thus, project is adopted as the unit of analysis for this research.

3.6.2.4 The logic linking the data to the proposition:

One advantage of using the case study strategy is its ability to generalise the research output of the study towards/against a proposition (Yin, 2009). Thus, a strategy and/or technique linking the collected data and the theory/proposition is needed. In other words, the analytic strategy broadly explains how the evidence is to be analysed which according to Yin (2018) is used to interpret the evidence (data) and link it to the theory/proposition. According to Yin, the analytic strategy is developed based on the proposition and case description. For this research, the research methodology is built on the abductive approach which aims to explain the causality mechanism of contractors' cost overrun. Based on that, an analytic strategy that developed on case description is the most suitable for this research. The case developing will be used to focus on the data that needs to be collected and ignores unrelated data. The codes that have been used to analyse the data will be explained later in this chapter.

An analytic technique has been used to link the data to the proposition. For this research, an analytic technique called pattern matching logic has been used (Yin, 2009). The technique is one of the most analytic techniques used with the case study strategy (Yin, 2003) and compares the proposition pattern to the predicate ones which increases the internal validity of the research and helps to draw the research conclusion about the problem under investigation. Moreover, the technique will help to generalise the findings for qualitative data which is the case for this study. This study used the four profiles for the context (Economic, Business environment, Resources, and Regulations and Laws), and cost overrun causes classification system (see section 4.5.7) as guides to match any similarities with the cases under investigation.

3.6.2.5 The criteria for interpreting the findings:

The fifth point for the research design is to identify the criteria for interpreting the output of the collected data after being analysed. As a continuation of the previous steps and based on previous choices, the research will use a comparative approach. The criteria will compare the four profiles, and cost overrun causes classification system (see section 4.5.7) with the selected cases for the problem under investigation.

3.7 Research Sampling:

In this section, the researcher will explain the process that has been conducted and applied for the research sampling activity. The primary data collecting techniques used in this research, as explained earlier, are documents, SLR, and interviews. For documents and SLR, the process of choosing the documents and literature will be explained in 3.10.1 and 3.6.1. In short, for documents, all the public laws and regulations were chosen, rather than take a sample. For SLR, no sampling procedure has been conducted as well. However, some criteria for inclusion and exclusion were set up so as to choose useful documents.

3.7.1 Case selection:

The case study strategy is normally conducted by selecting a number of case studies that best fit the problem under investigation. The cases highlight the contextual details where it would be possible to analyse sequence events and the relationship between them. Researches have criticised the generalisability and the reliability in the case study strategy as they based on a small number of cases (Yin, 2009). However, in their defence researchers have explained that the case study, similar to experiment strategy, is not representing a sample (statistical generalisation) as its aim to generalise the theoretical proposition (analytical generalisation). Thus, selecting the most appropriate cases is an important step for analytical generalisation

With the qualitative studies especially when the case study is used, the sampling process are generally purposive and normally guided by the theory (Kuzel, 1992; Huberman and Miles, 1994). Moreover, it is not unlikely for such studies to be pre-defined as the studies are developed and under progress. As a role of thumb, multi-cases usually needed, although, it is possible to include only one case in a specific situation (i.e. critical case)

Some researchers have suggested a specific number such as Eisenhardt (1989) who recommended to use 4 to 10 cases to increase the validity and reliability of the results. Yin argued that Eisenhardt's number of cases might be needed in the case of theoretical replication, and he cited that 2 cases are enough in the case of literal replication.

Regarding which cases are the most suitable for a research, this will be based on the nature of the research and the problem. For example, in a study aimed to clarify as much as it could, extreme cases are the most suitable for this nature of research (Kuzel, 1992).

As it was illustrated in section (1.1.2), the Saudi construction industry is the largest in the region with billions of USD are invested in construction project every year. The public sector is the main owner of the construction projects with over 70% are owned by the public sector. Although literature emphasises on the uniqueness of each individual construction project, different types of construction projects are developed and procured using the same development process, regulations, and laws (see section 2.6). Thus, Although the public sector is developed and procure by different public agencies (ministries), the development process, practise, and procurement are the same are the under fixed strict regulations and laws and no room for self-reflection which is not the international norm.

As this study focus on explaining the affecting of the context, process, practises of developing project in the Saudi public sector, the case selected for the research inclines to the ‘best case scenario’ in terms of understanding the effect of the context, process, and practises on the contractors' performance. However, all the Saudi Arabian public authorities are following a unified approach (standardised approach) to develop and delivered a construction project. Moreover, it has explained in section (4.2.2.1) for the project conception phase, the Saudi Arabian public sector devises and manages its processes in projects pool and programmes rather than specific project so that making the individual project invisible to be picked. This research will not develop any case study selection criteria as any Saudi public construction will fit the purpose of this research.

3.7.2 Interview Sampling:

For the Interviews, a sampling procedure was followed to identify the experts to be interviewed (further discussed later in this section). The stakeholders were chosen from mainly owners and contractors involved in Saudi public projects. The interviewees included the owners, contractors and consultants. Since the consultants were employed by the owners to take care of the owners’ interests, and also the consultants' responses were not significantly different from that of owners, they were merged with the owners' responses. As owners and contractors in the Saudi public sector are organisations, and more than one individual works in both organisations, a pool of representatives was created. As owners and contractors play a key role in a construction project, it is essential to interview them and investigate their responses so as to achieve a better understanding of the Saudi public projects' delivery mechanism and contractors' cost overruns. The reasons for adopting two groups are to verify the construction company's view from a different perspective and to give the study more objectively.

According to Marshall (1996), the choice of an appropriate sampling technique is usually affected by the type of strategy and interview structure adopted. In general, there are two types of sampling techniques: non-probabilistic and probabilistic sampling (Merriam, 1998). According to Sandelowski (1995) and Walliman (2005) some of the methods of non-probabilistic sampling are:

- Purposive sampling (judgmental or expert): using expert knowledge to produce a sample that logically representative.
- Haphazard sampling: produce a representative sample by choosing sample haphazardly.
- Quota sampling: produce a sample by choosing representatives from a specific sub-group.

On the other hand, some of the probabilistic sampling methods are:

- Simple Random: produce a sample where each representative has an equal probability of being chosen.
- Stratified: produce a sample by dividing the population into sub-groups.
- Systematic: produce a sample where each representative is selected according to both a random starting point and a fixed.
- Cluster sampling: the total population is divided into clusters then apply a Simple Random approach on each cluster.

Theoretical or purposive sampling is the sampling technique chosen for this research which, as it has been noted by Walliman (2017), is a form of non-probabilistic sampling that targets a population having adequate (to answer questions) knowledge and experience. The technique provided an advantage for the interviewees to be chosen based on their experience and profession, although one of the drawbacks for this technique is the bias in measuring the choosing criteria. Guided by studies from the construction management field (Kikwasi, 2013; Baccarini and Love, 2013; Cheng and Li, 2002; Begum et al., 2007) relevant persons were chosen based on: accessibility and availability for the interview; extensive working experience in Saudi public projects and having current and direct involvement in the management of construction projects in the Saudi public sector.

One of the most critical aspects of interviews is the selection of interviewees (Johnson and Turner, 2003) as their knowledge about the topic under investigation has a vital bearing on the information relayed (Alalshikh, 2010). For this study, the key interviewees were selected from pools of experts who are well informed about the issue under discussion and who worked for the same public organisation so as to reduce the effect of different internal procedure bias. The interview process provided an opportunity for the contractors and clients to express their opinion towards a delivery mechanism as well as whether it could lead to contractors' cost overrun and how. The pool included the clients' representatives of the major processes as well as contractors.

The research samples in qualitative research are generally smaller compared to those in quantitative research. One of the principal reasons for this is that in qualitative research more data does not necessarily mean more outputs, as the frequency of themes, data, or codes is less critical in qualitative research. One occurrence of that information, code, or theme allows it to be part of the analysis stage, as qualitative research is more concerned with meaning and less with generalising of the research outputs (Ritchie et al., 2013; Crouch and McKenzie, 2006). Nevertheless, gathering qualitative data is very labour intensive, and analysing a large sample can be time-consuming and possibly impractical.

The number of informants needed to be interviewed was determined by the literature showing that sample size varies depending on complexity. For this research, the theoretical saturation, which means that data collection reaches a point where further data collection becomes "counter-productive" (Corbin and Strauss, 2008), was the primary guidance to choose the number of experts needed to be interviewed. After having conducted a series of interviews, there is a point when the researcher starts receiving very repetitive responses from the interviewees, and no new themes emerge. For this research, the number of experts interviewed was 11.

3.8 The research choice:

The academic literature uses the terms quantitative and qualitative to describe data types: quantitative focus on numeric data (numbers) and is thus used as a synonym for any numerical data collection techniques, while qualitative focuses on non-numeric data (words), which is used as a synonym for any non-numerical data collection techniques. Non-numerical data is a term that describes more than words; for instance, pictures and video clips are considered as non-numerical data (Saunders et al., 2009).

Figure 23 shows that when it comes to choosing the research method(s), a researcher will choose a single data collection technique (mono method) or more than one data collection techniques (multiple methods).

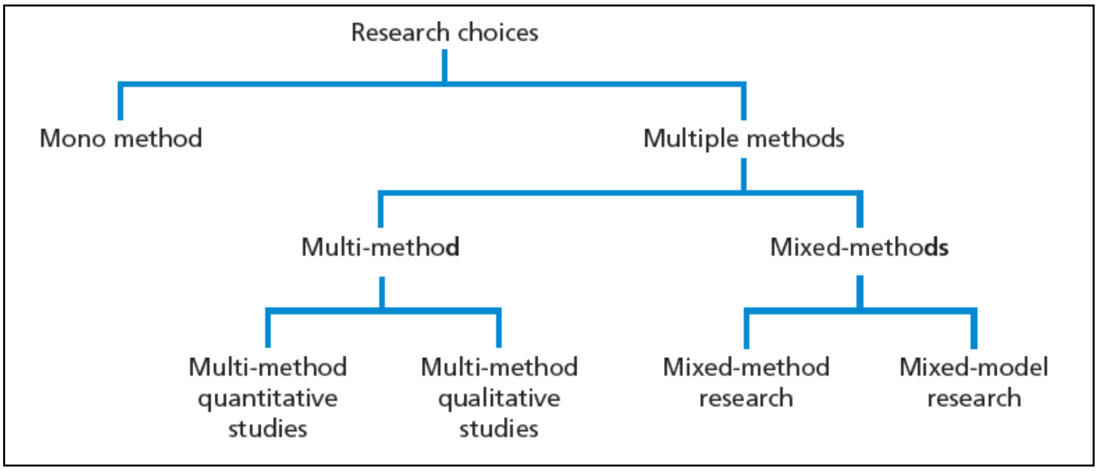

Figure 23: Research choices.
Source: (Saunders et al., 2009).

Multi-method research is a phrase that describes a research activity using more than one data collection technique and analysis process, but these are restricted to either quantitative or qualitative techniques (Tashakkori and Teddlie, 2003). Mixed-methods research differs in that, while it uses more than one data collection technique and analysis process, these can be mixed between quantitative and qualitative techniques. There are two types of mixed-methods research (Figure 23). Mixed method research uses "quantitative and qualitative data collection techniques and analysis procedures either at the same time (parallel) or one after the other (sequential) but does not combine them" (Saunders et al., 2009). Whereas mixed-model research "combines quantitative and qualitative data collection techniques and analysis procedures as well as combining quantitative and qualitative approaches at other phases of the research" (Saunders et al., 2009).

Smith (1981) argued that each data collecting techniques has its own strengths and weaknesses. As a weakness might affect the validity of the result, the researcher aims to use more than one data collecting technique. Hence, the strength(s) of one technique covers the weakness(es) of the other technique. Along with that and the nature of the research aim and objectives, the research has mentioned earlier that the type of research approach is purely abductive which, normally works with qualitative data. Moreover, three research strategies have been adopted. Therefore, the research choice for this research is multi-method qualitative research.

The next layer of the research onion is the time horizon.

3.9 Time horizon:

For any research, a researcher could study the research topic over a specific period, comprising what are described as cross-sectional, or over-extended points of time, which is considered as longitudinal (Saunders et al., 2009). Survey and case study research strategies are normally conducted over short periods; thus, they are normally considered to be cross-sectional research. Other strategies such as action research, grounded theory, archival research, and experiments are conducted over extended time. Thus, these strategies normally adopt longitudinal research (Saunders et al., 2009).

For this research, a cross-sectional time horizon is adopted. The research time frame, along with the research strategy that has been adopted earlier, as well as the nature of the research's aim and objectives, are the main reasons for this choice.

3.10 Data Gathering Techniques:

The sixth layer, which is the core of the research onion, comprises the research technique. In this section, the research will introduce the data gathering techniques that have been used and justification for those techniques. Table 10 shows the previous studies' tools to collect the data which are mainly questionnaire. This tool is normally used to collect data from a large population which is tailored to the approach for testing hypothesis for theoretical models. However, the questionnaire is not the best tool to collect data for this study as it aims to move from listing individual causes and ranking them, to develop a model that illustrates the complexity and dynamic connection between those causes and cost overrun.

Identifying and measuring the effect of individual causes do not reflect the reality which leads to inadequate assessing and managing causes leading to cost overrun. Nevertheless, the limitations of questionnaires as used in previous studies have been identified, which are:

- Poorly designed survey instruments. The respondents have to answer so many questions that this raises a concern about the quality of the answers.
- Focus on independent, single-cause identification and traditional net-effect correlational analysis.
- Questionnaire tool has three types of bias: observation by the individual, bias in the structure of the questionnaire and bias in the sample (Lind and Brunes, 2015). Although it is difficult to prevent these biases, none of the studies reviewed mentioned these biases nor provided any evidence to prevent them.
- The respondents are from mixed professional, etc. groups which will lead to misleading output as each group will give feedback of the causes from their point of view.
- The large difference in number from different respondent groups. In one of the studies, the number of respondents from contractors' groups is 4 times the number of respondents from clients' groups. This difference affects the output of the study as it depends on the average of all the groups.
- Poor causes impact measuring tool. The studies used tools such as RIW score which does not represent the statistically significant measurement of any instance.

There is a small number of restrictions about the data collection techniques that could be used for the case study strategy. Moreover, most of the techniques are used to collect both quantitative and qualitative data as the strategy normally combines both types of data. As a result of the research proposition developed earlier, the evidence that was used to support the proposition, the need to investigate the nature of the context and their effect on the contractors' cost overrun are criteria in the process of selecting the most suitable data collection techniques. Thus, the techniques used to collect the data are literature review, documents, and interviews. Using more than one source will contribute to the research validity and data triangulation.

3.10.1 Document:

One form of research data is termed *document*. A document, which could be internal or external to the organisation under investigation, is usually produced by an organisation (public or private) or individuals, and could be in the form of hard or/and soft (electronic) copy. Examples of *document* data are public law/regulation, reports, project contract, etc.

One of the main advantages of collecting data from documents is the effort and time needed is less compared to other data collecting methods. By assuming the data, a researcher requires is available and in the form of up-to-date documents there is an advantage as the data already exists (as a document) and there is no need to go to the field to collect it.

As with any data gathering technique, Yin (2018) identified some of the document technique's disadvantages such as availability, accessibility, and bias in reporting and selectivity. To reduce the effect of disadvantages, another data source recomended be used alongside other data source(s) (data triangulation) (Patton, 1987; Flick, 2004), although it could be used a mono data source.

The documents sourced for this study consisted of information relating to the procurement, process, and regulation used to deliver a construction project in the Saudi public sector. The source of the documents is a Saudi government bureau of exports (Bureau of Exports, 2019)

As section (3.6.1) shows, the data from the documents provided a deep understanding of the context of the Saudi public sector as well as the process of developing and delivering a construction project. This information also allowed the research to develop detail concerning the project life cycle phases and identify the potential weakness in the process of developing and procuring the project.

Prominently, there was a widespread lack of documents (regulation and laws) that clearly outlined the process steps to be followed at the project level, which led to a decision not to include the project level (see4.2.2 and 4.2.3). Furthermore, the documents source explained how the projects are chosen at the strategic level. There were also documents that explained the process used to develop and deliver construction projects at the organisation level which is the main focus of this research. The absence of such information encourages the research to use another source of information to fill the resulting gaps and reduce their effects in consolidating the explanations derived from the data.

Moreover, to reduce the drawback effects and produce more coherent outputs, the research will collect documents that contain data. Documents needs will be progressed through number of steps which are: evaluating document; obtaining access; analysis of the document, and summarising output.

Initially, the researcher needs to assess the available documents and identify which one(s) will help to achieve the objective. The next step is to obtain access to the identified document(s) so as to establish only the relevant document(s). This step will be repeated, as some of those documents initially appearing to be relevant, may be found later not to be. Analysis is the next step, where the relevant document(s) will be analysed. Finally, the output of the analysis will be documented and presented.

This data collecting technique is one of the techniques for supporting a case study strategy which was recommended by Yin (2003), along with archival records, interviews, observations, physical artefacts. Indeed, this research has chosen another data gathering technique, which is *interview*, so as to get ridge output for Objective One. The nature and the scope of Objective One is the main reasons for choosing this data gathering technique, in addition to the research strategy, approach, and philosophy that have been adopted before.

Documents will be the primary data sources to achieve Objective One, while interviews will be used to fill the gap identified within documents (the most suitable data sources for this objective), where formal steps are expected to be taken by a public organisation. A project's documents are expected to be sanctioned, administered and closed formally by the public organisation responsible for that project, through regulations related to public projects (see section 2.6), and usually are generalised for all public projects, resulting in a formal status that could reduce any adverse effects. Nevertheless, interviews will also be used to test and elaborate on sources for the documents which, within the factors of availability and relevance (to the case), were collected, and relevant data was retrieved.

For a Saudi public agency (see Chapter Two), the extent of regulatory flexibility and freedom are minimal. The regulations and laws used to deliver services are generally authorised by the highest authority in the country which is The Council of Ministers (CoM). Thus, to identify the relevant regulation and laws related to delivering public construction projects, the researcher had to review all the regulations and laws issued by CoM. A useful source is the Saudi Laws Compendium issued by the Bureau of Experts within CoM. The Bureau of Experts website provides the total number of laws, which are categorised in 7 volumes (folders) as summarised in Table 27.

Folder No.	Category	Number of laws included	Total number of laws
1	Basic Laws	5	336
	Media, Culture and Publication Laws	17	
	National Security, Civil Status and Criminal Laws	27	
2	Commerce, Economy and Investment Laws	53	
3	Diplomatic Corps, Protocol and Ceremonies Laws	5	
	Education and Science Laws	10	
	Hajj and Islamic Affairs Laws	8	
	Municipal Services and Urban Planning	25	
4	Military Service Laws	7	
	Civil Service Laws	10	
5	Laws of Agriculture, Water and Biota	27	
	Judiciary and Human Rights Laws	19	
	Tourism and Antiquities Laws	7	
	Youth and Sports Laws	4	
6	Health Laws	25	
	Energy, Industry and Mining Laws	19	
	Labour and Social Care Laws	26	
7	Finance and Audit Laws	23	
	Transportation and Communication Laws	19	

Table 27: Saudi Laws Compendium.
Source: (Bureau of Experts at the Council of Ministers, 2002).

To identify the relevant laws and regulations based on the scope of the research, the researcher reviewed all 336 laws and regulations and determined the following as most relevant to the focus of this research:

- Basic Law of Governance.
- Organization of the Saudi Contractors Authority.
- Organization of the National Commission for the regulation of operation and maintenance and standardisation.
- Labour Law.
- Saudi Building Code Application System.
- Road and building system.
- Law of the Council of Ministers.
- Engineering Practice System.
- Government competition and procurement system.
- Contractor Classification System.
- Arbitration system.
- Commercial Registration System.
- Competition system.
- System of the Saudi Organization of Engineers.

This study first presents a description of the Saudi construction industry's nature as well as cost overrun issues worldwide as a precursor to developing a model that explains the current practice of delivering a public sector construction project in

Saudi Arabia. Explaining the process and its context is vital to the investigation of the cost overrun issue. The analysis was based on the content of the regulations, laws, and contract documents as well as interviews aimed at identifying all of the main processes used to deliver a public sector project in Saudi Arabia. Out of the 14 regulation documents initially identified in Table 28, some of the documents were excluded as they were found to be either insufficiently related to the construction works or out of the research scope. All the documents and people interviewed are listed in Table 28.

The investigation was guided (framed) by international best practice frameworks. Initially, the main process and phases to deliver a public construction project were identified. Following that, each core process was inspected separately for further detailed exploration. Any unclear process was further discussed and investigated using interviews.

Group type	Data Source
Government Regulation	Basic Law of Governance.
	Law of The Council of Ministers.
	Labour Law.
	System of The Saudi Organization of Engineers.
	Government Competition and Procurement System.
	Contractor Classification System.
	Arbitration System.
	Commercial Registration System.
	Competition System.
	MoF Approved Projects
Projects Documents	Tender Documents
	Acceptance Offer Letter
	Start Work Letter
	Basic Condition Contract Documents
	Special Condition Contract Document
	BoQ
Interviewees	Head of Design Department
	Head of Construction Department
	Head of Financial Department
	Owner’s Representative Engineers
	Contractors’ Project Manager and Representative Engineers

Table 28: Objective One’s data sources.

3.10.2 Systematic Literature Review (SLR):

Objective Three requires a systematic review and evaluation of the cost overrun literature and identification of the main issues within the body of cost overrun research. The systematic review strategy was adopted for this objective, and data was collected by applying the SLR technique. 105 studies were the sources for these objectives, and were analysed based on different factors such as their geographical location, year of publication, research strategy, data collecting and analysing techniques …etc. As a result, the main schools of thought were identified, as well as the weaknesses of the current studies, and then synthesised. Themes, categories, and relationships of causes, concepts, or outcomes are identified through the data analysis. Tables illustrating the resulting themes or outcomes are provided for constant comparison in the data analysis phase of the review. The results and discussion go beyond reporting, and allow for the synthesis of multiple comparisons and conclusions. Throughout each of the steps of the integrated literature review, steps to assure trustworthiness are adopted (Whittemore and Knafl, 2005).

By collecting data from the literature review and interviews, the main causes of the contractors' cost overrun in Saudi public projects were identified to fulfil Objective Four. This needed an explanatory analysis to identify causes that affect contractors' cost performance and allow predictions of possible improvements. Thematic analysis was used, based on the theme developed in Objective Three. To fulfil the objective, both literature and interviews were used as sources of data. Causes identified from the literature were the starting point; a pool of causes identified from the literature contained over 500 causes. For the sake of concision, causes deemed similar were combined, with two industry experts subsequently reviewing this activity, deleting any causes deemed irrelevant to the context, and this resulted in further modifications being applied, resulting in a revised causes list. The causes passed through sieves that were based on the explanation in Objective One, as well as the nature of the industry as explained in Chapter Two. The final causes list was confirmed as a result of the interview as well as other causes that had been identified.

The researcher used causes of cost overrun themes (identified in Objective Three) as a starting point for the analysis. This is further particularised to the Saudi Arabian public sector context by using the explanation identified in Objective One, as well as literature about the nature of the construction industry (Chapter Two). The causes of contractors' cost overrun were thematically categorised under (Procurement, Regulation, Country's economy, Force majeure, Uncertainty, Fraudulent practices, Social, Process, and Behaviour) which are the blocks that will be used to build the causes path.

3.10.3 Interviews:

Literature shows that there are different types of interviews such as: Active, Oral history, Group interview, Debate and Confrontation, Long interview, Mutable interviewers, Projective, and Narrative (Kvale, 2008; Mason, 2010; Drever, 1995; Britten, 1995). In such techniques, through face to face or distance interviews, experts answer specific questions, prepared by the interviewer earlier, related to the topic under investigation.

The third data collection technique for this research was the use of interviews, and this covers Objectives One, Two, Four, and Five. Interviews were found to be the best data collecting technique for these objectives for the following reasons:

- In general, interviews provide an opportunity to interact with experts about the topic under investigation, and as this is usually on face to face basis, this gives an opportunity to analyse non-verbal communication for more information.
- For purely qualitative research, interviews handle such data well and are normally considered as the foundation of a successful investigation (Easterby-Smith et al., 2008a).
- This technique is flexible and usually is lengthy, compared to other techniques, as it gives the researcher the opportunity to dig into the narrative answer using follow-up questions.

Although some disadvantages have been raised, such as being less standardised, time and money consuming, and difficult to get co-operative respondents, this data gathering technique is the most suited technique for the stated research objectives.

For Objectives One and Two, interviews are the most suitable data techniques to be used to fill the gaps found within the documents and literature. Moreover, it will also help to evaluate current practice(s) of developing construction projects and whether it has been followed in a real-life situation. Nevertheless, interviews also help by looking at the problem under investigation through different stakeholders' lenses which eventually provides deep understanding.

The researcher argues that using the existing literature as a starting point and base on which to build interview questions with informative interviewees could lead to deep understanding of cost overrun causes. This technique has been useful in situations where little is known about the subject under investigation. Such a technique also will be used to gather information to build causes paths after investigating the context intensely (Objectives One and Two). A causal model will be built after the paths have been gathered and combined. This will then be evaluated through using interviews to determine respondents' views about the developed model.

Other data gathering techniques such as projects' documents, for example, are not suitable to build the model, a considerable amount of documented data on completed projects is required, and this is not available to the researcher due to the sensitivity of cost data for contractors and the generally poor quality of contractor documentation. Questionnaires also have some limitations: bias in observation by the individual, bias in the structure of the questionnaire and bias in the sample (Lind and Brunes, 2015).

In this research, individual interviews have been used because of the sensitivity of cost data for contractors. Individuals could be more willing, in an interview environment, to share information, especially regarding any negative experience. Moreover, individual experience is a vital resource in this investigation. Figure 24 shows the different types of interviews.

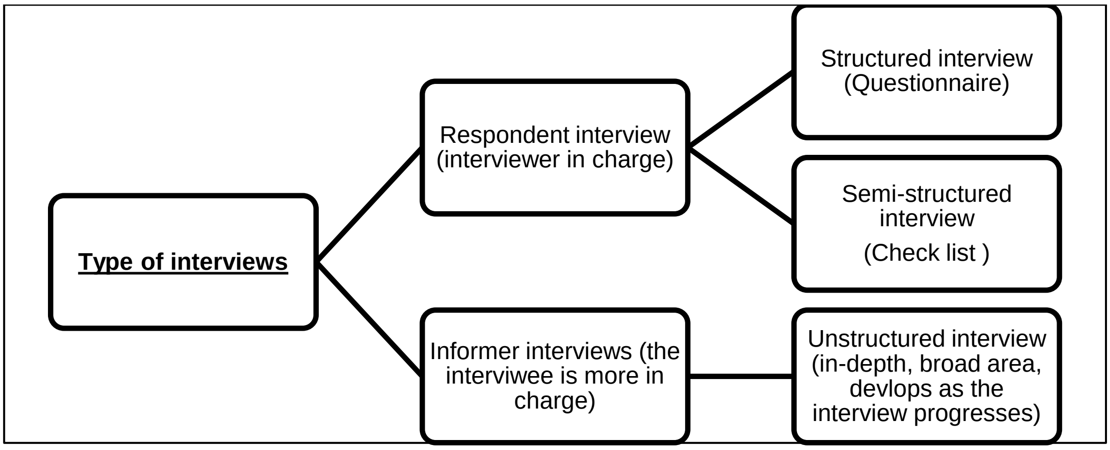

Figure 24: Types of interviews.

In this research, semi-structured (focused) interviews were adopted, in which the interviewer prepared questions to guide the interview. As the research objectives were sufficiently precise at the time of conducting the interviews, this type was chosen, rather than open-ended interviews which are usually used when there is little known about the research focus. Closed-ended interviews, on the other hand, are normally used when a short answer to test a developed theory is needed. Objective one, for example, is going to be used to explore the parts of project delivery practices that are not covered by documents, as well as to test whether the same practice written in documents is used in reality. Semi-structured questions are the most suitable type that could help to achieve research Objectives three and four. This type provides flexibility to the interviewee to aim for a short (shallow) answer and or dig for in-depth answers (Easterby-Smith et al., 2008a).

Semi-structured interviews were used for this research in two rounds, allowing the researcher to collect data that illustrated how the projects are developed in the

Saudi public sector, and how the context effect on the contractors' cost performance. Semi-structured interviews are flexible and allow the interviewer to explore deeper and explore topics related to the problem under investigation. The interviews took around 45 minutes each and, in a location, agreed with interviewees prior to the interviews.

The interviews also allowed the research to develop the codes related to construction projects development and procurement that were to be labelled across all interviewees within the data analysis. Moreover, it allows the researcher to use the pre-assigned codes related to the cost overrun causes identification and paths. Based on the literature review the aide memoir around the questions based on a list of topics that need to be covered was developed.

The research used a protocol for the interview which describes the engagement of the researcher and the approach of collecting and documenting the pieces of evidence. Moreover, it allows the researcher to achieve consistency over the interviews. Nevertheless, the protocol is infused by the research problem, questions, aim, and objectives.

The research method literature shows that different types of questions could be used in interviews. For example, Mohamad (2014), mentioned that a qualitative interviews' questions are mainly divided into: introduction: follow up; probing; specifying; factual and descriptive; structural; contrast, and generative questions. Moreover, a sequence of events within an interview has been suggested by experts:

- *Introduction* is the first part of an interview; the researcher needs to introduce himself (name, background, and current research status) and explain the aim of the research in general and the aim of this interview. Nonetheless, an ethics form was signed by each interviewee, which explained to them their rights, and who has access to data as well as anonymity, and the boundary of confidently.
- Following that, the type of the earlier questions are *warm-up* and *straightforward* questions.
- After that, the interviewer will move to the *main body* of interview where the interviewer tries to extract information about the investigated topic.
- *Cool-off* questions are used to diffuse tension possibly caused by the main part of the interviews.
- Finally, comes *closure*, where interviewees are thanked and made sure they are happy to continue as part of the research.

Using the above guides, and based on gaps raised during the literature review stage (Strauss and Corbin, 1998), the interview questions were developed (Table 29). In these interviews, the researcher aimed to achieve more than one objective. Thus, for Objective One, for example, the questions were intended to fill and explore the gaps that had been found in the document regarding current practices of delivering Saudi public projects, as well as confirm/discard document practices in the real-life situation. Two rounds of interviews were conducted.

Besides these questions, researchers use phrases such as “tell me about it” or “can you give me an example” to keep interviewees talking and providing information about a specific point that needs to be investigated further.

Before conducting the interviews, the researcher attended online classes that provided skills and tips for interviews. Moreover, a pilot study was conducted with relevant experts and which pertained to testing and improving the quality of the interviews’ questions before the real data interview take place (De Vaus and de Vaus, 2013).

A pilot study for the semi-structured interview questions was carried out with five respondents. The feedback led to some adjustments in the questions. Experts from Saudi Arabia with a background in construction cost management were involved in the pilot study during which irrelevant questions were eliminated from the initial list. This facilitated a quicker understanding and shorter response time from the respondents. The pilot study then led to the data collection process and analysis.

Also, the issue of trustworthiness had to be considered by the researcher in order to enable a higher number of participants to be involved in the research. This was achieved by following standard guidance:

- The design of the interview should be well considered, and avoidance of unclear, lengthy, confusing questions should be applied.
- Avoid leading question and being judgmental as well as give the interviewees time to answer.
- The use of additional information whenever needed.
- Emphasising the purpose of the research to the participant; this carries great value in respect to the issue of the trustworthy.
- Finally, making it clear to the participants that they can withdraw at any point of the interview or the questionnaire will undoubtedly increase their trust in both the research and the researcher.

Topics	Question, Sub-Question, and/or tasks	Objectives from the question/ Sub-Question/tasks
Introduction	Researcher introduced himself and his background. Explain the research aim and objectives, how the research output could benefit the Saudi construction industry, why they have been chosen, the process of the interview and their right to withdraw at any point of the interview, why I record the interview and who has access to the data, and how their identity will be anonymous. Sign interview consent form.	To build a trust relationship with the interviewee, as he should feel comfortable, and understand the research to give the best possible answer.
Warm-up Demographic Info	Would you please introduce yourself? Degree? Possession? Experience? Would you please tell me about the company you are working for? Classification? Size? Experience? Type of projects? Number of staffs? What is your department and responsibilities?	Warm-up and straightforward questions to build trust and confidence with the interviewee. Demographic information about the interviewee.
Introduction	Would you please tell me about the characteristics of the projects that your company is generally involved with? Projects' ownership? Type? Size? Are they different? Why do you prefer this type?	To know whether the interviewees are familiar with public projects. To understand owners' and contractors' point of view regarding preferring public projects over private
Project life cycle	How you are usually involved in such projects? How does that differ from a project to another? How projects' designer is usually involved in projects? What are the tender documents? What the process and duration to study and price projects? What happens after you submit a tender? How does the law deal with a sudden material price change after submitting the tender and start construction phase? To what extent do you think public agencies usually follow the STPL? As a contractor, do you have an idea about the estimated budget by owner?	To investigate interviewees familiarity with tendering process and STPL? Investigation public projects life cycle: at which milestone contractors are usually involved in projects? Moreover, how could that affect projects performance? To test whether the tender and procurement law is applied? What are the shortcomings of applying the STPL? Is the contractor is covered if the material prices change during the construction phase start?
Cost-related	How you usually deal with pricing the BOQ table for public projects? How a material price database could help contractors to price BOQ? In the absence of a national database for the material price, how do you estimate?	An Item price analysis. To what extent is the absence of a national database for material/labour price would affect public projects contractors estimating/claims? Any alternatives? How contractors usually are build-up their price? What is the method of estimating?

		Different type of projects is going to effects pricing?
Issue facing public projects	In 2009, the National Anti-Corruption Commission (NAC) issued a report about public construction projects and stated that there are 3000 stalled (defaulted) public projects, from your point of view what leads to such situation? In your opinion, to what extent the current project delivery mechanism is involved in such phenomena? How would the Saudi context affect?	To investigate the main issue that faces public construction projects in Saudi Arabia? To what extent does the Saudi tendering law affect a contract?
Relationship between client and contractor	How would you describe: the relationship between client and contractor, contractors and sub-contractor, contractor/clients and Suppliers within the Saudi construction industry? How could a long relationship between you and other parties in the Saudi construction industry be conducted? How and how often do you contact the owner during the construction stage?	To understand the relationship type between public projects' parties in Saudi Arabia. To what extent is the Saudi tendering law and contract is affecting the relationship between projects parties especially between contractors and owners? Are projects' parties planning typically to conduct a long relationship?
Public work contract and problem-solving mechanism	What sort of contracts are generally applied within public projects? How could you describe the risks allocation with the SPC? What about the rewards for the party holding the risks? Within the Saudi construction industry, how problems are solved?	Literature shows that that public work contract allocates most risks to contractors: To investigate and test the mechanism of risks allocation in public projects contracts? Why would contractors hold the most risks?
lesson learnt mechanism	Within the Saudi public sector, how does the *lesson learned* mechanism work?	Is there any lesson learnt mechanism within the owner department?
Cost overrun	Q: Are you familiar with the phrase "cost overrun"? Would you be able to define it? Q: From your point of view, what are the factors that would lead to a contractors' cost overrun? Q: From your point of view, how would a contractor avoid cost overrun or reduce its effects?	To test contractors' understanding of cost overrun To identify the main causes of contractors' cost overrun from different parties' point of view To understand what would help to reduce the contractors' cost overrun.
Cool off	Thank the interviewees Contact information for future contact Still happy to take part in research	

Table 29: Two rounds of interview questions.

Table 30 shows the interviewees, who are mixed from both the owner's and the contractor's sides. During the selection process of who was to be interviewed, the focus was on the individuals involved in the process of development and procurement construction projects from the owner side, and the individuals who are managing the construction projects from the contractors' side. This was also affected by the availability of the interviewees. To avoid over-relying on one source, multi-interviews were conducted several individuals who hold the same position. As Table 30 shows a total of 22 interviews were conducted across the case study.

During the analysis and to ease the analysis for the research, the content of the interviews was presented in tables that contain paragraph text to link the relationships between the eleven interviewees.

The interviews involved 11 highly experienced personnel from the owners' and contractors' sides (Table 30) with between 7 and 39 years in the industry with qualifications from BSc to MSc. This is important as the sampling for this research is theoretical sampling, which does not depend on the random larger population but rather on a smaller number of experts with in-depth views about the subject.

Inter. Code	Position	Degree	Experience	Organization Experience	Organisation classification	Project budget ($ US) normally involved in
C1	PM	BSc. Eng.	12 Y.	21 years' experience in building, mechanical, and electrical work.	2nd in Building 3rd Electrical 4th mechanical	10-40 M
C2	PM	BSc. Eng.	39 Y	45 years' experience in all projects type.	1st in all categories.	15 M and over.
C3	PM	BSc. Eng.	35 Y.	21 years' experience in building, Electrical work.	Building 2nd, Mechanical 2nd Electrical: 2nd	10.6- 37.3 M
C4	PM	Msc.Eng.	12 Y	30 years' experience in building, Electrical work	Building: 3rd Mechanical 4th Electrical 5th.	1.2-10 M
C5	PM	BSc. Eng.	22Y	Around 16 years' experience in Roads.	Roads 3rd, building 5th, sewage 5th.	Up to 40 M
C6	PM	BSc. Eng.	11 Y	35 years' experience in Roads only.	Roads 2nd	Vary
C7	PM	BSc. Eng.	30 Y	41 years' experience in Roads mainly	Roads 1st, building 1st, swage 1st.	Vary
O1	Owner Rep. (Vice Presidency for Projects)	BSc. Eng.	8 Y	15 Years	Public Organisation	All projects sizes and types
O2	Owner Rep. (Vice Presidency for Projects)	BSc. Eng.	11 Y	15 Years	Public Organisation	All projects sizes and types
O3	Owner Rep. (Finance Department)	BSc. Accounting	16 Y	15 Years	Public Organisation	All projects sizes and types
O4	Owner Rep. (Studies and Designs Department)	BSc. Eng.	7 Y	15 Years	Public Organisation	All projects sizes and types

Table 30: Interviewees' Backgrounds.

3.11 Data analysis:

Literature shows that there are different types of data analysis techniques for qualitative data which could be classified based on different categories, such as whether a technique is based on coding or interpretation, or based on interpretive or sequential analysis (Moerman, 2017). Content analysis and thematic analysis most common forms of analysis within qualitative research Content analysis is defined as "the process of organising information into categories related to the central questions of the research" (Bowen, 2009), while thematic analysis is based on recognising and identifying patterns (themes) within the data as well as emerging themes becoming the categories for analysis (Fereday and Muir-Cochrane, 2006). Within the literature, different analysis guidance have been identified, with Schmidt (2004), for example, offering a five-step guide to conducting thematic analysis:

First: Material Categorisation; the researcher categorises the collected data by going through data such as a transcribed interview and identifying individual aspects that could be related to the investigated topic.

Second: Themes Developing; the different identified aspects are developed as themes based on the research objectives and aim.

Third: Nodes Developing; themes divided into nodes (smaller codes) that contain more detailed information than themes.

Fourth: Linking codes; the codes will be linked to form Cases.

Fifth: Interpretation; the cases are interpreted to give meaning to the research.

Thematic analysis was used as the main tool for analysing the data. The reason of choosing this toll that thematic analysis goes beyond simply counting phrases or words in a text (as in content analysis) and explores explicit and implicit meanings within the data (Guest et al., 2011). Moreover, according to Braun and Clarke (2013), thematic analysis can be used to explore questions about real-life experiences, behaviour and practices, the factors and social processes that influence and shape particular phenomena, the explicit and implicit norms and 'rules' governing particular practices, as well as the social construction of meaning and the representation of social objects in particular texts and contexts. Based on that, thematic analysis is the best analysis tool to achieve this research aim to build a cost overrun causality model that include the effect of the context and the process of developing construction projects.

As a result of the large amount of the qualitative data collected, there was a need to use an appropriate tool to manage the data. The litreature, documents, and interviews were printed and managed manually, and all of the data coded manually. The previous studies were used to draw a background of the Saudi public sector (four profiles in chapter two) and the schools of thought regarding cost overrun causes (objective three). The laws and regulations, on the other hand, have been used to illustrate the process and procedures used to develop and procure construction projects. Finally, the interviews are used to fill any gaps that need to illustrate the process and procedures, the mechanisms of the context affecting the contractors' cost performance, and build the paths of the causes. Before the analysis started, the data were presented in tables. For example, for the interviews, under each of interview's questions follwed by all of the interviewees' answers.

In the beginning, and as a result of the volume of the qualitative data, the textual data were reduced and presented in a more suitable way using tables to help to draw conclusions. The data reduction step is a continuation of the previous reductions which are inherent in decisions taken during the research design, such as the type of framework and data collecting techniques (Miles and Huberman 1994). It is worth mentioning that the main aim of data reduction through coding in qualitative research is to organise the large amount of data in a way it would be possible to draw research conclusions.

However, the choices for the codes and coding mechanism cannot be totally objective, which is one of the critiques of qualitative studies. Unbiased choices have been conducted by the researcher which are based on the case study design and the propositions illustrated in section (3.6.2.2).

Thus, the codes fundamentally are apprised by: first, for the context investigation, the themes mainly guided by the theories that have been discussed in section (1.1.4) as well as in section (4.5.7) for the causality path. In according with that, the main themes for the context investigation the main four lenses are used which are Economic, Business environment, Resources, Regulations and laws. On the hand, the main themes for the causality chains building are Procurement, Regulation, Country’s economy, Force majeure, Uncertainty, Fraudulent practices, Social, Process, and Behaviour.

Although the above results in a significant number of pre-defined codes for each objective, through the analysis activity some of the codes merged with others and, as a result, the number and the contents of the codes changed over the analysis process. A good example of the merging of codes are the causes codes where their number started with hundreds and ended in a smaller number (see section 4.4.4.3).

By using the codes described above, the data has been reduced and arranged in a formalised way. As a result, the data has been rearranged under the defined codes. The researcher has used tables to arrange the textual data.Those codes are considered to be the main part of the analysis stage. Both types of codes (descriptive and interpretive) (Miles and Huberman 1994) are used in the analysis phase for this research in order to obtain the supportive data explaining the context, and how construction projects are developed, and their effect on contractors' cost performance.

As illustrated earlier, codes could be either pre-defined or developed from the data through the process of analysis. Thus, and more than one time, the researcher repeated the coding procedure. the repetition of the procedure allows the researcher to be closer to the collected data and understand it more, as well as the codes to become more accurate in representing the problem under investigation.

The researcher put significant care and consideration into the development of the codes so as to keep them in the short-term memory through the analysis phase. To manage that, the researcher has analysed each of the objectives separately, with the total number of codes for the whole study being over 200 codes. The maximum number of codes that could be manageable by a researcher, according to Miles and Huberman (1994), is 50 codes. Conducting the analysis for objectives individually is arguably better for the research and results in more accurate results, since conducting over 50 codes at the same time could lead to missing some of the coding and wrong coding. This was also found by Blismas and Dainty (2003) who encourage researchers to self-control during coding and highlight the drawbacks of using an over-large number of codes beyond a researcher’s ability.

After four times going through the data, no new codes appeared to the researcher. The first passing through the data produced over 200 codes for the objectives, however, going through the data again the number of codes had been reduced after refinement where a number of codes were merged. The new list was used in on the second pass and as a result, the list was refined. The same process was done for a second and then third time until the final codes were developed.

Assigning a piece of text to a number of codes is another method that is used to refine and reduce the number of codes which is recommended by Blismas and Dainty (2003).

During he initial identification of codes through the text it was found that a number of codes were similar, which resulted in merging similar codes together or combining under one category (node). To avoid overlap between codes which would result in inaccurate analysis, the researcher put an effort throughout the analysis phase to distinguish between the different categories. The total final number of codes is 32 which are used as the base for the analysis and how the data will be presented. According to Miles and Huberman (1994), data presentation is part of the data analysis as it helps in extracting the finding from the data and construct conclusions out of data.

The analysis in this research is presented in tables where the individual codes are linked to text from the collected data and the relationship between the codes is also illustrated. Data presentation (displaying), nevertheless, increased the robustness of the conclusion and discussion as well allowed codes analysis to be informed by relevant variables.

3.12 Causal Loop Diagram (CLD):

The discussion of the previous studies in sections (3.3, 3.4, 3.5, and 3.6) shows that the majority of studies frame the cost overrun problem in a manner that ignores the complex and highly dynamic context of projects, as well as not evidencing that traditional net-effect correlational analysis has been taken. Moreover, previous studies lack examination of the impact of interrelationships/causalities between two or more factors. The causes are listed as stand-alone causes, thus ignoring any interaction between causes. Researchers used statistical methods to rank the contributing factors according to their impacts without considering the interactions among/between these factors. Moreover, the studies suggested solutions and remedies without identifying the root causes of the overruns. Any attempt to address the cost overruns would be futile unless the root causes are identified because cost overruns are a net result of complex relationships between two or more factors. Based on these limitations, this research uses a tool called causal loop diagram (CLD) that allows the researcher to present the interrelationships/causalities between causes. A causal loop diagram (CLD) is a diagram that aims to represent the interrelation between variables visually (Sterman, 2001). It was also described by Schaffernicht (2010) as "qualitative diagramming languages". Some of the advantages that attract researchers to use the tool are the non-complex, uncomplicated, easy way to represent the interrelation and interference between the variables, thereby allowing ease in understanding by people who have little l knowledge about the research. CLD is also used as a tool to expose a problem or model in a way to be understand by a team (cost overrun for this research).

The causes identified in an earlier stage of the study will be used to develop causal paths leading into a causal network. The paths are categorised thematically under the themes developed in Objective Three. To build the model, data from the literature, documents, as well as interviews are used. The causal path used relevant literature as the starting point for further discussion with the interviewees to both identify further causes and paths that are not incorporated, and to modify interrelationships.

In this model, the paths and relationships between causes are established without concentrating on the degree of relationship (influence) or even indicating whether the relationship is a reinforcing one or a negating one. In addition, and for the sake of brevity and reduction of network complexity, an initial mini network of paths from the early stages were developed. Thus, the new path will start from these mini-networks rather than directly from a single cause.

The causal model diagrams prepared were presented to key informants as well as presented at a national construction conference in Saudi Arabia for further discussion. Based on these discussions the causal model was further refined.

According to Lane (2008), a CLD consists of the three main components which are:

- A variable: This component is representing the factors (for this research causes) which affect each other in real life. For the sake of this research, as it will be explained thoroughly in section 4.6.1, the variables (causes) are divided into three types which are: Root causes, Intermediate Causes, and Direct Causes.
- An Arrow: This component is representing the causal connection between variables (causes). Normally, an arrow in the CLD is represented along with (+) or (-) which represents the influencing between variables by a direct (+) and indirect (-) relationship between variables (causes) between variables (causes).
- A Loop polarity: This component represents the type of the loop, whether it is reinforcing (+) or balancing (-).

For this research, the CLDs are used as a thinking development tool of the cost overrun causality as represented by the understanding by the researcher and interviewees, non-Saudi and Saudi, of the contractors' cost overrun causes. The main focus in this model is the chain development of the causes that needed to fully understand the system more than focusing on the comprehensiveness of the causes as recommended by (Lane and Husemann, 2008).

Although one of the main features of CLD is it being presented in closed loops, the diagram in this research is not a fully closed loops' diagram. The main reasons for this difference being that the CLD is not representing the whole system for contractors' cost overrun causality rather than part of it which are limited by the research limitation (section 1.6). For example, the final CLD presented in section 4.6.3 represents the CLD started by the contractors' involvement in the project (tender phase). Moreover, construction projects are considered as an open system which affects and is affected by external factors.

One of the disadvantages that have been identified for this approach (CLD) is the "polarity confusion " between the variables or the loop (Lane and Husemann, 2008). To overcome such a limitation, the polarity for arrows and loops will not be used for this research model. Instead, during the CLD development, an explanation of the relationship between the causes will be provided.

3.13 . Research Trustworthiness:

One of the main differences between daily observations and research is that research is more believable than observation. Thus, knowledge resulting from scientific research should be more defensible by critically examining and testing the processes of choosing a research philosophy, approach, strategy, and data collecting and analysis to assure the rigour of research processes and the inferences made. The main criteria used in providing a defensible knowledge are validity and reliability (Cook and Campbell, 1979; Kidder and Judd, 1986; Seale, 1999). Research philosophy and strategy play a major role in choosing the processes, adherence, and rigour required to be followed to satisfy these criteria. Table 31 explains the trustworthiness criteria implemented in the research:

	Major measure of Trustworthiness	**The study's approach to comply for the trustworthiness requirement**
Content validity	Ensures that the interviews' questions are related to the interviewees' level of knowledge.	This research uses the judgement of experts with a high level of experience for validation and pilot study for the interviews questions as well as the synthesis literature review.
Criterion validity	Evaluate the effectiveness of the instrument to measure what is designed to measure.	The sample population and size, as well as level of knowledge, were considered during the process of designing semi-structured interview questions.

	Major measure of Trustworthiness	The study's approach to comply for the trustworthiness requirement
		The pilot study was used to evaluate the effectiveness of the research instruments. A brief introduction which includes explanation was used prior to the interviews.
Construct validity	Translation validity	Although the evaluation mainly based on previous literature and personal experience, the research methods must be designed to reflect the theoretical research background. Moreover, the pilot study was used to evaluate translation validity.
	Data triangulation (multiple sources of evidence)	The research uses a multi data source (different documents, literature review, and interviewee) and collection strategy by employing literature synthesis, document analysis and interviews as its data sources.
	Review of transcripts and draft by peers, key informants, etc.	The summarised outputs (Causality Model) was presented in the biggest Saudi conference as well as it was reviewed by key informants and contractors in the public sector.
	Present cases systematically (from research question to a conclusion and vice versa)	The links between research objective (and questions), research conceptual framework and analysis output were established.
	Explanation of data analysis (clarification of data analysis procedure)	Content analysis of documents and interviews guided by international best and accepted practices is used.
	Theory triangulation	The study heavily relied on other research and international cost overrun causes as its part of the analysis in identifying causes of cost overrun as well as building the causes paths.
	Multi-analysis techniques have been used	Content analysis, as well as thematic analysis, were used as the major analysis techniques.
External validity	Rationale for case study selection	The rationale for selecting the Saudi public project delivery mechanism is presented.
	Details on case study context	Details of the nature and main feature of the Saudi public project context are presented.
	Comparison with other literature/study	A comparison with the literature and other contexts is conducted when it is applicable (especially for the cost overrun part).
Reliability	Case study protocol (report of how the entire case study was conducted)	A summarised presentation of how the study is conducted is presented in the above section.

	Major measure of Trustworthiness	The study's approach to comply for the trustworthiness requirement
	Case study, literature review, and survey databases (contain all available documents, interview transcripts, archival data, etc.)	Database of the documents analysed, and interviews conducted is maintained and can be accessed upon request.
	Maintain chain of evidence	As much as possible, chain of evidences from research question to the conceptualization to the data analysis and conclusions and recommendations made are established.

Table 31: The study's approach to complying with the trustworthiness requirement.

3.14 Ethical considerations:

Participants' personal safety and data confidentiality are the main ethical issues, with confidentiality being a key factor in participants being more willing to participate in a research project if their identity and data is kept confidential. This factor also affects data accuracy and validity. To reduce such effects, and using the literature as guidance, the following action was taken:

- Personal questions kept to the minimum.
- Securing access: the main researcher is the only one who has access to the raw data.
- To keep participants anonymous, a coding system has been used during the data analysis and output presenting.
- The research data bank was stored in an encrypted electronic server (university server). Another copy has been stored in a private storage cloud. Both data locations are compliant with the United Kingdom Privacy Act.
- The data will be kept for five years in case it is needed. Data will then be deleted from all stored locations.

Besides ensuring confidentiality, some actions were taken to cover relevant legal matters for the research participants' privacy. A consent form was signed by all the research participants before the interview was conducted. Moreover, the interviewer made it clear that:

- They have the option to withdraw from the study at any point during the interview or after.
- Data will be used for only a research purpose.

- Illustrate to them the aim of the research, interview stages, expected time, as well as the process of data collecting method.
- The coding protocol used during the analysis stage was fully explained.
- Any participant in this research (either an individual or an organisation) had the process of the data collection, analysis and distortion illustrated to them.

3.15 Summary of the research method:

The research onion model has been used for this research as guidance. As shown in Figure 25, a Pragmatism research philosophy was adopted. The second layer of the onion shows an abductive approach as the research is purely qualitative. As illustrated earlier, different research strategies have been adopted for different objectives: Figure 22 shows that Systematic Literature Review, and Case Study, have been used as research strategies. In the beginning, documents and interview were used to develop a model exploring the current practice for developing public projects in Saudi Arabia. Evaluating that, the main weaknesses were illustrated and identified. Synthesising the literature review was used to identify and evaluate the cost overrun literature. Finally, the survey and literature used to develop causes paths and model using CLD as a tool. The finding(s) of the data collection were validated using four expert interviews.

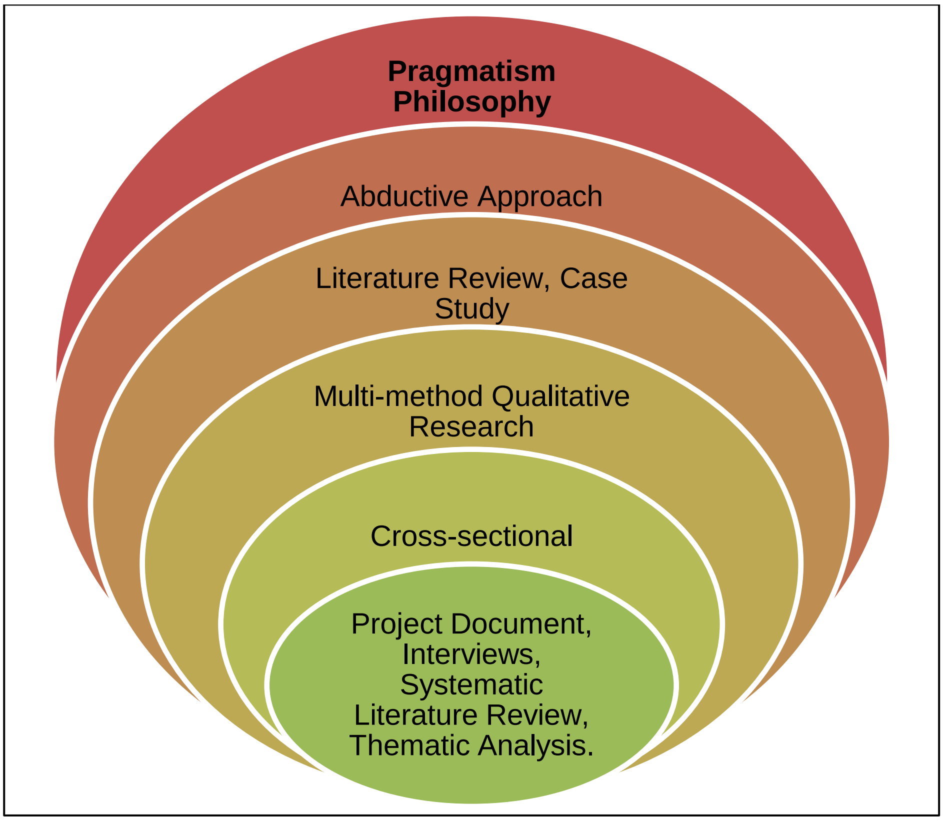

Figure 25: The research onion for this research.

Chapter 4: Analysis and Discussion

4.1 Introduction:

This chapter includes the analysis and discus of data gathered to achieve the research objectives and aim. The data gathering, sampling, and analysing techniques for each objective were detailed in chapter three (section 3.10). Based on section Research Design: (research design), the data gathering techniques used for this research are: Interviews, Documents, and Systematic Literature Review. The data analysis and discussion for each objective will be presented individually; it will be shown how each objective contributes to the final result; the contractors' cost overrun causal model.

4.2 Objective one:

Chapter Two explained the context of the Saudi construction industry. The country's economy, business environment, etc. are examples of the context exploration. As a continuation to achieve objective one, the process and practices of projects development will be explored.

For this objective, the current practices and processes used to deliver a public sector construction project in Saudi Arabia are explored and described. This includes the presentation and evaluation of organisation structure, project phases, and development process. Data has been extracted from the project and government documents as well as interviews and analysed by using the content analysis technique. The final output was presented to experts in the Saudi public sector for verification, and the output was refined in response to their comments.

4.2.1 Organisation structure:

Since Saudi Arabia was established on 23 September 1932, public authorities have gone through different development and structures changes, often aligning with the country's strategic planning. For example, between 1964 and 2003, most of the public projects were under the Ministry of Public Works, which was revoked in 2003, and their responsibilities moved to other ministries. A public organisation structure is typically approved by the council of ministers. Although the public organisations in Saudi Arabia vary in their responsibilities, their project organisation structure is similar especially in the higher stages. The regulations presented in section 3.10.1 authorise a public agency to deliver construction projects but for this objective, only the Saudi public sector (owner) side has been explored — the main reason being that all the public authorities in the Saudi public context follow the same laws and regulations, thereby resulting in similar organisational structures, unlike contractors (private sector) who are not acting under such rules and can, therefore, adopt diverse institutional structures. Moreover, the focus of the study is more on understanding the effects of the owner side in creating contractors' cost overrun.

Figure 26 shows the whole structure of a Saudi public organisation and the departments that are contacted directly with projects. Beside other divisions that are not responsible for projects directly, such as human resources, projects are developed and delivered usually under a separate main division called Project Division which links directly to the Minister and Vice Minister for projects. The division is not only responsible for implementing new projects but also for maintaining existing projects. The division works in a project-based manner to conduct, oversee, and manage the planning, designing, execution, and maintaining all types of projects. In this context, a project is a primary unit for all the tasks such as production, organisation, innovation, and competition (Hobday, 2000). Moreover, the structures, strategies, and capabilities of that organisation build around projects' needs (Hobday, 2000). The General Administration of Projects is the department responsible for implementing new projects, with sub-departments of Planning and Contracting Department, Implementation Supervision Department, and Studies and Design Department. The full responsibilities for these departments are shown in Table 32.

Although the organisation structure has been identified as one of the factors of project success (Walker and Vines, 2000), it has limited functionality (the hierarchical relationship among the departments/teams/personals). The organisation structure, for example, does not present how the project organisation actually works. To overcome such limitations, and based on the same information gathered from projects' document and interviews, the researcher has built a figure (Figure 27, page 123) that shows supply and demand chains which include money, material, and information flows.

To be clearer about the organisational structure of a Saudi public sector, the structure has been divided into three levels based on Parsons' institutional levels (Morris and Geraldi, 2011) as in Figure 26 (page 122).

Division	Responsibilities
The Ministry, Projects Division	• Review the general plan of the ministry • Work on long-term plans of the ministry • Follow-up and supervision of all operations and maintenance of all facilities • Supervision of all projects. • Hand over projects to beneficiaries (End-user). • Providing technical consultation to the ministry. • Developing the technical and administrative workforce.
General Administration of Projects	• Receipt of project's documents (drawings, technical specifications, and BoQs) that have been scheduled for implementation. • Identify project resources and supervision. • Communicate and coordinate with approved contractors to implement the projects. • Prepare the pre-construction meeting and provide all the clarifications and answer inquiries. • Study, review and approve plans submitted by contractors • Monitor progress of all projects' implementation activities and ensure compliance with the terms and documents of the contract. • Study and review the proposed amendments to the projects by the project manager or the beneficiaries and submit them for final approval. • Study, review, and approve contractors' and suppliers' executive plans, materials, equipment, and equipment. • Prepare daily, weekly and monthly workflows reports. • Provide technical advice to the ministry. • Participate actively with the Department of Studies and Design in the advanced stages of the project development. • Participate in initial and final handovers. • Communicate and coordinate with the Finance Department to renew financial commitments for projects under implementation or to increase financial engagement in accordance with the approved amendments to the scope of the contract. • Closing contracts. • Arrange and organise files, records and documents of executed projects. • Release bonds.
Implementation Supervision Department	• Developing and updating the procedures followed in overseeing the implementation of projects. • Address the problems and obstacles that may arise during the project execution period. • Define the responsibilities of the implementation supervision teams. • Monitor and supervise the implementation of projects. • Control cost during the implementation phase within approved funds. • Follow up the projects implementation programs and verify the progress of work according to the approved.

Studies and Design Department	• Follow-up all studies and design for the ministry's projects. • Increase efficiency and invest in human resources and develop their capacities. • Identify the design teams and devices. • Preparation of lists of approved designers. • Study and analyse the design stage bids. • Participate in preparing the annual budget for new projects and projects under design. • Quality control of project design documents.
Planning and Contracting Department	• Monitor the completion of the contracting procedures of all tenders and direct purchase. • Preparing, auditing, and signing contracts from both parties. • Ensure that the STPL is applied. • Declaration of the results of opening envelopes and competitions • Completion of the procedures for the contractors' payment.

Table 32: Departments' Responsibilities.

The three levels are:

- Technical level (Micro Level): Operates within the project, representing the delivery-execution core, strategic setting up this core (the project) and shielding it from environmental disruption (to manage in them).
- Strategic level (Meso Level): Operates within the project (to manage in them).
- Institutional level (Macro Level): Outside and around the project (to work on or for projects).

The data from the interviews further clarified the limitations of such a structure and it has been found that:

- The Saudi public authorities are based on a traditional organisational structure usually used by bureaucratic systems.
- The administrative and relations levels and regulations build vertically and divide into departments, so power flows vertically from the top downward.
- The degree of complexity and length of the structure increases as the size of the ministry increases.
- This leads to increasing of the gap between the various departments and the top of the management hierarchy, thereby adding difficulty in communicating with the top of the administrative hierarchy.
- Such a structure does not follow the principles of the modern organisation structure which aims to reduce power lines.

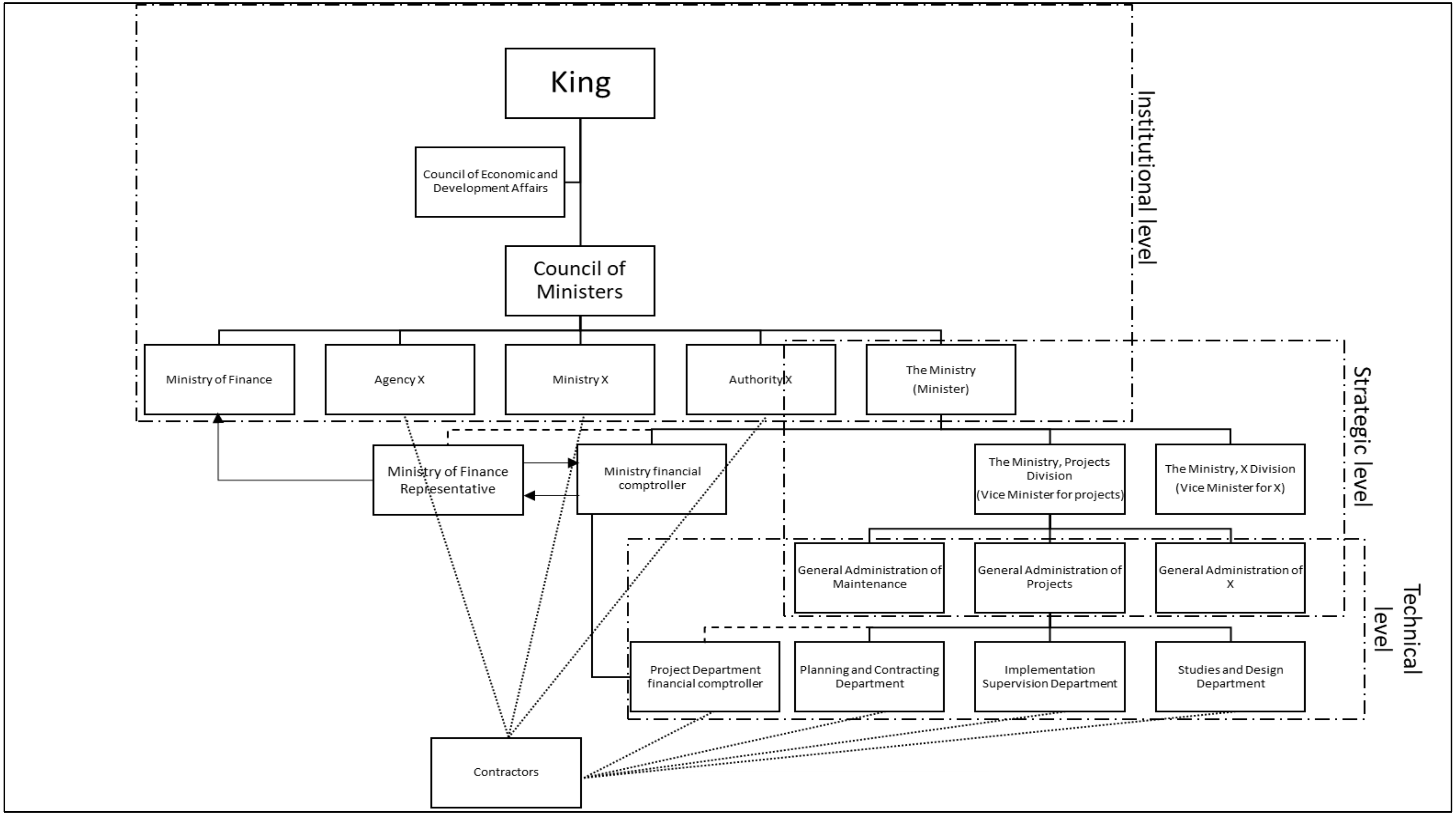

Figure 26: Organisational structure of a typical public agency.

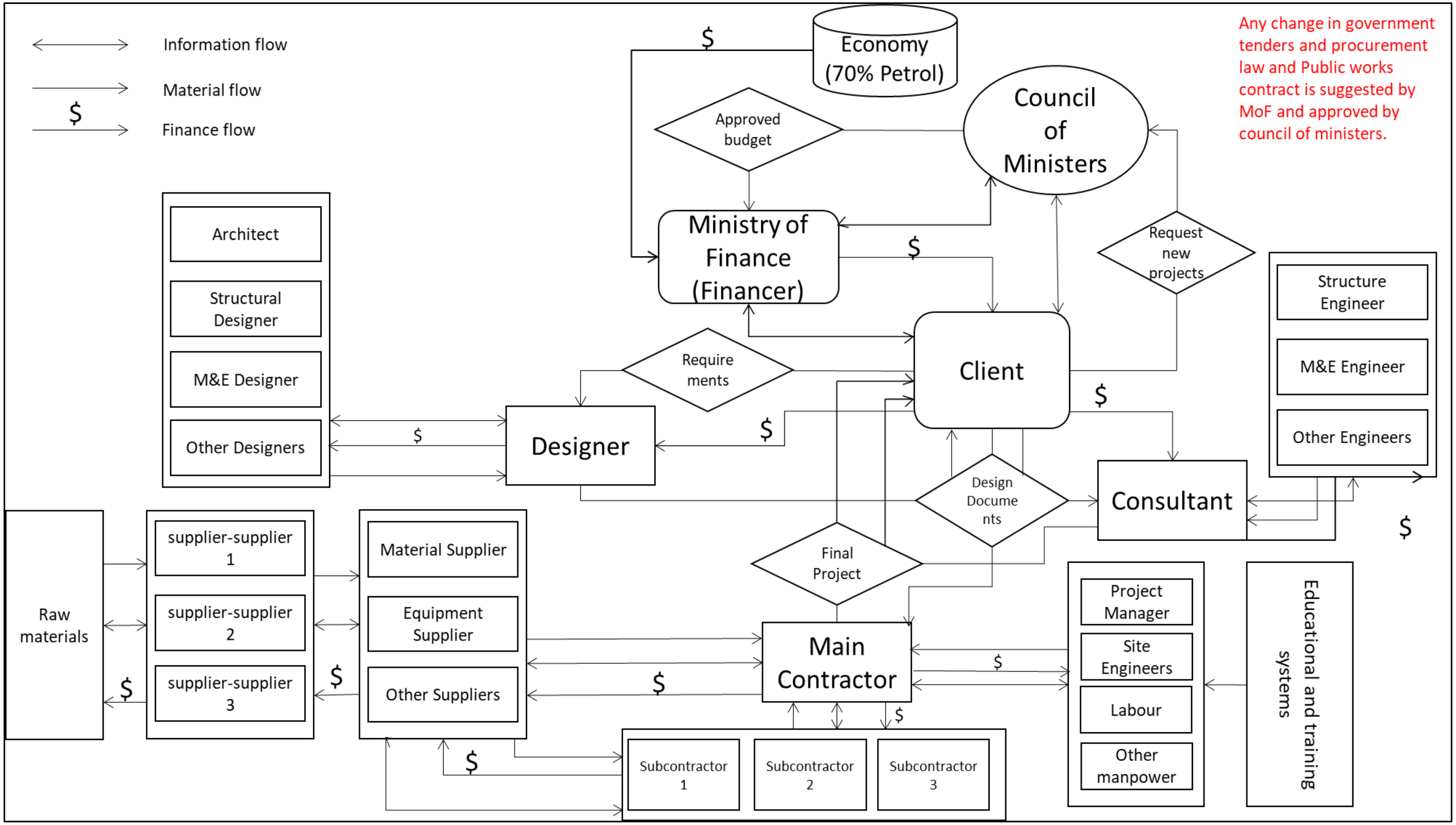

Figure 27: supply and demand chains in Saudi public sector.

4.2.2 Construction public project phases in Saudi Arabia:

Literature shows that there are different project life cycle phases. Projects' type, technology, and delivery mechanism affect the project life cycle phases such as their number and sequences (Wideman, 2004; Turner et al., 2009).

Based on relevant regulations, laws, and interviews, a Saudi public project operating under normal situation, where a ministry does not jump some phases because of external factors, can be shown to pass through four phases:

4.2.2.1 The project planning phase:

Data availability was limited to this phase. Neither the documents nor the interviewees show, for example, whether there are specific steps, forms, regulation to be followed. This phase involves the identification of pools of potential projects for implementation. Although planning could be implemented by the Planning and Contracting Department (bottom level of the organisation structure), planning is based on Ministry long, medium, and short plans as well as the need for projects from other departments. The planning process goes up the organisation structure for approval based on different factors such as the country's economic situation that year, which determines the number of approvals by the Council of Ministries and thereby the ministry's annual budget. The output of this stage is normally provided to the designer during the design service tender sub-phase.

4.2.2.2 Design Phase:

According to relevant laws and regulations, the Saudi public sector adopts the traditional delivery strategy; the development phase is executed sequentially to the implementation phase. To fill the experience and technical gap of designing and supervising construction projects, government agencies appoint an external consultant office beside the General Administration of Projects' departments (see the organisation structure Figure 26 (page 122)). However, the regulations consider, financially approve, and procure each service to the projects separately. Thus some of the sub-phases are repeated as Figure 28 shows.

This phase involves the development of the project design (drawings, specifications, and BOQ). In this phase, 70% of the final product's cost is typically defined (Kochan, 1991). This phase can be divided into three sub-phases:

A. Financial Approval sub-phase: The financial regulation deals with any service such as designing, consulting or constructing separately. Thus a financial approval is needed for each service. Financial approvals are normally included in the ministry’s annual budget. Failure to sign a contract for the approved services within the fiscal year will force the government entity to refund the money back to the Ministry of Finance (Saudi Ministry of Finance, 2006).

B. The design procurement sub-phase: As each service is treated separately, procuring the service is the second step after it was financially approved. As Figure 28 shows, this sub-phase comprises seven steps and ends with the contract being signed with the appointed designer office (see Table 36).

C. The design sub-phase: Although the data collected does not provide steps to be followed for the design sub-phase, which could be understood as projects are unique and each design could be treated to the Studies and Design Department best judgement, it involves the development of a detailed design. According to the Saudi Government Tenders and Procurement Law, a detailed design, set of specifications, bills of quantities (BOQ) and the estimated costs must be prepared for the intended project before the implementation stage take place. This document will be provided to the contractor(s).

4.2.2.3 The implementation phase:

Similar to the Design phase, the regulations consider, financially approve and procure projects construction separately; thus, similarly, to design this phase is divided into three sub-phases:

A. Financial Approval sub-phase: No difference from the design financial approval.

B. The construction procurement sub-phase: Similar to the design phase procurement. However, in the implementation phase, only the contractors' who are classified and qualified could be part of the process (refer to the contractors' classification system in chapter two)

C. The construction sub-phase: this sub-phase involves the procedures and actions that reflect the development outputs and produce the physical structure to achieve the objective the project is planned for.

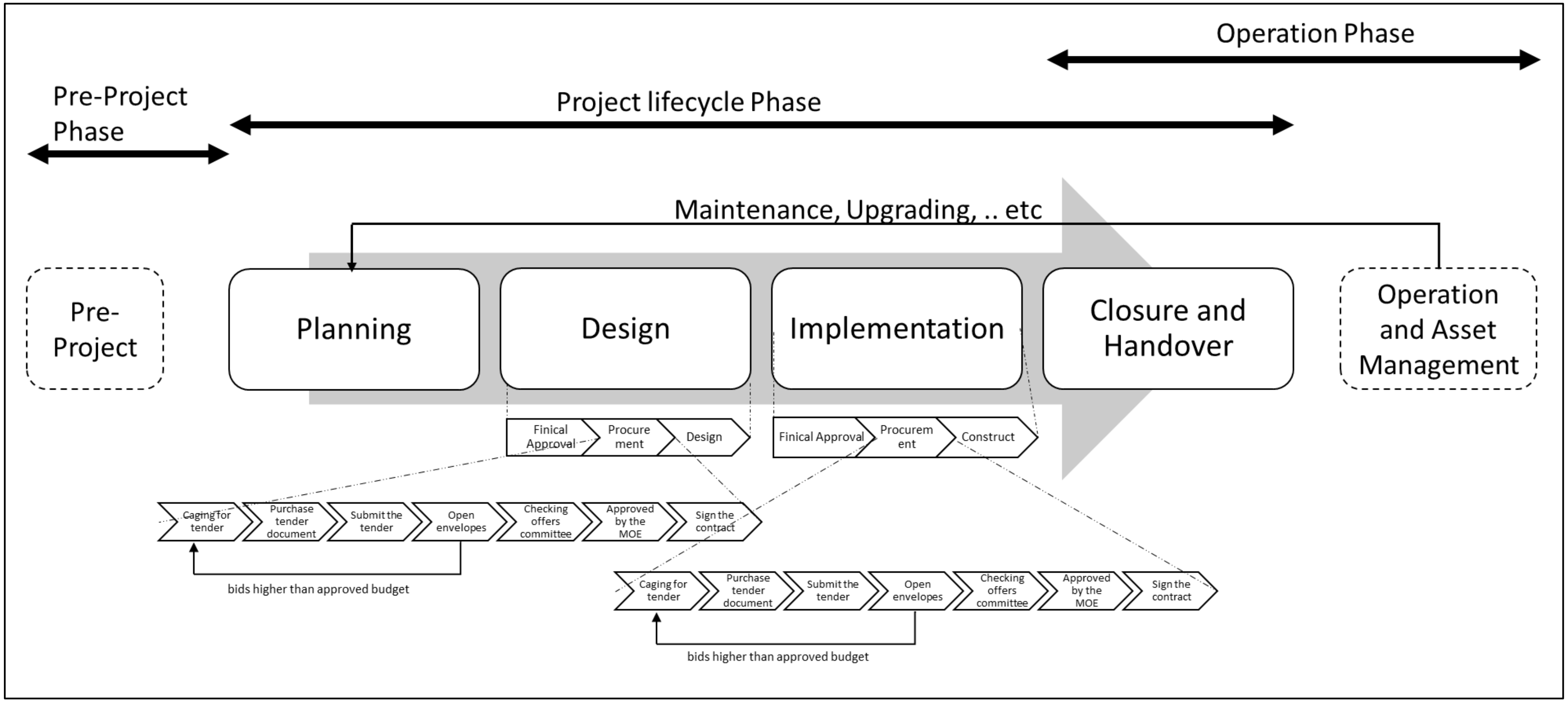

Figure 28: Project life cycle phases.

4.2.2.4 The project closure phase:

After completing all construction tasks, the contractor will hand over the initial project to the client initial. A committee will hand over the project and sign an initial handover form. After a year, the final handover will take place, and the final payment (not less than 10% of the contract value) will be paid to the contractor. However, the financial guarantee will not be returned to the contractor until the maintenance period, which runs from provisional acceptance to final acceptance is finished.

The project responsibility will move from the General Administration of Projects to the General Administration of Maintenance.

4.2.3 Saudi Public Project Processes:

In this section, the main processes of a construction project delivery are presented as practised by a Saudi public agency (extracted from the project document and interviews). To ease the understanding of the processes, they are presented in a table (Table 33). The processes are divided based on the main four phases being similar to the project phases in Figure 28. For each main process and sub-process, the Input Resource(s), Government Bodies Involved, Major Control(s), and Output(s) will be presented. As the process at the operation level could change from one agency to another, and the case study is the Saudi public sector, the process will not include the operation level. The table is presented hierarchically from general information to detailed information.

Phase	Process and sub-Process	Input Resource(s)	Government Bodies Involved	Major Control(s)	Output(s)
Planning phase	Five-Year plan development	• Feedback of the previous plan. • Country Long-term Strategy. • Country vision and objectives for five years.	• Council of Ministers (CoM). • Ministry of Economy and Planning (MoEP). • Ministry of Finance (MoF). • Council of Economic and Development Affairs (CoED).	• Country future strategy. • Finance-Ability. • Country's Capacity.	• Five-Year country plan. • Programs and projects to be implemented during a five-year plan
	Annual plan development	• Five-Year plan • Programs and projects to be implemented during a five-year plan.	• The minister. • Vice-ministers for different divisions. • The ministry project division. • Planning and contracting department (PCD).	• Five-Year Plan. • Ministry prioritisation and strategy. • Stakeholders' need. • Annual budget.	• Annual plan. • Programs and projects approved to be implemented that year.
Development	Design service procurement	• List of approved projects for design. • Project Development Plan Strategy.	• Studies and Design Department (SDD) • PCD. • Tender analysis Committee • The Minister • MOF	• STPL. • Implementing regulation STPL. • Budget • Capacity • Urgency	• A singed design services contract.
	Project design	• Singed design services contract. • Annual plan. • End-user requirements.	• SDD • End-users.	• Consulting Engineering Services Contract (Design). • Design standards. • End-user Requirements.	• Design Report. • Tender Documents (Drawing and BOQ).

	Supervision service procurement	• List of approved projects for design.	• Implementation Supervision Department (ISD). • PCD. • Tender analysis Committee. • The Minister. • MOF.	• STPL. • Implementing regulation STPL. • Budget • Capacity • Urgency	• Consulting engineering services contract (Supervision)
Implementation Phase	The project coalition setup and design review	• Design Report. • Tender Documents (Drawing and BOQ).	• General Administration of Projects (GAP). • SDD • Contractor.	• Consulting engineering services contract (Supervision) • The ministry standards and manual. • Market Forces.	• Revised design. • Revised tender document.
	The project quality assurance and monitoring	• Project recourses. • Land • Project Documents (Drawing and BOQ).	• The MOF. • GAP • SDD • Consultant. • Contractor.	• Consulting engineering services contract (Supervision) • Revised design. • Revised tender document. • Public Work Contract (PWC). • Annual allocated budget. • Capacity. • Urgency.	• The accepted Construction projects (initial handover). • Unsettled contractual issues.
closure	The project commissioning and contract closure:	• Finished projects. • Initial handover report.	• Hand over committee. • The MOF. • General Administration of • Projects. • Consultant. • Contractor.	• Public Work Contract (PWC).	• Final Handover Report

Table 33: Public Construction Projects Process.

4.2.4 Procurement method evaluation:

Construction projects are often implemented using a temporary alliance of different organisations brought together to develop and construct the project. The procurement system affects project governance, transaction cost, productivity, and coordination and interrelations of processes (Tookey et al., 2001). Moreover, it has been argued that the right choice of the procurement method will lead to construction project success (Bennett and Grice, 1990; Tookey et al., 2001).

Over the years, different procurement approaches to deliver construction projects have been developed (Table 34), and each approach has its advantages and drawbacks. Some of the approaches are design-bid-build, design-build, and construction management (Gordon, 1994; Konchar and Sanvido, 1998; Dell'Isola, 2002; Gransberg and Molenaar, 2004; Gruneberg et al., 2007).

Scope	**Separate design and construction**			**Design-Build**	**Design-Build-Finance**	
Organisation	Prime Contractor	Construction Manager	Multiple Primes	Design-Build Team	Turnkey Team	BOT Team
Contract	Lump Sum Unit Price Cost Plus GMP	Fixed Fee Cost Plus GMP	Lump Sum Unit Price Cost Plus GMP	Lump Sum Unit Price Cost Plus GMP	Lump Sum GMP	Unique to Project
Award	Bid. Cap. Negotiate. Qual &Price Time & Price. Qual, Time and Price	Bid. Negotiate. Qual &Price Time & Price. Qual, Time and Price	Bid. Cap. Negotiate. Qual &Price Time & Price. Qual,Time and Price	Bid. Cap. Negotiate. Qual &Price. Time & Price. Q, Time and Price. Des & Price	Bid. Cap. Negotiate. Qual &Price. Time & Price. Q, Time and Price. Des & Price	Bid. Cap. Negotiate. Qual &Price. Time & Price. Qual,Time and Price Des & Price

Table 34: Type of construction contracting methods.
Source: (Gordon, 1994).

The regulation and laws that are analysed to explore the procurement approaches in delivering a public-sector project in Saudi Arabia are: Government Tenders and Procurement Law (STPL); Implementing Regulations of the STPL; Consulting Engineering Services Contract (Design); Consulting Engineering Services Contract (Supervision); Public Work Contract (PWC), and Contractor Classification Law (CCL).

4.2.4.1 Procurement Method:

The STPL regulate procedures for tenders and procurements carried out by government authorities. This includes any product and services of any amount where a Saudi government agency will be the beneficiary. Thus, services such as design, consultant, and construction are under the law.

In 1977, the Saudi government and procurement law was published for the first time by the highest authority in the Kingdom (Royal Decree Number M/14). This system has been republished with minor changes in 2006 (Royal-Decree-No.M/58, 2006). In 2007, the Implementing Regulations of the STPL document were published by the MOF. Both documents have been analysed by the researcher.

As seen in Figure 29, according to Article 6 of the STPL "All government works, and purchases shall be subject to public competition except for those exempted from competition under the provisions of this Law". This includes designer, consultant, and construction services. The other two purchase methods are direct purchase and specific purchase which used in cases for emergency and specific purchases such as weapons and mechanical parts.

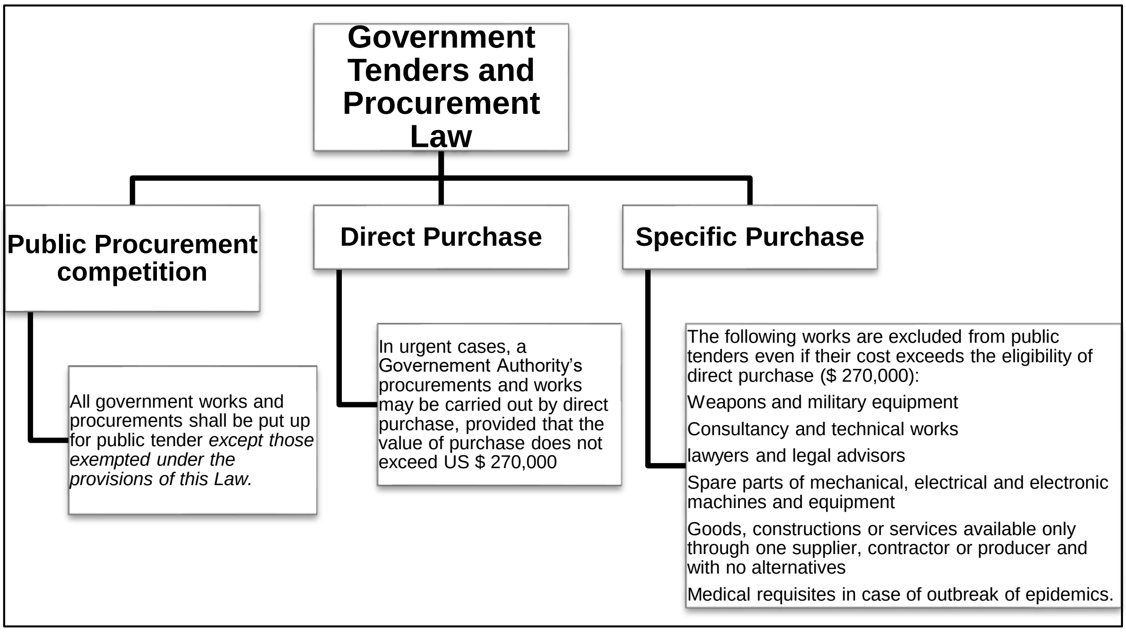

Figure 29: Types of purchases in the Saudi public sector.
Source: (Royal-Decree-No.M/58, 2006).

Although there is no direct mention in the STPL about the procurement approach that should be used in Saudi Arabia to deliver construction projects, as it is used to procure all government works and services, Article 29 states: “In the preparation of contracts, government agencies are obliged to use approved contract forms”. The formal contracts, which should be used for any construction services that are funded by the government, show a separate contract between the design, consultant, and construction services, and there is no other formal contract that combined between the design and construction services. Moreover, the law in multi Articles is explicit that an agency should prepare "detailed technical specifications" for the projects before a tender takes place. To confirm this, the researcher has reviewed construction projects’ tender announcements in the multi-agencies websites and can confirm that all the announcements mention drawings and BOQs to be purchased. Saudi public agencies use a quadripartite governance structure (client-contractor-consultant-Designer). However, the dispute resolution party is not existing in the governance structure.

Based on the above facts, the procurement approach uses a traditional approach (Design-Bid-Build) DBB. For contractors in Saudi Arabia, based on the Gordon classification, the contractors' scope is construction, using prime contractor organisation and unit price contract, and chosen based on bid award. These will be investigated thoroughly in the next sections.

Focusing on the approach used in the Saudi Public sector (DBB), the main feature of this approach is: the public agency will be in an individual contractual relationship with the other three parties (designer, consultant, and contractor). The contracts used with each party will be discussed further in section (4.2.4.3). The design, tendering, and construction processes in this approach are conducted sequentially. Thus, the processes and parties responsible for this approach are fragmented. The sequential delivery raises one of the main positive points about the DBB where the scope definition and Design at the commencement of construction are fully developed. Thus, the owner's requirements are transmitted, as well as the parties involved (owner and contractors) being more aware and able to measure risks involved in the projects at construction stages. The disadvantages are that projects are constructed over a more extended period as well as the coordination being weak because of the fragmented process. Nevertheless, the certainty and predictability in this approach might be abused or lost which is more related to the nature of the construction industry where the factors that could affect projects during development and construction cannot be entirely anticipated.

The procurement process, which is applied to appointed designers, consultants, and contractors separately, and to different stages as Figure 28 shows, are summarised in Table 35.

4.2.4.2 Awarding practice:

The selection of appropriate service provider (supplier) that is capable of successfully developing and delivering the project is one of the important decisions faced by clients and affect the project success (Holt, 1995; Yang et al., 2003). According to the STPL, a government purchases provider could be chosen based on three types (Figure 30), based on which, construction services are delivered using Close/Selective Tender and Open Tender forms. However, the criteria for choosing providers remains the same, which is the lowest price (Table 36).

Name	Requirement and explanation
Tender Announcement	• The competition should be announced in 2 local newspaper and the public agency website. • The announcement of competition should contain clear and comprehensive information about the product/services, with the following minimum information: • Name of the organisation • Competition number, description and purpose • Classification area • price of tender documents and place of sale • Time and place to submit bids and open envelopes. • Minimum 30 days between the announcement day and submit bids day.
Tender Document purchase	• The only service provider who purchases the documents could submit their bid.
Bid Submission	• Bids should be submitted in writing on the original forms that have been purchased from the government agency and placed in stamped envelopes. • Tender Submission Documents are: • Bid bond (1% of the total bid). • Classification in business. • Certificates (Commercial Register, Zakat or tax payment, Social Insurance, affiliation to the Chamber of Commerce). • Achieve the minimum percentage of jobs nationalization. • Official tender letter with the total amount. • Priced BOQ (in case of construction service).
Open Envelopes	• The envelopes are opened by a committee. • The envelopes are opened at the specified hour and day.
Tenders Analyse	• The tenders are analysed by a committee which has the authority to include and exclude tenders and recommend which offer should be awarded. • The committee recommends that the offers be awarded to the lowest bidder. • The committee cannot exclude bids on the grounds of low prices unless it is 35% or more below the estimates of the government authority and prevailing prices.
Awarding Decision	• The Minister has the power to award the winning bid. • An official Awarding letter will be handed to the winner. • The winner should submit a Performance Bond equal to 5% of the total bid within ten days.
Financial Approval by MoF.	• In case the service contract costs more than USD 1.3 M or is over a one-year duration.

Sing Contract	• Use the formal contracts that are issued by the MOF. • The contract is between governmental authority and the business owner. • The contractor is responsible for reviewing all engineering and technical designs and must notify of any technical errors affecting the safety of the establishments or find errors in specifications or drawings. • The Contractor cannot refuse or minimize their performance in providing his obligations, based on the breach from the Government's side. • The Government Authority may increase the obligations of the Contractor within the scope of the contract by not more than 10% of the total value of the contract or reduce these obligations by not more than 20%.

Table 35: Procurement process in Saudi public sector.
Source: (Royal-Decree-No.M/58, 2006).

Service Providers	Tender Form	Awarding Criteria
Designer	Close/Selective Tender	Lowest Price
Consultant	Close/Selective Tender	
Main Contractor	Open Tender	

Table 36: Service providers tender forms and awarding criteria.

Focusing on the contractors' tender form, construction projects' contractors are selected on an open tender approach, and the lowest bid is awarded even if bidding is less than the estimated budget by up to 35% (Royal-Decree-No.M/58, 2006). A positive point about the Open Tender form is that service providers are selected on an unbiased base. Moreover, the owner will gain the lowest price because of the extensive competition. It is also considered as a safe mechanism, as suppliers will be less likely to collaborate in raising their bids. On the other hand, the open tender mechanism is less attractive for experienced suppliers because of high competition and that the lowest price wins. Furthermore, analysing a large number of bidding documents might consume a significant amount of time and money.

The STPL claim that the approach is chosen to protect public funds from corruption and to execute projects at the lowest possible cost, however, the approach might lead to the choice of unqualified contractors or not deliver projects on the best value for money. This could explain the unanimous answer by all the interviewees (owner and consultant) which repeatedly mentioned "the unqualified contractors".

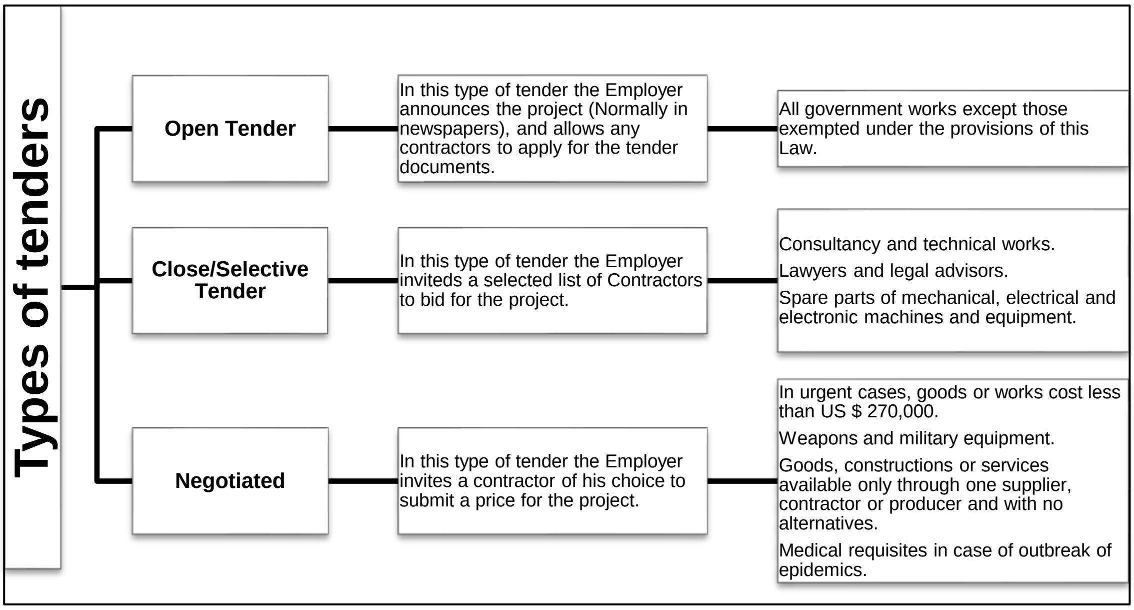

Figure 30: Types of purchases in the Saudi public sector, according to the tender forms.

The STPL and its Implementing Regulations' articles ensure that financial criteria should be the main ones to be applied at the analysis step, and that the lowest price should win (even if it is lower than the 35%) the competition, which could be partly explained by the fact that the implementing regulation are issued by the MOF. According to the law "No offer may be excluded on the grounds that it is technically unsuitable as long as it complies with the conditions and specifications established and is consistent with the provisions of the Regulation." In fact, before the analysis committee can recommend excluding a bid on the base of low price (lower than 35% of the estimated price), capability, or capacity, the committee must:

- Review the estimated price by the client and ensuring the moderation of the estimated indicative prices and their compatibility with prevailing market prices at the time of bidding.
- Assess the technical expertise of the bidder and similar works carried out by him.
- Assess the financial position of the bidder to ascertain his financial ability and potential.
- Discuss the bidder to clarify the bases and criteria for estimating bid prices.
- A total agreement from the committee members that prices are very low.

Otherwise, the committee should recommend awarding the lowest price bid. The process according to interviewees is lengthy and time-consuming and it unreasonable to be done within the time frame given by the law (within 30 days).

Moreover, the accuracy of excluding the lowest price bids is questionable as each ministry procures hundreds of bids each year.

Another example; the regulation that the “MOF Representative” should be a member of the committee but not mentioned any other experienced member of any main technical field. Thus, the technical analysis for the committee is questionable, especially for consultant and design services where the negative outputs of the products do not appear until the construction phase.

Bajaber and Taha (2012) claim that using the open tender method without contractors’ prequalification will result in schedule delays, cost overruns, very low quality, and many disputes. This also supported by other authors who believe that no matter which awarding approach is adopted, analysing the provider’s technical and financial capability is critical to project success (Merna and Smith, 1990; Moselhi and Martinelli, 1990; Herbert and Biggart, 1993). However, for the Saudi public sector, there is no formal classification system for design and consultant services. For the construction sector, there was no one until 2006.

In 2006, the Saudi government introduced its contractor's classification system (SCC). The system aims to classify contractors, who want to work on public projects that cost more than USD 1.1 Million, to a level which is commensurate with their financial, technical, administrative and executive abilities. The system divides works into twelve categories, and ranks contractors into five grades in each category, from 1, which is assigned to large companies, to 5, which is allocated to small firms. The government specifies a minimum grade for each proposed project,and only contractors at that level or higher are allowed to bid. According to the law, the total of the contractor’s bid will not be accepted if it is higher than his range in Table 37. For example, if a contractor is classified as 3rd in the building field, his bid will not be accepted if it is more than USD 18.6 million.

There is an argument as to whether the classification system is enough as a tool for classifying contractors. According to the interviewees, the lack of classification system or tools that reflect the designer and consultants capabilities are more likely to lead to poor design and consultancy, especially when chosen based on lowest price — this relates to the lack of awareness of the importance of the designer and consultant by the decision makers. The data from the interviews show that the decision makers are tricked by the small cost of design and consultant services (compared to construction) and focus on solving the problem at the construction stage with the contractor, thereby ignoring the real trigger of the issues which is before the construction phase.

The classification system has been criticised by all the interviewees from the owner side. The contractors' classification system, according to the owner interviewees, is limited and does not reflect the contractor's actual capabilities. Nevertheless, the system is not including all types of projects, for example, small projects (less than USD 1.1 M) are not included in the classification, i.e. any contractor could apply for projects' tender. The owner side interviewees mentioned that the classification system is outdated and not reflecting the rising complexity in construction projects. Moreover, they mentioned that the classification certificate, which is provided during the tender stage to the owner to asses tenders' technical abilities, is only mentioned in the degree but is not clear about the exact technical ability and records of his previous jobs. i.e. the technical abilities of contractors in the same degree classification vary, but a contractors classification certificate does not reflect that.

Construction Fields		**Contractors' classification degree and the highest contract's value in (US $ millions)**					
		1st	**2nd**	**3rd**	**4th**	**5th**	**Without Classification**
Buildings	Budget	More than 74	74	18.6	5.6	1.8	1.1
Roads	Budget	More than 112	112	37.3	11	3.7	1.1
Water & Sanitation Works	Budget	More than 112	112	37.3	11	3.7	1.1
Electrical Works	Budget	More than 74	74	18.6	5.6	1.8	1.1
Mechanical Works	Budget	More than 74	74	18.6	5.6	1.8	1.1
Electronic Works	Budget	More than 74	74	18.6	5.6	1.8	1.1
Industrial Works	Budget	More than 112	112	37.3	11	3.7	1.1
Marine Works	Budget	More than 112	112	37.3	11	3.7	1.1
Dams	Budget	More than 37	37	11.2	5.6	1.8	1.1
Landscaping	Budget	More than 37	37	11.2	5.6	1.8	1.1
Well Drilling	Budget	More than 3.7	3.7	1.1	0.4	0.1	0.03

Table 37: Contractors' classification categories and degrees.
Source: (Contractors classification agency, 2010).

From the owner perspective, owner representatives (Engineers who represent the ministry) believe that the system should not replace the technical analysis by the technical committee form of the different engineering departments, but be used along with it, which is not the current method used right now, in order to get the best qualification tool for bids.

4.2.4.3 Public Work Contracts with Designer, Consultant, and Contractor:

As mentioned earlier, a public authority uses different contracts to engage with each designer, consultant, and contractor (Table 38). The main point identified is that the three contracts are used for all type, size, and complexity of projects.

Moreover, the contracts do not allow service providers (designer, consultant, nor contractor) to negotiate conditions (contracts of adhesion “take it or leave it” that gives no ability to negotiate) (Council of Ministers, 1988). As this study is about the contractors’ cost overrun, only the contract that relates to contractors (PWC) will be further investigated.

In 1988, the Saudi Government adopted a standard form of contract for all public works, known as a Public Work Contract (PWC). Although the source of PWC has not been disclosed, Cowling (2011) and Al-Qassem (2004) claimed that the PWC is based on the 3rd edition of the FIDIC conditions of contract (1977). The PWC is used for all kinds of projects (civil, mechanical) and all degrees of project complexity.

Between	**And**	**Contract name**
Public Agencies	Designer	Consulting engineering services contract (Design)
	Consultant	Consulting engineering services contract (Supervision)
	Main contractor	Public Work Contract (PWC)

Table 38: Public work contract with different service providers.

There are some benefits to using one form contract for all public works, such as getting more experience in the use of that form and developing it. However, it seems that the PWC has not benefited from that, as small modifications were made to it only once, in 2007 (Gulman, 2012).

This contract comprises the following documents: basic contract document and general conditions. Moreover, there are appendixes to the contract which are part of the contract: special conditions (if any); special specifications (if any); plans and drawings; general specifications; BOQ, letter of award.

The basic document contains seven articles that illustrate the following: contracting parties, the purpose of the contract, contract documents, contract duration, contract value, contractor responsibility, payment method, and that the contract is subject to the laws of Saudi Arabia.

The general conditions contain sixty-one articles covering: general obligations, rights and duties, powers of the engineer; assignment to others and subcontracting; suspension of work and change orders; fines; preliminary and final handovers; maintenance, and finally, withdrawing the work from the contractor.

The general conditions were evaluated by Ibn-Homaid (2006) based on eleven factors that have been ranked by owners, contractors and consultants, and it was concluded that the PWC general conditions are “barely adequate”.

Different studies identify the PWC as one of the primary reasons for the underachievement of government projects in Saudi Arabia. The Saudi National Anti-Corruption Commission analysis of 800 governmental defaulted projects ranked the PWC as one of the common leading causes of defaulted projects (Al-Rabiah, 2013). A document was issued by the contractors' committee in the Chamber of Commerce and Industry stating that the PWC is one of the main reasons for the underachievement of public project performance and emphasising that using fair and balanced contracts, such as FIDIC, would decrease the number of defaulted Projects (Alshele, 2013).

Broadly, the PWC general conditions were evaluated by owners, contractors and consultants in Ibn-Homaid (2006) study and it was again concluded that the PWC is "barely adequate". From the documents and interviews the following points have been identified:

Contract Clarity:

The basis of the relationship between two parties in construction projects are the terms of the contract, and the more contractual clauses between the owner and the contractor are clear, balanced and fair to the parties, the better the relationship, leading to a successful project. However, the PWC is full of articles that are not clear, nor complete. For example, Article 10.2 states: "The Contractor shall be responsible for reviewing engineering and technical designs in full detail and shall notify the Work Owner and the Engineer of any errors or observations it discovers in the plans and drawings during work execution". Several questions might be raised because of the article's incompleteness including but not limited to: Is there a time limit? When does it start and end? Would an extension to the contract duration be considered? What is the procedure to notify the owner? What is the limit of these mistakes? If errors lead to redesigning, who should be responsible for the redesign? Based on this limitation, a project's owner and the contractor might assume different answers for the above questions, a dispute between them will accrue, and project performance will be affected. Moreover, contractors' pricing is going to be less accurate as their responsibility and risks are not fully clear. This agrees with Ibn-Homaid (2006) study which found that only 45% of contractors and owners think the PWC's general terms are complete.

PWC Risk Appropriation:

Literature shows that a contract should be balanced when apportioning risk, and the best practice for managing risk is allocating it to the party that can best control it.

The imbalanced contract is the main cause for tension between parties, project abandonment, drop in the building activities, lousy reputation and inability to secure project finance or securing it at higher costs due to added risks (Mbachu and Nkado, 2004).

Beside the PWC ambiguities, reviewing the 65 PWC articles found the PWC does not follow 'balanced' practice, as most of the projects' risks are assigned to contractors, even the ones which are under the owners' control such as payment delay for completed work. Moreover, there is a full and overstatement of the contractor's responsibilities and obligations; in all the PWC articles, contractors' duties and responsibilities are clearer than their rights. Most of the articles state the contractors' responsibilities (the contractor is responsible for …) and limit the statement of rights (the contractor has the right to ....). Contractors' interviewees confirm that some of the government agencies develop "unfair special conditions" by using a special conditions appendix to allocate risks to contractors that have not been mentioned in the general conditions, thereby passing the problem to contractors. In some cases, contractors have been asked to redesign a building's foundations depending on the soil test, and re-update the technical specification to suit the civil defence specification.

Literature shows an agreement with this finding; Abbas (1998) described the PWC as a "one-sided" contract that allocates too many risks to contractors. Cowling (2011) also believes that the PWC risk allocation mechanism is different from the one that the international construction industry may be used to.

The data suggested that an imbalanced contract is related to it having been written by the MoF. It is assumed that the documents are prepared by a team from different majors such as Engineering, Law, and Finance. However, the PWC is produced by MoF, which arguably provides contracts' texts and conditions that protect the owner and may contribute to any extra cost. For example, one of the risks that shift to the contractors is the payment delay, where according to PWC, contractors are expected to produce work and should not suspend work based on payment delay (Article 59).

However, data shows that owner representatives are unaware of the fact that most of the risks are allocated to the contractors and also of their effects on project performance and relationship. Interviews evidence that the interviewees from the owner's side believe that the risk appropriation is balanced in the PWC and in their opinion risks are not mainly held by the contractor. Contractors, however, believe that they hold all of the risks and not the owner. Similar positions are found in Ibn-

Homaid (2006) study which found that the “contract fairness” factor is the only factor that both owners and contractors disagree on. 65% of owners in the sample believe that PWC is a fair contract compared to only 33% of the contractors’ sample.

From the interviews with both contractors and owner, there were agreements and disagreement regarding which risks contractors should be holding. Both parties believe that technology risks should be held by the contractors as he is the most experienced. However, there is disagreement in the risks related to payment delay and decision-making delay, as contractors believe these should be held by owners. Interestingly, when contractors were asked which risks an owner should be responsible for, they allocated only three risk categories (delay of payment, change of design, and lack of works’ scope and definition). From the interviews, contractors believe that owners, which is meant by that the engineers who represent the owner, are less knowledgeable than them which is logical as contractors interact with technical challenges. This was clearer during the interview as contractors mentioned “knowledge of owner/representative” as a risk should be considered during the pricing tenders.

Although allocating all technical risks to the contractors might not be the best practice in another context, In Saudi Arabia, Khaliluddin (2010) and AL-Salman (2004) show that this is normal practice. Both studies show unfair risk allocation in that the projects’ risks allocated to owners is either a minuscule number or none, while contractors are holding more than half of the risks categories (Table 39).

Study	**Alslman (2004)**		**Khaliluddin (2010)**	
Type of contract	Lump sum		General	
Responders	Contractor		Project managers	
Total number of risks	25		36	
Type of risk allocation				
	Perception	Practice	Perception	Practice
Contractor	6	17	10	14
Owner	3	0	3	2
Shared	4	2	10	7
Undecided	12	6	13	13

Table 39: Risk allocation in the Saudi construction sector.

Unequal party:

The contract signed between the parties should give the contractor the right to be an equal party with the employer and the consultant. However, most Saudi laws and regulations maximise the role of the State and put it in a higher degree in comparison to another party because the state manages public interests.

Therefore, there is no room for equal rights between the ministry, which manages public utilities and affairs, and the other three parties (designer, consultant, and contractors) who are considered as the private sector. The PWC review shows that contract articles give the hegemony to the owner and his representatives over other parties (designer, consultant, and contractor).

The contractor is under the full control of the owner, and this power is often exploited to pressure the contractor to waive his rights in the contract, and the contractor is always worried that the loss of his rights would happen if any dispute occurred, no matter how simple, and is often forced to implement things outside the contract (requested by the owner) in order to avoid what the owner can exploit in these contracts. Although not all the corresponding contractors' identified exploitation by the owner, they agreed that the contract allows such exploitation.

This could explain the acceptance by contractors of the unfair contract which is not accepted by most of the contractors in Saudi and other countries in normal condition, however, the general conditions of the PWC are fixed and are not negotiable.

Encourage bad bids:

The procurement approach encourages two types of bids: suicide bidding and over-price bidding, neither of which are beneficial to the client/public. The Saudi construction market is competitive with more than 3500 classified contractors and 1.2 M construction enterprises (CDSI, 2014) and the STPL awarding projects on the base of the lowest bid even if bidding is less than an estimated budget by 35%, which increases the likelihood of choosing unqualified contractors and/or suicide bidding. Combining this selection approach with ambiguous contract conditions that allocate most of the risks to the contractor, results in projects usually not finished on time and/or to quality, and endless claims from both sides. This is challenging for contractors, as one of the main contractors' successes criteria is to finish the project on price or achieve a lower figure to make a profit (Elattar, 2009). Contractors might face bankruptcy or/and abandon that project, triggering the process of re-tendering, which has a negative impact on all the project's parties. In this lose-lose situation, it should not be a surprise that the Saudi national anti-corruption commission reported 3000 defaulted construction projects in 2013 (SNAC, 2013). On the other hand, contractors cover the unusually high number of allocated risks with very high markups (Shash and Abdul-Hadi, 1992) and end with over-price bidding (Alhzaha, 2013). Under the above conditions, contractors of Saudi public projects are more likely to suffer from cost overruns.

4.3 Objective Two:

The Saudi public construction project delivering process has not previously been explored nor assessed. Nevertheless, the weaknesses of the context and process in leading to contractors' cost overrun has not been discussed in the literature. In this objective, the key weaknesses within the context and current practices that are affected the contractors' performance will be identified.

Problems and issues in the construction industry in developing countries, such as Saudi Arabia, have been studied since the 1960s and it has been found that they are complex, fundamental, and embedded in the context system, as well as increasing in extent and severity over the years (Ofori, 2004).

According to Ofori (2000a) the common problems that face construction industries in developing countries, and which are out of the industry's control, are related to construction materials (shortages, etc.), technology (low level of technological development), lack of technical skills, and complex procedure regulations and contracts. In line with this, the Saudi construction industry faces considerable challenges from the various forces that are embedded within the context and the process of delivering construction projects (as explained in Objective One).

Objective Two aims to identify and explain weaknesses within the process and practises of delivering a public construction project that could affect the contractors' performance. To add value to the identification of the weaknesses in the processes and practises, the contribution factors, which are the factors within the context of Saudi Arabia that could inflate the effect of the weak points, will also be identified. The data have been analysed after being collected using the literature and interview based approaches explained in section 3.10.

The identification of the weaknesses also is going to be beneficial for other researches that aim to improve the public projects' performance. Beside the poor performance exploration in section 2.6.1, the Saudi Arabian Minister of State admitted, during the announcement of the state budget 2016, that in 2015 a review over the five-year plan's records shows that 7,200 government projects are in default with a total value of about 1.0 trillion riyals (44.8% of the total value of government projects between 2005-2015) (Omari, 2016).

The identification of the weaknesses will be through a focus on the context, processes and practises that have been explored in chapter two and objective one. This is logical, as the high number of projects which are under different ministries (owners) suggests that the weaknesses are context, processes and practices related, rather than related to one agency or party.

4.3.1 Context weaknesses:

The context in which a construction project is developed and built has an impact on the project's performance. The following weaknesses have been identified through the data analyses.

4.3.1.1 Lack of a stable environment:

The major data inputs affecting the annual plan and project development do not lie within the technical level authority. The main effects come from the functional level and the external environment, both of which are not unusual to change, as mentioned in the interviews. However, such a weakness usually leads to a change in the projects' scope and objectives. Interviews have given examples where project scope has been changed at a very late stage of construction, leading to the project being suspended, sometimes for years, before receiving authorisation and funds to apply the changes in the scope.

In addition to the unpredictability of the input factors, data suggest both a lack of awareness in the higher levels of organisational structure of the effect of such change, and a lack of learning from suspended projects.

4.3.1.2 Lack of legitimate legal mechanism:

The development of a legitimate legal mechanism is one of the most important points that complement the balance of contracts in the matter of liabilities and damages. It prevents a party from abusing his powers. However, it is not unusual that contractors face a public owner who abuses his powers.

According to the contractors' interviewees, going to court to prevent abuse could cost more than the abuse because of a lengthy delay. The unlawful confiscation of the contractor's bonds is one of the abuses of power that was given to the owner by the PWC. Contractors also mentioned the lack of a fair compensation system within the legal system encourages them to avoid any misunderstanding or clash with the owner.

The above points (raised by interviewees) agree with the literature criticising the mechanism of the Saudi legal system relevant to the public sector, for which weaknesses were discussed in section 2.6.1.

4.3.1.3 Nature of the industry weaknesses:

The different nature of the construction industry and its supply chain compared to other industries such as manufacturing is one of the main reasons limiting the ability to adopt solutions from other industries such as manufacturing (O'brien, 1999). Some specific weaknesses of the construction industry (identified from the data) that differentiate the industry from other industries and lead to poor performance in projects are:

- Project-based production systems
- Customer influence
- Buyer-supplier relationship
- Low invest in training and development
- Participants' multiple goals
- Temporary relationship(s)
- Fragmentation within the industry
- Resistance to change nature
- Number and type of stakeholders
- Lack of openness and opportunistic behaviour

Saudi public construction is not the only industry suffering from such characteristics; literature suggests this is the norm of the construction industry worldwide (Fearne and Fowler, 2006; Pesämaa et al., 2009; Kornelius and Wamelink, 1998; Miller et al., 2002; Lu and Yan, 2007; Arantes et al., 2015; Egan, 1998; Cheng et al., 2010; Love et al., 2002; Baiden et al., 2006; Hu, 2008; Briscoe and Dainty, 2005; Yadav and Ray, 2015; Kumaraswamy et al., 2005; Cheng et al., 2001; Xue et al., 2007; Huxham, 1996; Cox and Townsend, 1998).

4.3.2 Organisational structure weaknesses:

The data identify the following weaknesses in the organisational structure

4.3.2.1 Traditional organisational structure:

As shown in section (4.2.1), the administrative levels build relations, in response to regulations, in a vertical manner; control flows from the top of the structure down. The organisational structure is bureaucratic, rigid, inflexible, and centralised, with authority vertically flowing between connections according to hierarchical channels only. Moreover, the decision-making process is governed by formal regulations and precise instructions. Such a structure builds a gap between the various departments and the top of the management hierarchy as well as impeding communication (Lowry, 2001). Moreover, the structure causes problems among the members of the agency, resulting in tension and dissatisfaction and thus a lack of productivity and poor quality which is further affected by the structure being less responsive to changes to the external environment surrounding the structure. Nevertheless, decision-making regarding the degree of delegation of authority to subordinates is weak, resulting in a lack of flexibility within the structure. This lack of flexibility leads to a poor organisational climate, employees always feeling under pressure, and many restrictions that prevent creativity and productivity.

4.3.2.2 The absence of a project management role:

The organisation structure applied by the Saudi public organisation normally covers tens of projects at a time, leading to inefficiencies and significant transaction costs (explained in section 4.2.1). Moreover, unlike contractors, the concept of the project manager as identified in the literature (project manager as the client's representative, responsible for project success, and oversees all project aspects including planning, developing, implementing, and closure (Love et al., 1998)), is not applied by the Saudi public authorities. Project manager responsibilities and their implementation are segmented over departments and persons (section 4.2.1) and, to make it worse; the current structure regulations do not support or encourage integration, cooperation, in addition to there being unusual communication systems between professionals (owner representatives in different phases and within the same phase; see section 4.2.3).

4.3.2.3 Decision-making cycle:

The essence for an organisation's success is the efficiency of the decision-making process as it significantly affects achieving of its objectives; some studies link the efficiency of any organisation to the efficiency of decisions taken at different levels. However, the data shows that decision-making in a Saudi public context is centralised in the hands of senior management – a situation linked with killing ambition and creativity among staff and ignoring uniqueness among projects as the interviews data shows.

In the Saudi public case, inflexible regulations, laws, and rules issued from outside sources (the Council of Ministers and MOF), make no room for a public organisation to go out of the norm for creativity in decision making as one response to construction projects becoming more complex and creative.

An excellent example of the effect of decisions on construction projects is the critical decision of choosing the service provider (designer, consultant, and contractor). According to the STPL, the minister has the authority to make that decision based on the tender analysis committee's recommendation (explained thoroughly in section 4.2.4). Although the decision is a crucial decision, the following weak points can be identified:

- The decision process is confined to inflexible regulations.
- Top management decision; the departments that are working directly with providers are not participating in the process.
- Due to the centrality of the decisions, the degree of delegation is low, and the powers are governed by the regulations.
- The decision cycle is long and complicated.

4.3.2.4 Communication:

As a result of the central system, bureaucratic structure, and the depth of the organisational structure in a public agency, the coordination between the various departments, communication system, and the work procedures are poor (a vertical form from top to bottom and vice versa), can be centralised, and requires a long cycle to achieve its objectives.

Poor flow of information between the decision makers (top management level) and the departments that interact with projects directly leads to a blockage within the information exchange channels, thereby leading to project delay. Interviewees mention that decisions could take over a year to be taken, leading them to suspend work on that part of the project.

Lack of communication mechanism between professionals and departments in the current method means that problems in the specific phase are handled by the department responsible for that phase only.

4.3.3 Procurement weaknesses:

The procurement approach has been discussed in section 4.2.4. Some of the weaknesses that have been discussed are:

- No Selection (Fixed approach) of project delivery approach.
- No Selection (Fixed approach) of service providers approach.
- Poor Selection of mode of payment.

- The owner may take advantage of the contractor
- The general contract of construction does not specify the administrative structure of the employer.
- The weaknesses of the contract are linked to the weaknesses of the general organisation structure.
- Giving the Ministry Engineer (owner representative) absolute powers.
- Failure to give the Consultant Engineer his due powers.
- The consultant and the contractor shall bear all responsibilities in case of violations.

The research resources that discuss the PWC are very limited; very few studies were found. The researcher examined the PWC and compared it to the FIDIC building and engineering works contract, designed by the employer (Red Book). The reason of choosing the FIDIC contract that the claim by the contractors' committee in the Chamber of Commerce and Industry and the statement by the official spokesman for FIDIC in the Arab Gulf region that adopting the FIDIC contract for the public sector will decrease defaulted projects by 70% (AlKanani, 2012).

The researcher's findings concerning the main parts of the contract that make it different are shown in Figure 31.

The main points of difference between the FIDIC contract and the PWC have been illustrated in Table 40. The points are not limited to the one in the table. However, they are the main ones that could affect the contractors' cost performance.

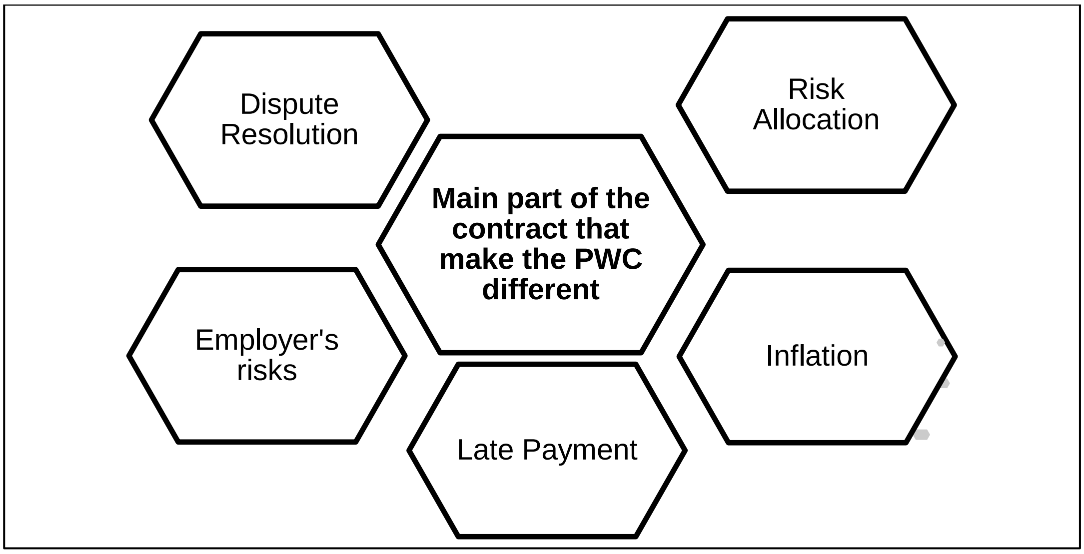

Figure 31: Main part of the contract that makes the PWC different.

Main Part of difference.	FIDIC building and engineering works, designed by the employer	The Public Work Contract
Dispute resolution	The contract outlines a procedure which contains three levels to solve any conflict which occurs: First Level: Project Consultant Second level: Dispute Adjudication Board Third level: Arbitration.	There is a special court to bring cases against government agencies called the "Board of Grievances."
Site Data	It is the Employer's responsibility to make available to the Contractor his information regarding the project sub-surface and hydrological conditions, before and after the Base Date (Article 4.10).	Nothing was mentioned regarding the Employer's responsibility.
Unforeseeable Conditions and Difficulties	If the Contractor encounters unforeseen physical conditions, he will be entitled to a time extension for the delay, and payment of any cost (Article 4.12).	Nothing was mentioned regarding the unforeseen physical conditions. However, it was stated that the Contractor should make his investigation of the site before submitting his tender.
Extension of Time for Completion	The Contractor is entitled to a time extension under the following causes: scope variation, climatic conditions, unforeseeable shortages in the availability of personnel or goods, the delay attributable to the Employer, and delays caused by authorities. The Contractor determines the time extension (Article 8.4 and 8.5).	If the delay is due to unforeseen circumstances or for reasons beyond the contractor's control, the contract will be extended (Article 52). However, the employer determines the time extension.
Suspension of Work	Unless the Contractor causes the suspension, the Contractor is entitled to a time extension for any delay, and payment of any cost. After 112 the contractor could terminate the contract (Article 8.8, 8.9, 8.10 and 8.11).	The owner has the authority to suspend the work progress at any time and without any extra cost if it: • Is stipulated in the contract. • Is necessary, to perform the work properly. • Occurs by reason of weather conditions. • Is the Contractor's default. • Is necessary for the safety of works (Article 32). However, it was not mentioned if the Contractor is entitled to payment of costs for other cases. Moreover, the contractor does not have the authority to terminate the contract under any circumstances.
Adjustments for Changes in Cost	If Contractor provides "table of adjustment data", the cost will be adjusted for rises or falls to the cost of labour, Goods and other inputs to the Works by using a formula (Article 13)	Fixed cost.
Employer' s Risks	The contract mentions Employer's risks if it affects the work progress directly, such as: War, rebellion, terrorism, disorder, the Employer uses any part of the Permanent Works, design, forces of nature which are unforeseeable (Article 17.3).	Nothing was mentioned in the contract about Employer's Risks

Force Majeure	The Force Majeure, which could be defined as an exceptional event or circumstance that is beyond a Party's control, is well defined and examples were given such as (not limited to): war, hostilities, rebellion, terrorism, riot, explosive materials, and natural catastrophes. If the Contractor is prevented from performing his substantial obligations and suffers delay and/or incurs Costs by reason of such Force Majeure, the Contractor shall be entitled subject to a time extension for the delay, and payment of any cost. After 112 any party could terminate, and the contract is entitled to a time extension for payment of any cost that occurs during that time and any expected profit. (Chapter 19).	The Force Majeure is not defined or mentioned in the contract, and only one example was mentioned and could be under the umbrella of Force Majeure Military Action such as war, hostilities, rebellion, terrorism, and explosives. However, if that cause occurs, the contractor must continue his obligations unless the owner asks him to hold work progress. Moreover, the contractor does not have the option to terminate the contract. If the owner terminates the contract, the contractor will not be entitled to any expected profit as it is against Sharia law.

Table 40: Main points of difference between the FIDIC contract and the PWC. Sources: (IFCE, 1999; Royal-Decree-No.M/58, 2006).

4.3.4 Project life cycle weaknesses:

Following the explanation of the project life cycle in section 4.2.2, Where it was shown that the construction project life cycle follows similar cycles to that presented in the literature by different authors (Turner et al. (2009); Wideman (2004)) and that construction projects in Saudi public sectors are executed in segmental and sequential processes and phases, it can be added that different departments and personnel are responsible for handling each phase and requirements, thereby resulting in a fragmented method with deliverables as they are handed over from one phase to the next phase. Decisions also are taken separately and without considering their impact on other phases and professions, which has been argued to build unseen 'walls' between disciplines, professionals and departments, as well as a lack of creativity and innovation (Love et al., 1998). Besides the lack of coordination and communication between participants (Egan, 1998), the literature shows that the current approach has the following weaknesses shown in Table 41.

Main category	Weaknesses Points
Cost	Increase real costs. Margins maintenance. Poor production planning.
Recourses	Poor transparency in transactions. Poor resources utilise.
Value	Poor value-adding across the entire supply chain. Deliver poor value to the client. Uncertainty of out-turn costs. Maximise transaction costs.
Efficiency and effectiveness	Poor internal and external efficiency. Poor competitive advantage.
Innovation	Poor innovation in products, processes and organisation
Processes	Fragmented business processes. Increase waste in the process.
Communication	Poor communication among the collaborating partners.
Relationships	Lack of trust Adversarial inter-organisational relationships. Poor synergy. Short-term relationship.
Experience and learning	Lack of transfer expertise between all parties.
Targets	Project delivered does not meet user needs. Time Overrun. Cost Overrun. Miss organisational goals. Poor customer satisfaction.

Table 41: Weaknesses points in the traditional project life cycle.

4.3.5 Context and practices weakness matrix:

Based on the previous founds in objective two, the research start establishing the linking between the weaknesses that has been identified in Objective Two. The links, which are presented in Table 42, were identified from the data that has been analysed. All the links will be used in model that will be developed in Objective Five.

Phase	Weakness points in the process	Contributed factors	Result in
Planning Phase	Lack of stable environment	Lack of ability and control estimation of future events	Poor project planning
	Fixed project delivery method	Lack of best practices in contracting for construction services	
	Bureaucratic system.	Low commitment to project control through deadlines. Distant relationships with project managers. Change is perceived as negative. Long process between different government agencies. Lack of coordination between owners and government service providers. Number and type of stakeholders	A gap and lack of communication between the departments and top management.
	Traditional organisational structure (Long and complex organisational structure).	The routine in the business without change or development or response to the changes that are external to the environment. Lack of active communication.	Tension and dissatisfaction with work and thus lack of productivity and poor quality.
Design	Choose designers on lowest price.	Not clear about end-user requirements. Lack of designer experience. No contractors, sub-contractors, and supplier's early involvement. Short-term relationship. No classification system for designer. Lack of technical tender assessment.	Premature tender documents (drawings, BOQ, and specifications)
	Choose consultants on lowest price.	Lack of consultant experience. No clear role for consultants during construction phase. Lack of trust between contractors and other parties. Short-term relationship. No classification system for designer. Lack of technical tender assessment.	Poor consultant performance

Phase	Weakness points in the process	Contributed factors	Result in
Implementation Phase	No clear role for consultants during construction phase.	Fragmentation in projects development phases. Projects are developed by different stakeholders.	
	Lack of trust between contractors and other parties.	Short-term relationship.	Adversarial environment between parties.
	Choose contractors on lowest price.	Lack of technical tender assessment. Short-term relationship.	Poor contractors' performance
	Unbalanced risks allocation.	No arbitration options. Very long court process. Lack of legitimate legal mechanism. Participants' multiple goals Owner abuse his authority No resolution office	No compensation against owner Lack of trust between contractors and other parties.
	Short-term relationship between contractors and public sector	No direct contact between contractor sub-contractors, and suppliers and designer. No direct contact between sub-contractors and suppliers with owner, designer and consultant.	Lack of transfer knowledge and expertise between parties. No information sharing between contractors and other parties.
	Method of payment for completed work	Lack of stable economic. Change on the state regulation and economic. Inflation shortage of input resources most of which are imported (material and machinery) weak industries and supply chains with which construction interacts low skilled manpower supplies.	Payment Delay Cost overhead overruns.
	Owners' representative has high authorities over contractors.	Low investment in training and development	Owners' representative abuses his authority

Phase	Weakness points in the process	Contributed factors	Result in
	Lack of communication protocol between the stakeholders	Fragmentation within the industry	Poor communication between projects' stakeholders.
Closure and Handover	No clear hand over process	Customer influence	Projects do not meet user needs.
	Long guarantee duration	Unbalanced contract risks	Contractors' cost overrun

Table 42: Context and practices weakness matrix

4.4 Objective Three:

Although there is an argument that construction project practices should accept cost overrun as part of the industry (Hartmann and Dorée, 2015), the SLR shows that hundreds of studies are investigating the problem. Objective three is to systematically review and evaluate the cost overrun literature to identify the main issues within the cost overrun research. To achieve this objective, cost overrun literature data was collected using a literature review approach.

4.4.1 Data Analysis:

This sub-section is continuing the work presented in chapter three. The formulation of the keyword was already presented (section 3.6.1). As will be shown in this section and based on the data that has been identified, the researcher will analyse the data that will be used to achieve the Objective Three and Objective Four. The 105 resources will be analysed based on different characteristics such as location, followed by excluding the unrelated resources.

4.4.1.1 Resources criteria filtration:

As a continuation of the SLR steps (section 3.6.1), the criteria identified in step one will be applied in the literature review search output that has been presented in chapter three. Table 43 describes the tool that has been used for each criterion.

The number of resources identified through the filtration is shown in Table 44. As a result of applying the criteria to the identification of papers to be included in the data, the number of papers was reduced from over 5700 to 71. The number of papers reduces gradually as each criteria is applied (Table 44).

<table>
<tr><th>Criteria</th><th>Filtration mechanism</th></tr>
<tr><td>Published</td><td rowspan="4">The researcher, where available, used the filter provided by the database. In case no filter is available, all the results went to the next step and were filtered by the researcher in the “research aim” filtration step.</td></tr>
<tr><td>Peer-reviewed</td></tr>
<tr><td>Language</td></tr>
<tr><td>Type of sources</td></tr>
<tr><td>Research aim</td><td>Unlike the previous criteria. A manual technique was used. The researcher filters the articles by their title as a first step, then by their abstract as a second step.</td></tr>
</table>

Table 43: SLR filtration mechanism for SLR criteria.

Database	Number of search results	Number of Prereview	Language	Type	Aim	Remove duplication
ABI Complete (ABI Global)	324	130	130	125	21	21
Business Source Premier	236	232	222	222	15	13
Science Direct - Elsevier	3,291	3,291*	3,291*	3,236	13	10
SAGE journals	62	31	62	31	2	0
Emerald	42	42	42	23	9	4
Willy online library	106	102	102*	102	2	0
Scopus - Elsevier	887	888*	833	594	52	23
Institution of Civil Engineers Digital Library	835	772	772	233	2	0
Total	5783	5488	5454	4566	116	71

Table 44: number of resources through the filtration.
(*) the filter is not available.

4.4.1.2 Literature Review Analysis:

As the above table shows, the evaluating activity resulted in 71 papers being identified. Moreover, 34 new resources were identified through reference list checking. To ease the analysis and synthesis processing, a coding system was introduced for 105 potential resources identified from the previous identification steps (presented in Table 45).

4.4.1.3 Primary analysis:

The 105 resources have been extracted from different databases as Figure 32 shows:

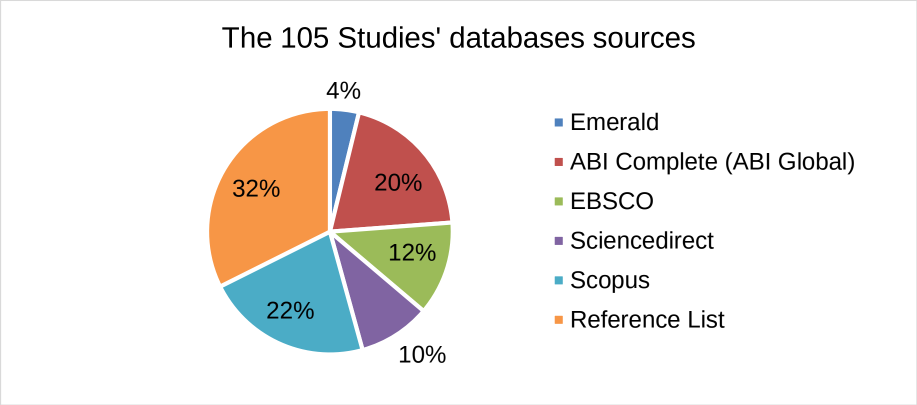

Figure 32: The 105 Studies' databases sources.

The 105 papers have been extracted from 61 Journal titles (Table 46). The leading journal title is presented in Figure 33.

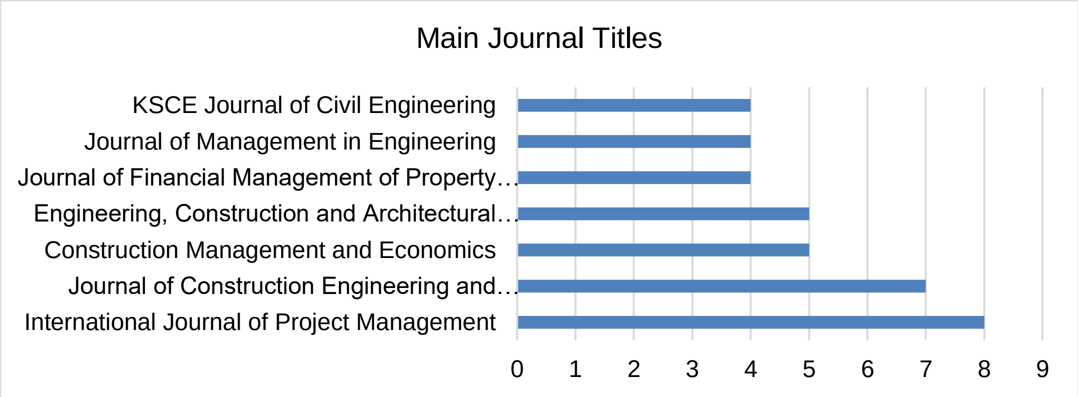

Figure 33: The main journal titles the 105 were extracted from.

On regards location, ten studies contain a study sample from around the world. One of the good examples for that is study No. 91, which contains a sample of 258 projects located in four continents. Two papers contain a sample of data from a specific continent (Asia), and three papers are not applicable to such classification. As Table 47 shows, the rest are spread over 39 countries.

Source	Code	Source	Code	Source	Code	Source	Code	Source	Code
(Famiyeh et al., 2017b)	No. 1	(Iyer and Jha, 2005a)	No. 22	(Toh et al., 2012)	No. 43	(Meier, 2010)	No. 64	(Ahiaga-Dagbui et al., 2016)	No. 85
(Dada and Jagboro, 2007)	No. 2	(Barinov, 2007)	No. 23	(Arditi et al., 1985)	No. 44	(Adafin et al., 2016)	No. 65	(Abderisak et al., 2017)	No. 86
(Park and Papadopoulou, 2012)	No. 3	(Ahsan and Gunawan, 2010)	No. 24	(Bari et al., 2012)	No. 45	(Knight and Fayek, 2000)	No. 66	(Olawale and Sun, 2010)	No. 87
(Enshassi et al., 2009)	No. 4	(Jennings, 2012)	No. 25	(Cheng, 2014)	No. 46	(Memon and Rahman, 2014)	No. 67	(Vu et al., 2016)	No. 88
(Dissanayaka and Kumaraswamy, 1999)	No. 5	(Shing-Tao Chang, 2002)	No. 26	(Aziz, 2013a)	No. 47	(Lee and Kim, 2016)	No. 68	(Cunningham, 2017)	No. 89
(Lu et al., 2017)	No. 6	(Alinaitwe et al., 2013)	No. 27	(Samarghandi et al., 2016)	No. 48	(Shanmuganathan and Baskar, 2015)	No. 69	(Cantarelli et al., 2010)	No. 90
(Skitmore and Drew, 2003)	No. 7	(Shane et al., 2009)	No. 28	(Sovacool et al., 2014)	No. 49	(Mhlanga et al., 2016)	No. 70	(Flyvbjerg et al., 2002)	No. 91
(Nasina and Nallam, 2016)	No. 8	(Creedy et al., 2010b)	No. 29	(Wang and Yuan, 2011b)	No. 50	(Eliufoo, 2017)	No. 71	(Bubshait and Al-Juwairah, 2002)	No. 92
(Meeampol and Ogunlan, 2006)	No. 9	(Ameh et al., 2010)	No. 30	(Nassar et al., 2005)	No. 51	(Allahaim and Liu, 2015)	No. 72	(Jarkas and Haupt, 2015)	No. 93
(Aljohani et al., 2017)	No. 10	(Omran and Mamat, 2011)	No. 31	(Bhargava et al., 2010)	No. 52	(Baloyi and Bekker, 2011)	No. 73	(Singh, 2009a)	No. 94
(Love et al., 2012)	No. 11	(Rosenfeld, 2014)	No. 32	(Enshassi et al., 2010)	No. 53	(Dissanayaka and Kumaraswamy, 1998)	No. 74	(Doloi, 2013)	No. 95
(Frimpong et al., 2003)	No. 12	(Lee, 2008a)	No. 33	(Rashed and Shaqour, 2014)	No. 54	(Durdyev et al., 2012)	No. 75	(Kim et al., 2008)	No. 96
(Kaming et al., 1997b)	No. 13	(Alzebdeh et al., 2015)	No. 34	(Abdul Rahman et al., 2013)	No. 55	(Le-Hoai et al., 2008b)	No. 76	(Abusafiya and Suliman, 2017)	No. 97
(Mahamid and Dmaidi, 2013)	No. 14	(Wanjari and Dobariya, 2016)	No. 35	(Rahman et al., 2013b)	No. 56	(Memon et al., 2011b)	No. 77	(Flyvbjerg, 2008)	No. 98
(Kaliba et al., 2009)	No. 15	(Mahamid, 2014)	No. 36	(Ramabodu and Verster, 2013)	No. 57	(Memon et al., 2012)	No. 78	(Ansar et al., 2014)	No. 99
(Yang and Chen, 2015)	No. 16	(Larsen et al., 2016)	No. 37	(Memon and Rahman, 2013)	No. 58	(Okpala and Aniekwu, 1988)	No. 79	(Flyvbjerg et al., 2009)	No. 100
(Olaniran et al., 2015a)	No. 17	(Derakhshanalavijeh and Teixeira, 2017)	No. 38	(Muya et al., 2013)	No. 59	(Terrill et al., 2016)	No. 80	(Ahiaga-Dagbui and Smith, 2014)	No. 101
(Lind and Brunes, 2015)	No. 18	(Rahman et al., 2013a)	No. 39	(Zafar et al., 2016)	No. 60	(Chimwaso, 2000)	No. 81	(Bhargava et al., 2017)	No. 102
(Mansfield et al., 1994)	No. 19	(Niazi and Painting, 2017)	No. 40	(Kim et al., 2017)	No. 61	(Radujkovic, 1999)	No. 82	(El-Maaty et al.)	No. 103
(Baloi and Price, 2003)	No. 20	(Polat et al., 2014)	No. 41	(Alghonamy, 2015)	No. 62	(Al-Agele and Al-Hassan, 2016)	No. 83	(Love et al., 2016)	No. 104
(Koushki et al., 2005)	No. 21	(Love, 2011)	No. 42	(Hameed Memon et al., 2013)	No. 63	(Love et al., 2015)	No. 84	(Merrow, 2011)	No. 105

Table 45: The coding system for the 105 studies.

Journal	Number of resources	Journal	Number of resources
International Journal of Project Management	8	IEEE Transactions on Engineering Management	1
Journal of Construction Engineering and Management	7	International Journal of advances in applied sciences	1
Construction Management and Economics	5	International Journal of Applied Engineering Research	1
Engineering, Construction and Architectural Management	5	International Journal of Collaborative Enterprise	1
Journal of Financial Management of Property and Construction	4	International Journal of Innovation, Management and Technology	1
Journal of Management in Engineering	4	International Journal of Managing Projects in Business	1
KSCE Journal of Civil Engineering	4	International Journal of Mechanical and Mechatronics Engineering	1
Journal of Construction in Developing Countries	3	International Journal of Science and Management	1
Procedia Engineering	3	International Journal of Sustainable Construction Engineering and Technology	1
Procedia - Social and Behavioral Sciences	3	Investment Management and Financial Innovations	1
Project Management Journal	3	Journal of Applied Sciences	1
International Journal of Construction Management	2	Journal of Academic Research in Economics	1
International Journal of Project Organisation and Management	2	Journal of Civil Engineering and Architecture	1
Journal of Engineering, Design and Technology	2	Journal of Civil Engineering and Management	1
Modern Applied Science	2	Journal of Engineering and Applied Science	1
Acta Structilia	1	Alexandria Engineering Journal	1
Journal of the American planning association	1	Journal of Urban Planning & Development	1
Applied Research Journal	1	Building and Environment	1
Australasian Transport Research Forum Proceedings	1	Proceedings of 2nd International Conference on Construction in Developing Countries	1
Organization, technology & management in construction: an international journal	1	Research Journal of Applied Sciences, Engineering and Technology	1
California Management Review	1	Sadhan	1
Built Environment Project and Asset Management	1	Studies on Russian Economic Development	1
Canadian Journal of Civil Engineering	1	The CIB W55 & W65 Joint Triennial Symposium	1
Cost Engineering	1	The Engineering Economist	1
Computer-Aided Civil and Infrastructure Engineering	1	The IES Journal Part A: Civil & Structural Engineering	1
Energy Policy	1	The Journal of Engineering Research	1
Energy Research and Social Science	1	The Scientific World Journal	1
Engineering	1	Transportation Research Part A	1
Environment and Planning B: Planning and Design	1	World Applied Sciences Journal	1
European Planning Studies	1	None	1
European Journal of Transport and Infrastructure Research	1		

Table 46: All journal titles for the 105.

Country / Region	Number of resources	Country / Region	Number of resources	Country / Region	Number of resources
Malaysia	11	UK	3	Iraq	1
Australasia	6	Vietnam	3	Israel	1
India	5	China	2	Kuwait	1
USA	5	Ghana	2	Mozambique	1
Nigeria	4	Iran	2	New Zealand	1
Palestine	4	Zambia	2	Oman	1
Egypt	3	Afghanistan	1	Pakistan	1
Hong Kong	3	Bahrain	1	Qatar	1
Korea	3	Botswana	1	Russia	1
Saudi Arabia	3	Canada	1	Sweden	1
South Africa	3	Croatia	1	Tanzania	1
Taiwan	3	Denmark	1	Thailand	1
Turkey	3	Indonesia	1	Uganda	1

Table 47: Literature Review location disruptions.

Based on the United Nations country grouping, Figure 34 shows the percentage each group holds. The Latin American and Caribbean group are the only group with no paper which could be related to the language as Spanish is the primary language used in this group. On the other hand, the Asia-Pacific group holds the most significant percentage.

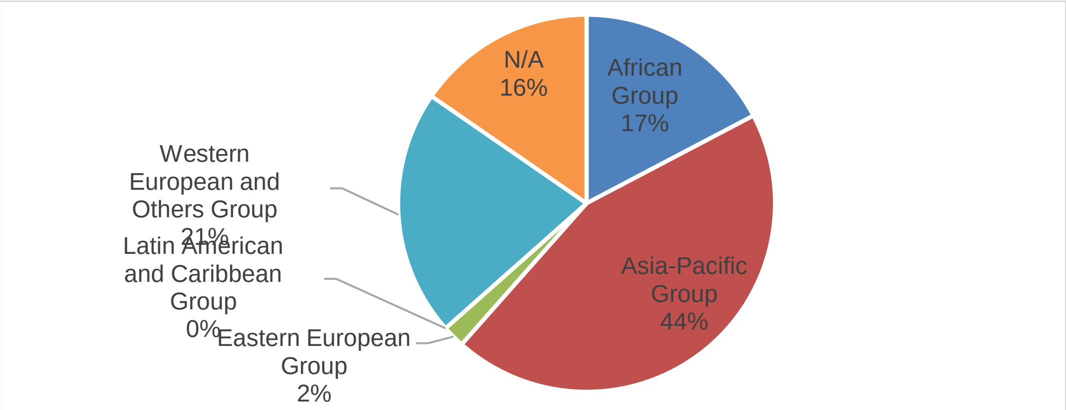

Figure 34: Location country grouping percentage.

The 105 papers were published over the period from 1985 to 2017 and Table 48 shows the number of papers published annually over that period. As Figure 35 shows 93% of the studies are published after 2000.

Year	Number of resources	Year	Number of resources	Year	Number of resources	Year	Number of resources
1985	1	2000	2	2007	2	2013	11
1988	1	2001	1	2008	4	2014	9
1994	1	2002	2	2009	5	2015	9
1997	1	2003	3	2010	8	2016	13
1998	1	2005	3	2011	5	2017	12
1999	2	2006	1	2012	7		

Table 48: Distribution of 105 over the years 1985 - 2017.

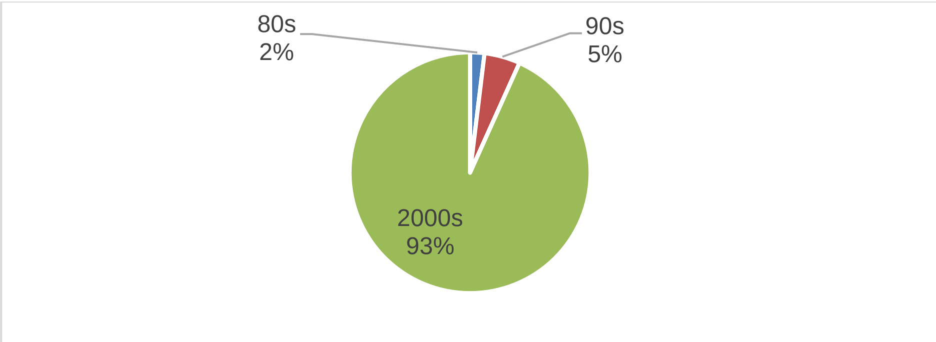

Figure 35: Distribution of 105 in the 80s, 90s, and 2000s.

The main focus of the study is construction projects. Thus studies that focus on construction projects are extracted from the databases. To analysis the sources depending on the construction project type, the research adopted a classification system that is agreed by international organisations such as:

- The International Standard Industrial Classification of All Economic Activities (Statistical Division at United Nations, 2008).
- UK Standard Industrial Classification of Economic Activities 2007 (Office for National Statistics, 2009).
- Statistical Classification of Economic Activities in the European Community (Statistical Office at European Communities, 2008).

The "construction" category excludes the following activities:

- Architectural and engineering.
- Project management.

The main classification section and sub-section can be summarised in Figure 36.

It is worth knowing that not all the papers mentioned which type of construction projects that they were focused on, thus the *construction projects* category is for studies where the focus is not mentioned or is kept general.

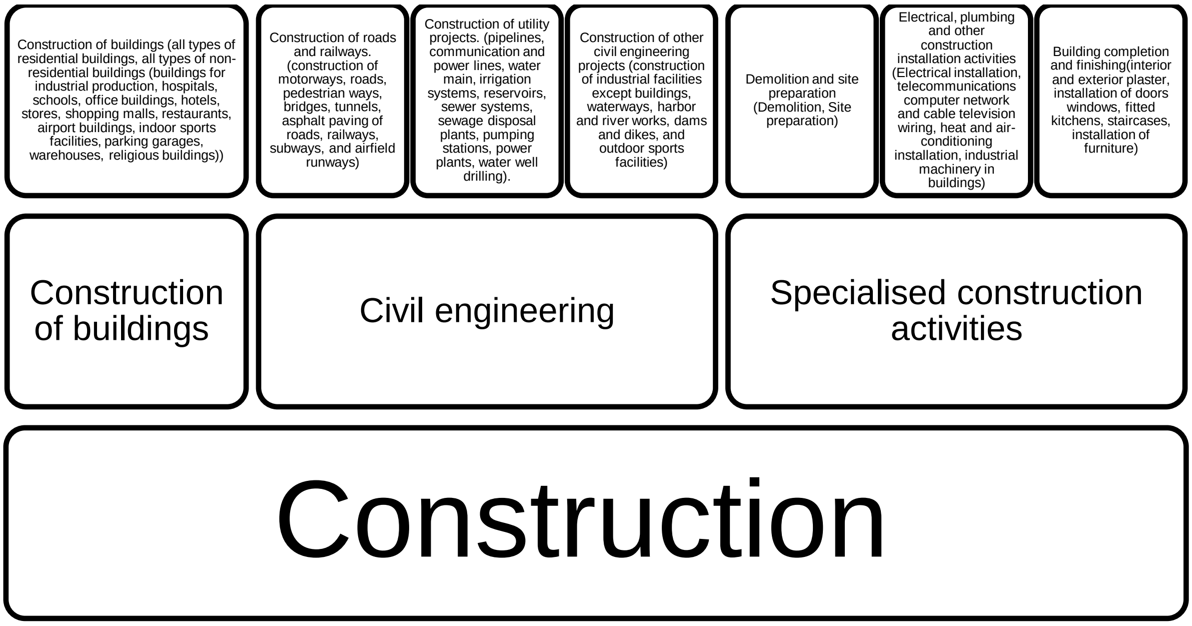

Figure 36: Construction main classification section and sub-section.

Project types	No. of resources	Project included
Construction (Construction of buildings)	26	Educational building, Hospitals, Industrialised Building System, Administrative, Residential.
Construction (Civil engineering)	30	Transport, Pharmaceutical, Groundwater, Hydrocarbon, Wastewater, Olympic Games, Engineering Design, Electricity, Asphalt Paving, Stadia.
B1- Roads and Railways B2- Utility B3- Other	18 9 3	
Construction Projects	46	Not Specific construction project type mentioned.
N/A	2	Not Applicable.

Table 49: Study number based on construction industry classification.

It is not unusual that time and quality performances are measured beside the cost performance in the same study within the construction industry literature. Some studies have found a simultaneous relationship exists between poor cost and time performance and suggest that cost and time performance should be studied together rather than separately (Bhargava et al., 2010). The analysis of the papers' aims and objectives show that three types of research focus exist (Table 50).

Focus	Number of the studies
Focus on cost performance only	77
Focus on cost and time performance	25
Focus on cost, time, and quality performance	2

Table 50: Studies classification based on cost, time, and quality performance.

4.4.1.4 Excluding Processing:

The literature analyse was dependent on the information extracted from a paper's abstract. In addition to this, the researcher did not have access in every case to all the full papers. Papers in Table 51 are those excluded because no access was available to the full paper even though the researcher tried alternative methods. While the researcher has access to the university (RGU) database as well as the Saudi Digital Library database, neither subscribe to the inderscience journal's website (Inder Science, 2019). The author also contacted the below papers' author(s) asking them for an individual copy of their work if that was allowed. However, only one author agreed to do so. Thus, the papers in Table 19 are not included in the analysis:

Study	Journal
No. 50	International Journal of Project Organisation and Management
No. 54	Journal of Engineering and Applied Science
No. 57	International Journal of Project Organisation and Management
No. 69	International Journal of Applied Engineering Research

Table 51: Papers with no access.

It is worth noting that the construction industry has developed rapidly over the last 50 years (Tah and Carr, 2000a). The construction industry environment and stakeholders have changed to become more complex, larger in size, as well as more global. Moreover, the procurement types and contracts have been updated compared to the ones used 20 years ago. Thus, it was decided to exclude the studies that have been conducted before the year 2000 from any further analysis. The total number of excluded resources is 7 (Table 52).

As can be seen from Table 47, some of the geographical regions were the focus of more than one study, therefore the author investigated whether the causes in these studies are duplicated, as this could affect the accuracy of the causes of cost overrun identification, which is one of the results of the systematic literature review. Reidentified the same causes from the same region (duplication of a study) is believed to affect the accuracy of the related causes' importance. Thus, it was decided to exclude any study present the same causes from the same region (duplication) as Table 53 shows.

Study Code	Year	Study Code	Year
No. 5	1999	No. 74	1998
No. 13	1997	No. 79	1988
No. 19	1994	No. 82	1999
No. 44	1985		

Table 52: Papers excluded based on year of publication.

Excluded Study	Similar to	Country / Region	Any difference
No. 4	No. 53	Palestine	Studies No. 4 and No. 53 contain the same causes but looking at the problem from two different perspectives.
No. 14	No. 36	Palestine	Studies No. 14 and No. 36 contain the same causes but looking at the problem from two different perspectives.
No. 39	No. 55	Malaysia	The same causes have been used in No. 40 and No. 55; however, it has been evaluated from the different point of view. Thus, it has been decided to include No. 55 (the contractors' point view) as it is more related to the research aim.
No. 56	No. 55	Malaysia	
No. 58	No. 55	Malaysia	
No. 63	No. 55	Malaysia	
No. 67	No. 55	Malaysia	

Table 53: Duplicated location studies.

The large number of context countries identified within the literature raised a question regarding transferability of the knowledge from this diversity of contexts to the research context. At this stage, a general focus is taken, and this excludes studies related to contexts exhibiting unusual circumstances that affect cost performance or considered to be a non-normal context. In such a context it could be argued that the unusual environment/context for construction projects affects the transferability of the knowledge from this source. For example, Palestine has been unstable politically for over 60 years, and as a result, the leading causes that have been identified for cost overrun are related to chronic political instability. The closing of borders (not a normal situation) is one of the main causes of cost and time overrun. In a similar case, where the paper aims to evaluate the factors causing cost overrun in a road project within a terrorism affected area in Pakistan, results show that “idling cost of plant and equipment due to security threats” and “site investigation due to security threat” were major factors responsible for cost overrun. Table 54 includes the papers that have been excluded on this basis.

Study code	Country / Region	Study code	Country / Region
No. 36	Palestine	No. 60	Terrorism Affected Areas in Pakistan
No. 53		No. 83	Iraq
No. 40	Afghanistan		

Table 54: Excluded studies because of knowledge transferability concerns.

Another analysis shows that some papers use secondary rather than primary data. It was decided to exclude studies not using primary data and depending only on secondary data on the basis of such a study possibly generating duplication of the causes. Thus, the following studies are excluded: No. 10, No. 86, No. 89, and No. 94.

A deep analysis of each paper shows the type of projects where the construction cost is not the major cost of the total project's budget such as telecommunication, IT, and military projects. Thus, it was decided to exclude such studies unless the study mentions the evaluation of construction cost (see Table 55).

Study number	Projects type
No. 17	Gas-Oil Industry
No. 30	Information and Communication Technology (ICT).
No. 38	Gas-Oil Industry
No. 64	The Federal defence and intelligence acquisition programs.
No. 68	Modular construction.
No. 105	Gas-Oil Industry

Table 55: Excluded studies based on the being non-construction industry.

Moreover, the papers in Table 56 were excluded as they focus on residential (domestic scale) projects. Such projects are normally small and owned by the individual private owner.

Study number	Projects type
No. 21	Residential Projects.
No. 75	Residential Projects.

Table 56: Excluded studies as a private owner.

It is worth mention that of the 105, most papers did not mention the type ownership of the project; however, only 33 papers clearly mentioned a focus on a public project.

A deep analysis of the papers focusing on time and quality performance beside cost shows that some of the studies are measuring the overall effects of a cause on cost, time, and/or quality in combination instead of measuring the effects separately. This way of measuring the effect of a cause on cost, time and quality overall is of limited value here, as it is claimed that cost, time, and quality are each affected by the same cause in significantly different ways (Larsen et al., 2016). Thus, if the effect is as different as the literature shows, it would not be accurate to measure the effects of a cause on two issues as it could affect a responder's judgement. Thus, No.12, No.48, No.70, No.76, and No.78 studies are excluded.

A robust analysis within the contents of each paper shows some papers have issues regarding the type of the causes/factors/ risks that are identified and Table 57 illustrates the reason(s) for excluding such studies.

Study Code	Reason for excluding	Study focus
No. 2	The study is not identifying clear factors /causes /risks factors of cost overrun.	Risk factors
No. 7		Factors influencing the accuracy of the pre-tender building price forecasts
No. 9		The effects of the successful factors
No. 22		The effects of the failure and success attributes
No. 24		Causes of cost under-run.
No. 31		The effects of construction projects' successful factors.
No. 43		The cost factors that need to be considered when cost estimations are prepared.
No. 45		Seven classification types of cost
No. 49		Explaining and comparing the cost performance statistical data in different types of projects.
No. 52		Provide evidence that a simultaneous relationship exists between cost and time overruns
No. 85		Evaluate the literature on cost.
No. 87		Factors inhibiting effective project cost control.
No. 92		Factors contributing to construction cost.
No. 93		General risks
No. 102		Investigate the variation of cost estimates

Table 57: Excluded studies based on the type of causes/factors/ risks that are identified.

Out of the 105 papers, 55 studies have been excluded for different reasons as presented in the above section. The rest of the studies (50 papers) are used to achieve objective 3 and objective 4 (Table 58).

Figure 37 summarises the process filtration of cost overruns' literature sources.

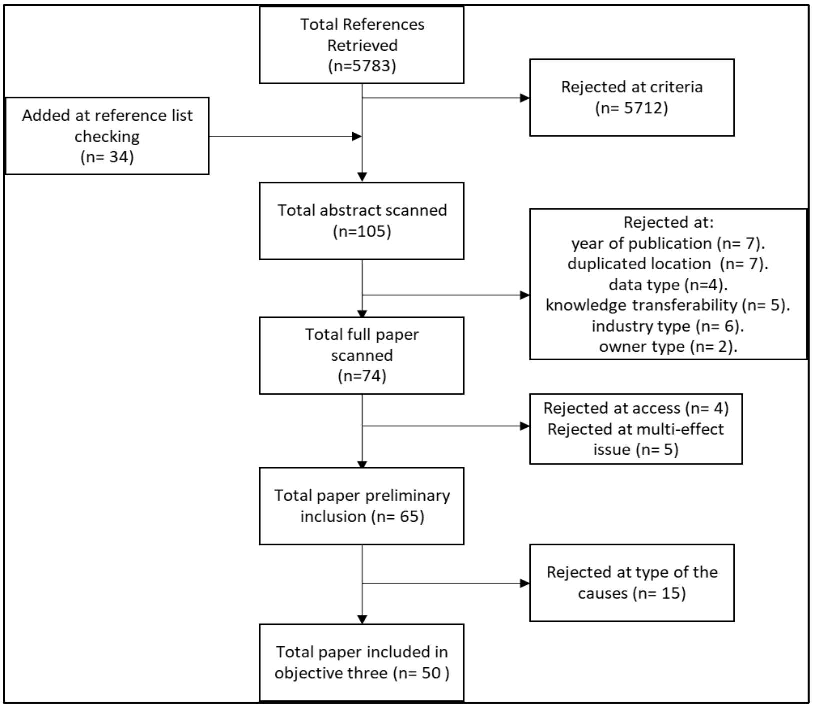

Figure 37: Sources identifications process summary.

Source	Code	Source	Code	Source	Code	Source	Code	Source	Code
(Famiyeh et al., 2017a)	No. 1	(Jennings, 2012)	No. 25	(Polat et al., 2014)	No. 41	(Knight and Fayek, 2000)	No. 66	(Flyvbjerg et al., 2002)	No. 91
(Park and Papadopoulou, 2012)	No. 3	(Shing-Tao Chang, 2002)	No. 26	(Love, 2011)	No. 42	(Eliufoo, 2017)	No. 71	(Doloi, 2013)	No. 95
(Lu et al., 2017)	No. 6	(Alinaitwe et al., 2013)	No. 27	(Cheng, 2014)	No. 46	(Allahaim and Liu, 2015)	No. 72	(Kim et al., 2008)	No. 96
(Nasina and Nallam, 2016)	No. 8	(Shane et al., 2009)	No. 28	(Aziz, 2013a)	No. 47	(Baloyi and Bekker, 2011)	No. 73	(Abusafiya and Suliman, 2017)	No. 97
(Love et al., 2012)	No. 11	(Creedy et al., 2010b)	No. 29	(Nassar et al., 2005)	No. 51	(Memon et al., 2011b)	No. 77	(Flyvbjerg, 2008)	No. 98
(Kaliba et al., 2009)	No. 15	(Rosenfeld, 2014)	No. 32	(Abdul Rahman et al., 2013)	No. 55	(Terrill et al., 2016)	No. 80	(Ansar et al., 2014)	No. 99
(Yang and Chen, 2015)	No. 16	(Lee, 2008a)	No. 33	(Muya et al., 2013)	No. 59	(Chimwaso, 2000)	No. 81	(Flyvbjerg et al., 2009)	No. 100
(Lind and Brunes, 2015)	No. 18	(Alzebdeh et al., 2015)	No. 34	(Kim et al., 2017)	No. 61	(Love et al., 2015)	No. 84	(Ahiaga-Dagbui and Smith, 2014)	No. 101
(Baloi and Price, 2003)	No. 20	(Wanjari and Dobariya, 2016)	No. 35	(Alghonamy, 2015)	No. 62	(Vu et al., 2016)	No. 88	(El-Maaty et al.)	No. 103
(Barinov, 2007)	No. 23	(Larsen et al., 2016)	No. 37	(Adafin et al., 2016)	No. 65	(Cantarelli et al., 2010)	No. 90	(Love et al., 2016)	No. 104

Table 58: Included studies after excluding irrelevant studies.

4.4.2 General View of the SLR:

After reviewing the studies, the following general points are identified:

- The systematic review shows there is a lack of comprehensive overview papers over cost overrun causes,
- The majority of the studies are repetitive studies and do not overcome the shortcomings in similar previous studies, include similar causes, and use similar methodology rather than build on previous work
- A diverse collection of terminologies was used to describe the same cause and concept.
- The complexity of the cost overrun issue in construction projects and its link to a different aspect.
- Lack of unified and clear cost overrun definitions in most of the studies.

4.4.3 Cost overrun definition:

Aspects of cost overrun were discussed in chapter one (section 1.1.3). The magnitude of cost overrun in different contexts worldwide and the factors affecting the magnitude have been identified and discussed. Moreover, the cost performance and the importance of positive performance from the contractor's perspective has also been discussed and to what extent different contractors are willing to accept cost overrun. Figure 38 shows the different cost performance positions that a contractor could be in after a project is finished.

The review of studies within the literature evidences a number of cost overrun definitions, as presented in Table 59.

The cost overrun definitions in these studies are not clear. Although there is an agreement that cost overrun is the difference between the cost in two points (predicted cost and actual cost, normally at project completion). However, a contract could be in different points in a project's life cycle depending on the procurement routes, for example, in DBB procurement, the contract starts just before the construction phase, while in the design-build procurement route, the contract starts just before the design phase. Moreover, at what percentage is overrun considered to be a problem and have an effect on project performance, is not mentioned in most studies. However, Alzebdeh et al. (2015) considered it to be 30% or more.

By the end of the project, when compared to the initial budget, a contractor is going to be in one of the situations illustrated in Figure 38, which are: (1) make more profit than planned, (2) make the planned profit, (3) make less profit than planned, (4) no profit has been made (Breakeven), or (5) loss. Nevertheless, identifying costs for contractors is more complicated as an item bid price contains different components over the basic cost. Thus, for some contractors, any overrun over the bid price is considered as a cost overrun, whereas for other contractors, as long as the overrun has not consumed the expected profit, there is no cost overrun.

For this research, the definition was adopted is the difference between the estimated cost and the final cost. The final cost is defined as the real and accounted total costs calculated at the time of project handover. The estimated cost, on the other hand, is defined as the total estimated cost at the tendering stage. Cost estimates become more accurate during the project process.

Interviewees from the contractors' side mentioned that any increase from the tender price submitted during the tendering stage should be considered a cost overrun.

However, there is a difference in opinions as to when cost overrun is acceptable. The percentages mentioned by the interviewees are between 2 and 7%.

Study code	Definition
No. 1	The percent difference between the final cost of the project and the original contract sum
No. 3	The difference between the actual cost at completion and the contract amount agreed between the client and contractor.
No. 15	The increase in the amount of money required to construct a road project over and above the original budgeted amount.
No. 16	The variation between the planned value before a project starts and the actual value once the project finishes.
No. 18	The basic definition of ‘cost overrun’ is that the final cost is higher than was budgeted in an earlier stage.
No. 20	The percentage difference between the final contract amount and the contract award amount.
No. 27	An increase in the amount of money required to construct a project over and above the original budgeted amount.
No. 33	The difference between the actual and estimated costs as a percentage of the estimated cost, with all costs calculated in constant prices.
No. 47	Cost overrun can be simply defined as “when the final cost of the project exceeds the original estimates.
No. 71	The difference between the agreed cost (contract amount) and the final actual cost of a construction project at completion, agreed by the client/employer and the contractor.
No. 88	Cost overrun is defined as actual cost over budget.
No. 97	The actual cost for the project is more than the estimated cost.
No. 101	The difference in cost at project completion and project definition stage.

Table 59: Cost overrun definitions in the SLR.

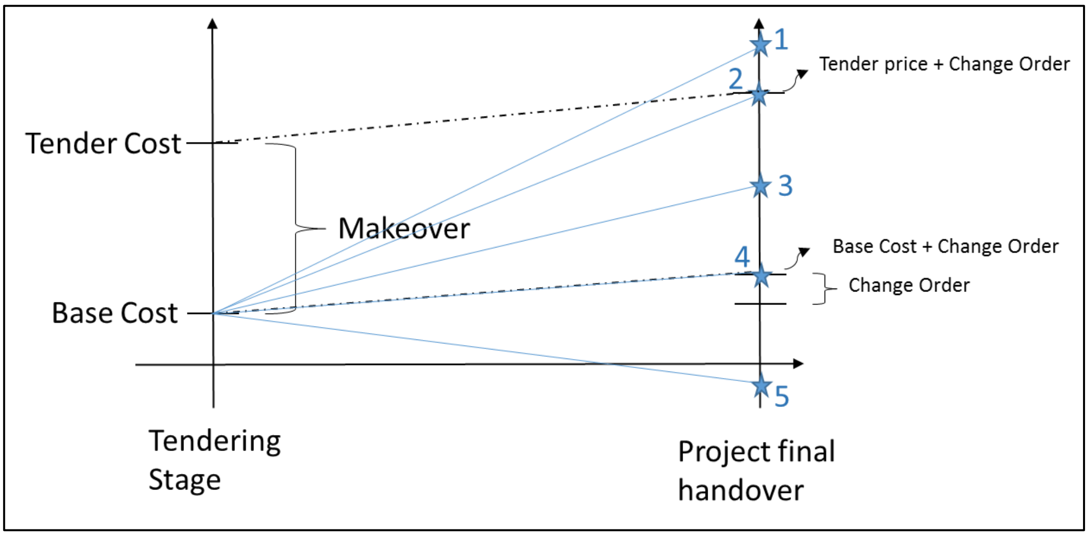

Figure 38: Contractors’ cost performance results by the end of a project.

4.4.4 Cost Overrun’s schools of thought:

The literature shows that there have been different approaches to investigating the causes of the cost overrun problem. Some studies listed different causes and ranked them by expertise, while others tried to link the causes of cost overrun into existing theories. In this section, the schools of thought of investigating the cost overrun problem are presented. Regarding the way of viewing and explaining the cost overrun, the researcher classified the 50 studies under three groups.

4.4.4.1 First Category:

In this group, studies sought to embed the explanation of cost overrun in a construction project to existing behavioural, economic, political theories. It is believed that embedding could be beneficial for understanding the phenomenon (Cantarelli et al., 2010). The studies included in this group are No. 18, No. 25, No. 80, No. 90, No. 91, No. 98, No. 99, and No. 100.

In this category, studies present a framework of explanation of the cost overrun in construction projects. Bent Flyvbjerg’s studies are the most well-known in this category, and some work builds on the Flyvbjerg explanation framework, such as No. 18.

Rather than identifying specific causes for cost overrun, in this category, studies presented four main explanation groups; the division seems to be based primarily on theories the explanations are based on or related to, which are:

- *Technical explanations* which include, for example, forecasting errors (including price rises, poor project design, and incompleteness of estimations), scope changes and inadequate organisational structures and processes. Forecasting theory and planning theory are the fundamental theories behind this type of explanation.
- *Economic explanations* are exemplified by deliberate underestimation due to lack of incentives, lack of resources, strategic behaviour, and poor financing/contract management. The background theories mentioned here are neoclassical economics and rational choice theory.
- *Psychological explanations*, exemplified by optimism bias among local officials, the cognitive bias of people involved in the project and a cautious attitude towards risk. Prospect theory and rational choice theory are mentioned as the relevant theories in this area.
- *Political explanation* which includes deliberate cost underestimation and manipulation of forecasts based on private information. Here, Machiavellianism and agency theory are mentioned as relevant.

The studies examine the explanation given for cost overrun in projects from the worldwide sample (Flyvbjerg et al., 2003b) and specific countries sample (Cantarelli et al., 2012a; Cantarelli et al., 2012c).

The following points are extracted from this category of studies:

- Cost overrun is a worldwide issue and could exist in any project.
- Cost overrun varies depending on the project geographical location (country) and type.
- The problem of cost overrun lies in the pre-implementation phase.
- Out of the four explanations, the psychological, political, economic explanations were accepted, while the Technical explanation was excluded as an explanation of the cost overrun.
- Projects that are more important are more vulnerable to strategic misrepresentation behaviour from project developers.

Researchers in the category support their output by the Prospect theory which proposes that humans make venture decisions based on the likelihood of gains or loss, but not based on the real outcome of that decision. According to the theory, humans show typically high confidence in their knowledge and are unable to realise their ignorance and any uncertainty in their knowledge, resulting in overestimating income and underestimating risk (Kahneman and Egan, 2011). Thus, at the stage of promoting a project, project developers and decision-makers are more likely to be under such human behaviour during the estimating of cost, risks, and outcomes. Researchers also found that these biased decisions are systematically taken over the years, and are often predictable, rather than random (Flyvbjerg, 2007).

Moreover, according to the data extracted from this category studies, there has been no improvement in project cost performance over the last 70 years, although expertise and technology have been improving over the same period. Although some explanations have been expressed by Kruger and Dunning (2009) as well as Ehrlinger et al. (2008) in regards the lack of improvement, the supporters of this category prefer that cost estimation is deliberately reduced for economic and political reasons which have been illustrated earlier. Moreover, they believe this excludes the technical explanation, as an improvement in technical aspects should reflect an improvement in cost performance which has not been the case.

While the first category studies have made a significant contribution to the identification of causes of cost overrun, the researcher found their explanations suit a particular type of project and explain the cost overrun in a particular project development phase. In other words, the causes and explanation of the studies is not necessarily an answer of cost overrun causes for all projects' type, size, phase, stakeholder, and most importantly, context.

Although the data included in the studies contains 258 projects from 20 countries, it seems that authors are assuming that projects are developing in the same process in all countries. The familiarity of a specific context could cause such misunderstanding. For example, cost overrun in this category has been defined as the difference of cost from the time of making the decision to build the project to finish the project, but in which milestone of the project life cycle the decision is made could be different. It has been found that in some contexts, such as with the Dutch for example, the decision to build goes through different stages over the project life-cycle (Odeck, 2004). In the Saudi public context on the other hand, the real decision to build a project is after the design phase is finished, where the financial approval is given. In such a late phase of project delivery, the project’s designs and tender documents are fully mature. In such cases, project developers are unlikely to lie about the real cost of the public projects (optimism bias and strategic misrepresentation), unlike an early stage of the project development where the design remains immature. Thus, the causes of the cost overrun provided by the first category could be used to explain the cost overrun in the early stage of project development. Nevertheless, the discussion also presents the importance of studying the projects' context in investigating the cost overrun problem which supports the importance of achieving Objective One in this study.

On the other side, the output of this category's studies lacks identification, examination, or explanation of intermediary conditions and events between the "Explanations" and cost overruns, resulting in a gap in time and events between the explanation (initial event) and output. This is also supported by Love et al. (2011) who analysed and evaluated cost and time overrun in two Australian case studies and concluded that the simple explanation provided by this category's studies (optimism bias and are strategic misrepresentation or deception and delusion) do not adequately explain cost overrun in these cases. Love labelled the output of this category as “misleading” because the studies do not delve into the complex interaction between variable and cost overrun during project development and implementation. This could be presented the importance of liking between the events (weaknesses) over the project development, and the issue needs to be solved (cost overrun) to overcome the limitation of studies in this category.

4.4.4.2 Second Category:

The studies included in the second category are No.11, No.42, No.84, No.85, and No.104. In this category, studies from this category move beyond the causes that have been identified in the first category (optimism bias and strategic misrepresentation) to identifying intermediary events that lead to cost overrun. Love et al. (2012) called those events “pathogens” that occur during project development and delivering. Pathogens have been defined as "latent conditions" within the project development system, and they are distinctive by:

- They are results of decisions taken by persons in top management and leading decision makers
- They are not identified until an error takes place
- Their impacts are not known before they are discovered.

Researcher in this category believes these pathogens, which are stimulated by strategic misrepresentation and optimism bias, are not included in the cost estimation leading to cost overrun. A mixed blend of “pathogens” has been identified in these studies, such as lack of capability, optimism bias, short time given to develop the design, unsuitable procurement approach, and unexpected events or bad luck. This view on construction projects in general (looking and identifying causes of poor performance in construction projects) is supported by other researchers such as (Pasco and Aibinu, 2008), (Odeck, 2004) and (Odeyinka et al., 2012). However, regarding the limitations of this view, the method of measuring these pathogens and the link between them is not clear.

4.4.4.3 Third Category:

The third category contains the largest number of studies (37 studies). In this category, studies’ authors believe that the best way to identify the main cost overrun causes is by identifying a list of causes through the literature and/or interview and present them in a questionnaire to the experts and decision-makers in the construction field where they rank and/or identify their effect on cost using Likert scales. Studies in this category start with a very long list of factors, and through the use of advanced statistical methods, the most important factors are identified. It is believed in these studies that the "broad experience" and the "well-founded view" will be reflected in judging the common cost overrun causes.

Authors criticised studies in Categories One and Two in that only a few causes of cost overrun are identified which is a result of the selective approach adopted. To overcome this limitation, the approach adopted in this category is to include all possible causes to reflect the whole image of cost overrun. The researcher believes that including all the causes is beneficial as some causes are significant in one context and not in another.

Studies in this category are divided into the following:

A. Studies that identify causes only and verify them normally using the literature review to identify the causes.
B. Studies that identify the causes and measure their effects (severity).
C. Studies that identify and rank the causes.

In general, there is a concern regarding the quality of the output of those studies that used a statistical approach to investigate complex issues in the construction industry such as cost overrun. Comparing to qualitative data, quantitative data generally are less deeply investigating in a problem. Further weaknesses of this category are:

- No clear definitions and characteristics for the categorisation as well as the causes itself.
- The use of superficial and ambiguous terminology for causes will be discussed later.
- Factor statements do not really reflect what is meant. For example, one of the studies presents a cause as "Project Financing", while what is meant by it is "the consequences of payment delay by owners such as delay and inability to cope with that".
- Poor understanding of project systematicity and lack of demonstrable causality.
- The majority of studies frame the overrun problem in a manner that ignores the complex and highly dynamic context of projects.
- Focus on independent, single-cause identification and traditional net-effect correlational analysis.
- Poorly designed survey instruments. The respondents have to answer so many questions that this raises a question about the quality of the answers.
- Questionnaires tool has three types of bias which are: observation by the individual, bias in the structure of the questionnaire and bias in the sample (Lind and Brunes, 2015). Although it is difficult to prevent these biases, none

of the studies has mentioned these biases nor provided any evidence to prevent them.

- The respondents are from mixed professional, etc. groups which will lead to misleading output as each group will give feedback of the causes from their point of view.
- The large difference in number from different respondent groups. In one of the studies, the number of respondents from contractors' groups is 4 times the number of respondents from clients' groups. This difference affects the output of the study as it depends on the average of all the groups.
- Some studies use the data from completed projects and measure the relationship between the causes/factors and the cost overrun amount in a statistical manner to identify patterns of cost overrun. Although this type of paper extracts the information from real cases, the real (deep) causes of the cost overrun might not be identified, typically due to project documentation possibly not being accurate (more general cause such as change order ...etc.). In one of the studies, the author acknowledged that the document that was used in his study might not point to the real cause (Ameh et al., 2010).
- Lack of the impact of interrelationships/causalities between two or more factors. The causes are listed as stand-alone causes, thus ignoring any interaction between causes.
- Researchers used statistical methods to rank the contributing factors according to their impacts without considering the interactions among these factors. Moreover, the studies suggested solutions and remedies without identifying the root causes of the overruns. Any attempt to address the cost overruns would be futile unless the root causes are identified because cost overruns are a net result of complex relationships between one or more factors.
- Poor causes impact measuring tool. The studies used tools such as RIW score which does not represent the statistically significant measurement of any instance.

4.4.5 Conclusion (Synthesis):

The SLR shows that there are attempts to investigate the causes of the cost overrun problem without much success (Ashworth and Perera, 2015). The in-depth analysis of the 50 studies that identify the causes of the cost overrun shows a lack of a holistic view to the construction projects and its context apart from the second categories studies that show a holistic view to construction projects and ignore its context.

Construction projects, in general, are dynamic and complex in their nature, developed over a long timeframe, and involved different persons and departments. Different stakeholders have different aims, backgrounds, skills, and view to the projects, from the trigger of that project until it's completed. This nature stimulates change and it is not unusual that projects' aspects (such as Goals, Scope, Design, Budget, Technology...etc.) are changing through different phases that are going through (Gil and Lundrigan, 2012). It is argued that construction projects continue changing over the "timeframe" and project’s phases, and these changes are positively linked to the duration of development timeframe. Thus, the project and its characteristics that are handed over are different from those at the conception phase; the project in one phase is arguably different from the prior phase and these changes reduce over the maturity of that project. The Scottish Parliament Building is an excellent example of these changes as the project started an extension of the old building with an initial budget of £40 million and ended as a whole new building at over £400 million cost (Fraser, 2004). The changing nature of construction projects, which has been expressed above, emphasises the importance of the definition of the cost overrun and the points at which cost overrun are measured between; identified as a limitation of the first category. Thus, it is believed that the first, second, and third categories measured the difference of cost between two different projects, which could explain the claim that 90% of projects suffer cost overrun (Flyvbjerg et al., 2003a), and the causes identified are not reflecting the real causes.

Global studies on the causes of cost overruns in infrastructure projects may help in identifying major causes in Saudi Arabia. However, due to differences in governance systems, geographical location, and cultural practices, the outputs of the other contexts’ studies are not reflecting the real causes for the Saudi Arabian context and are insufficiently comprehensive in relation to Saudi industry practice. This is supported by Cantarelli et al. (2012a) study which confirms that cost overrun in Dutch projects performed differently from other contexts. Furthermore, the area-specific study repeats the past findings — moreover, the consideration of the stakeholders’ responsibilities in addressing this chronic issue of cost overrun.

Based on these limitations, the SLR shows the previous works have not generally produced an adequate understanding, nor provided insights to the cost overrun causes in general, and for the public Saudi Arabian context specifically.

To overcome these limitations a new way of looking into the cost overrun problem is needed. The identification of singular and independent causes, which in most cases only describe the proximal causes, is counterproductive, as overrun causation can only be understood by looking at the whole project system in which it occurs, and how variables within that system dynamically interact with each other. Merely identifying and listing factors that may contribute to a cost overrun does not provide evidence of causation and the ability to draw conclusions about the underlying dynamics that lead to their occurrence. The focus on the net-effect contribution of variables, assumed to be linear and independent, may be insufficient to cope with the systematically complex systems such as construction projects, as variables of causation tend to be interrelated and interdependent as well as dynamic over the project's lifecycle. The crucial skill in understanding cost overrun is not just the ability to list or rank factors, but the capacity to see connections between the various causal factors as well as how they dynamically evolve over the course of the project. Thus, it is essential to adopt a systematic approach to understand the causes of cost overrun.

This research proposes to build a causality model for contractor cost overrun in the Saudi public sector. It is believed that such a method will overcome limitations in the previous studies which are presented in sections 4.4.4.1, 4.4.4.2, and 4.4.4.3. Moreover, based on the findings in the weakness links in section 4.3.5, the model will present the closest state to the reality of a well-established causal relationship. In addition, the proposed causality model also will reflect a fully understood cost overrun causation as it will overcome the limitations of the previous three schools. However, although the weakness of the context and practises have been identified and linked, further investigation for other possible causes that are not related to the contexts and practises will be identified and linked in Objectives Four and Five.

4.5 Objective Four:

Cost overruns is embedded in the context of people and organisations and interacting in the complex web of business models, governments, technology, market structures, procurement strategies, risks and uncertainty. It becomes difficult to isolate the root cost causes of overruns using generic broadcasted survey instruments and divorced from context (Love et al., 2016).

Literature shows that all stakeholders are vulnerable to cost overrun. However, contractor cost overrun, or contractors' loss, is more likely lower, under normal conditions, compared to other stakeholders, which are related to contractors' late involvement in projects. Projects, in general, are more mature in their later stages, and the vision and design of the projects are clearer compared to the point of owner involvement. Moreover, factors such as inflation and price rise are typically less affected in a shorter period of time.

To achieve Objective 4, this research will use the causes identified through the literature review as well as the ones identified through interviews. Using two data sources to identify the causes is believed to improve the quality of the outputs as well as reduce the possibility of missing important causes. However, only the causes related to the Saudi context will be included after any similar causes have merged and irrelated causes are excluded.

As could be seen in section (4.4.3), different cost overrun definitions are illustrated in the literature, so, as this study is looking at contractor cost overrun in the Saudi public projects, and as it has been illustrated in Objective One and Two that Saudi public sector is adopting the DBB contract and the first contact of contractors with the projects is just before the construction phase, the cost overrun definition that will be adopted is the percentage difference between the total final cost of the project and the original contract sum. A negative value indicates a project cost saving, while a positive value indicates a cost overrun.

4.5.1 Data Sources:

The causes of contractors' cost overrun are extracted from two resources. The first resource is the literature review and the second one is data extracted from interviews. This has been illustrated in detail in the methods chapter.

Interviewee data has already been analysed in section 3.10.3. As could be seen, the interviewees are experienced professionals in the Saudi public sector as well as the Saudi construction industry. Moreover, they are from different departments on both the contractor and owner sides. The method of analysing data has already been discussed in section 3.11.

For the literature review, the 50 studies that have been used to achieve Objective Three will be used to achieve Objective Four as well. It worth mentioning that although the aim of this objective is to identify the cause of contractor cost overrun in the Saudi context, the studies included in the literature review are identifying the causes from different perspectives which include other than contractors' perspective, such as the owner. Including such studies is the best way to achieve Objective Four as it could be seen in the development of the research query (section 3.6.1.1), including the keywords related to the contractors results in a very limited number of studies. Moreover, the nature of the construction industry (complexity and aggregated) results in these being the issues that are related to a stakeholder. Contractors, for example, affect or are affected (strong links) by another stakeholders' issue (owner or consultant for example). Thus, studying the causes for cost overrun will build a deep knowledge and understanding of the causes of cost overrun in general and contractors' cost overrun specifically. Moreover, some of the causes mentioned as cost overrun causes are in fact aspects of contractors' responsibility in another type of contract and should not be considered in this context. These were considered in some studies due to not adding contractual responsibility (contractor type and conditions) as one of the filters for choosing the causes. For example, an increase of the material price (identified many studies) considers it as a project cost overrun cause. However, where a fixed price contract is applied (Saudi Arabia, for example), contractors must absorb any such price increase. This highlights the importance of contractual responsibility as a filter/axis when identifying causes, and will be discussed more in the causes' identification section. In addition, many studies have contractors in their mix of respondents, and their responses are affecting (skewing) the output of the study. I.e. whenever contractors are a majority of respondents, the type of main causes in this study are more related to contractors' causes and responsibilities, although these studies aim to identify the causes of cost overrun from different perspectives. Nevertheless, the identification and classification of contractor cost overrun are not the last steps in this study. A further step, which is building paths for the causes, links and networks between/from/to causes through different project phase, will be followed. Thus, these paths, links, and networks will depend largely on the cost overrun literature.

To increase the reliability of the causes' identification steps, causes' filters will be developed and applied in the next section. These filters will exclude any causes that are not related to the contractors' cost overrun or the practices of project development in the Saudi public sector.

4.5.2 Causes from the literature review:

Based on the studies categories (Objective Three), the number of studies in each category is presented in Table 60.

The 50 studies analysis is presented in Table 61 which is more related to the causes.

One of the criticisms related to the identified literature is the different wording used to describe both costs overrun and its causes. Table 62 shows the results of further analysis of the wording issue, which caused the researcher to be more cautious regarding the causes extracted from these studies.

Category	Code of studies included
First	8 studies which are: No. 18, No. 25, No. 80, No. 90, No. 91, No. 98, No. 99, and No. 100.
Second	5 studies which are: No.11, No.42, No.84, No. 85 and No.104.
Third	37 studies which are: No. 1, No. 3, No. 6, No. 8, No. 15, No. 16, No. 18, No.20, No. 23, No. 26, No. 25, No. 27, No. 28, No.29, No. 32, No. 33, No. 34, No. 35, No. 37, No. 41, No. 46, No. 47, No. 51, No. 55, No. 59, No. 61, No. 62, No. 65, No. 66, No. 71, No. 72, No. 73, No. 77, No. 80, No. 88, No. 90, No. 95, No. 96, No. 97, No. 101, and No. 103.

Table 60: Number of studies in each category.

Classification	Sub- Classification	Number of studies
Project Type	Construction (Construction of buildings)	12
	Construction (Civil engineering) (Utility)	6
	Construction (Civil engineering) (Roads and Railways)	14
	Construction (Civil engineering) (other)	3
	Construction Projects	15
Study focus	Cost, Delay, and Quality	1
	Cost and Delay	6
	Cost only	43
Owner	Public	19
	Semi-public	31
Phase focus	Construction only	12
	Over phases	38
Size	Mega	10
	Large	4
	Medium	6
	N/A	30
Method of primary causes identification	Literature review only	18
	Literature review and verified by another method	14
	Case study	2
	Brainstorming	2
	Other	16
Point view	Owner (client)	31
	Contractor	9
	Projects	10

Table 61: Studies analysis.

The number of causes identified from all the studies is 271 (Figure 39). However, as a cause could be in more than one study the total frequency number of causes is

719 as can be seen in Appendix A. Thus, the initial causes' pool contains 271 causes, and all the causes and the studies they were extracted from are illustrated in a 15-page Table (Appendix A). The majority of the causes are considered similar therefore it is anticipated that the number of types of causes will be reduced dramatically after the similar causes are merged. Moreover, the irrelevant causes will be excluded as shown in the next sections.

Study Code	**Wording**		**Other reasons**
	For	**Used**	
No. 6	Cost overrun	Cost Performance	No cost overrun definition was used in the study
	Causes	Factors	
No. 8	Cost overrun	Cost escalation.	No cost overrun definition was used in the study
	Causes	Reasons. Issue.	
No. 20	Cost overrun	Poor Cost Performance	-
	Causes	Global Risk Factors	
No. 26	Cost overrun	Cost Increase	No cost overrun definition was used in the study
	Causes	Reasons	
No. 29	Cost overrun	Cost Overrun Significant Cost Overrun	No cost overrun definition was used in the study
	Causes	Risk Factors Owner risk Variables Reasons Factors	
No. 59	Cost overrun	Cost Escalation	No cost overrun definition was used in the study
	Causes	Major Causes Factors Attributed to Cause Cost Escalation	
No. 65	Cost overrun	Variability of cost	No cost overrun definition was used in the study
	Causes	Risks. Risk factors that influence the variability of cost.	
No. 81	Cost overrun	Cost performance	No cost overrun definition was used in the study
	Causes	Factors influence cost overruns	
No. 95	Cost overrun	Cost Overruns	No cost overrun definition was used in the study
	Causes	Attributes associated with cost performance	
No. 96	Cost overrun	Cost Variance	No cost overrun definition was used in the study
	Causes	Cost-influencing variables.	

Table 62: Studies with a wording issue.

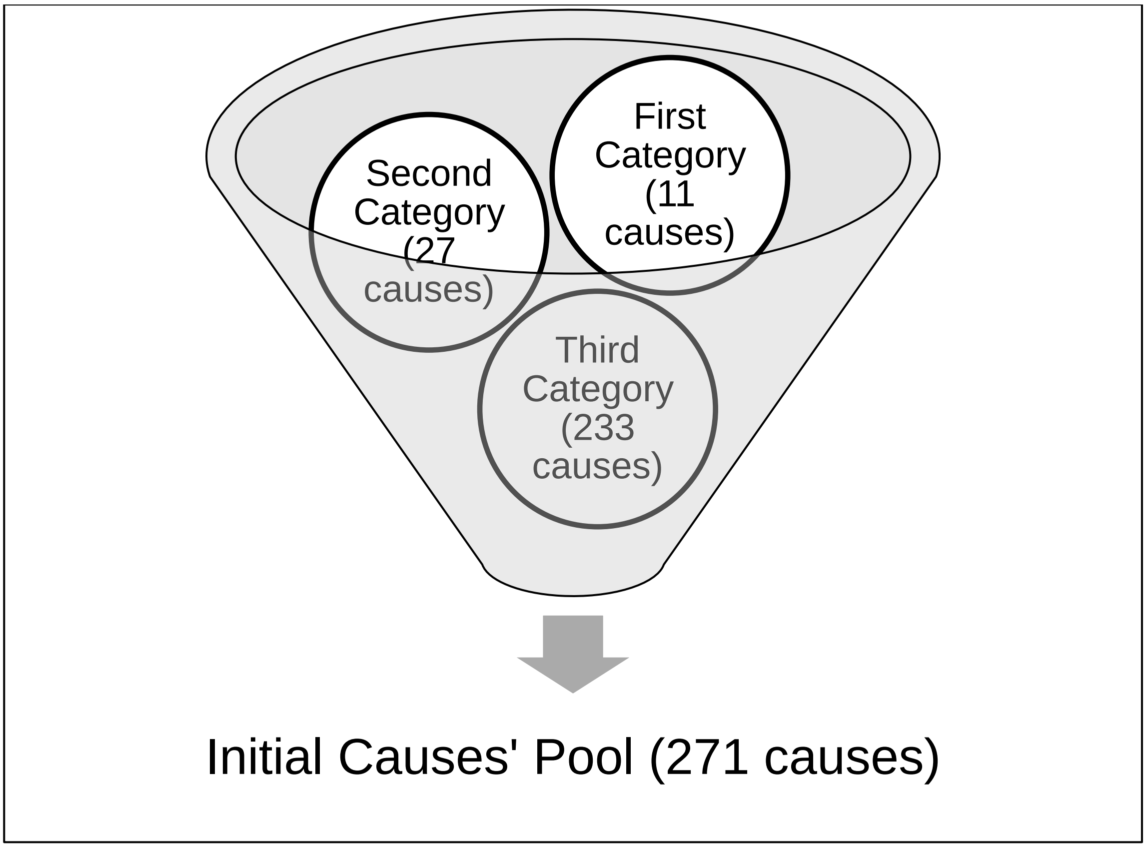

Figure 39: Initial Causes' Pool.

4.5.3 Causes from interviews:

Another source for the identification of causes is the interviews with industry experts. 11 experts from different background and representing different stakeholders (owner, contractors, and designers) were interviewed. All the interviewees were asked about the causes of the contractors' cost overrun. Their answers were analysed, and the causes extracted. The difference in background and viewpoint contributes to a deep understanding of the contractors' cost overrun issue. For example, owner representatives have argued that the contractors' cost overrun is a result of related causes such as an unqualified contractor being chosen, a poor method of construction implemented, or an inexperienced contractor. On the other hand, contractors blame the owner and present causes that are not related to the contractor, such as late payment, or a long approval process. As a result, other causes have been extracted from their answers such as a distrusting work environment between owner and contractor. It has been found that "blaming the other party" is not new in the construction research conducted in the Saudi Arabia context. Al-Kharashi and Skitmore (2009) and Assaf et al. (2013) who investigated delay causes mentioned that their data shows that contractors blame the owner and consultant, and vice versa. However, as another source of data is already included, this blaming effect is reduced.

4.5.4 Excluded causes:

Although the majority of the causes are related to the context of the research and are eligible to add to the causes' pool, some of the causes are unsuitable causes. These causes are normally identified in a single paper which relates to the context of the projects reported in that paper more than to construction projects in general. They could therefore be described as unique factors that would not merge with other factors. Thus, it was decided to exclude them from any further analysis. Examples of these factors and reasons are presented in Table 63.

The factor	Study Code	Reason for exclusion
Domination of the construction industry by foreign firms and aids	No.47	Such a factor seems to be context specific. Moreover, it has been identified as the least effect factor in the study.
The types of clients	No.46	The research focuses on public projects such a factor considered to be out of the research boundaries.
Contractors' bankruptcy	No.46	This is an effect of the cost overrun rather than a cause of cost overrun.
Complex investment process and administrative procedures	No.88	The research focuses on public projects such a factor considered to be out of the research boundaries.
Others	No.16	This factor has been excluded for its unclear meaning. Such a factor could mean anything.

Table 63: Example of the excluded causes.

4.5.5 Merging causes:

To merge the similar causes, at the beginning the unexcluded causes are divided into external and internal causes. The internal and external are then divided into sub-categories based on different characteristics. For example, the external categories are divided into context related subcategories such as a country's economic situation, relevant regulations ...etc. The internal categories, on the other hand, are divided based into phase-related subcategories such as planning, development, construction …etc. As the number of causes identified exceeds 250, another sub-division is also applied so as to accommodate similar causes accurately. An example of this sub-division is the causes within the implementation phase; they are divided into finance, scope, progress, experience, resources, technical, and project characteristics subdivisions. This helps the researcher to merge the similar causes in a more scientific way since the causes of cost overrun identified within the literature typically suffer from uncertainty and vagueness (Tah and Carr, 2000b).

The vague terms, which describe causes, are considered unavoidable (the reasons presented in section 4.4.4.3) in such type of research. To reduce the effect this limitation and improve the accuracy of the merging process, the researcher reviewed every cause definition in each study in order to inform the making of a better judgment regarding the definition of cost overrun causes. Moreover, the merging process is subject to human error, the effects of which can be mitigated, and the outputs improved along with the research validity, the merging process and its outputs (merged causes) were reviewed by two industry experts. The two experts have each been working in the Saudi public sectors for over 35 years. The reviewing process and related discussion resulted in changing some of the merged causes (split a cause into two causes or merge two causes into one). Moreover, the expert's comments resulted in some causes' wording being changed so as to be more understandable. An example of merging causes is illustrated in Table 64. The full list of merging causes can be found in Appendix B.

New cause	Merged Causes
Inappropriate procurement route and procedure	Insufficient time for bidders to study and prepare the tender
	Inappropriate contractual procedure
	The long period between design and time of bidding/tendering.
	Bureaucracy in the bidding/tendering method

Table 64: Example of merging causes.

4.5.6 Final list causes:

The merging process results in 49 causes which are presented in Table 65.

Table 66 presents the analysis of the 49 causes. The first column presents the number of studies that a cause occurs in, the second column is the number of occurrences (equal to or higher than the first one) in terms of the total number of the merged cause occurrence (the merged causes is represented more than one cause). To represent each cause's importance based on the first and second columns, a colour code was used where dark green means most essential and dark red means the lowest importance. The last two columns present a causes order (out of 49 causes) based on the number of studies that cause occurs in and a number of occurrences.

Based on the analysis in Table 66, five ranking categories have been developed to distribute the 49 causes based on their occurrence during the identification steps (Table 67). The first category includes the most frequent causes 13 causes, the second category 8 causes, the third category 8 causes, the fourth category 7 causes, the least frequent category including13 causes.

Code	Cause
C1	Inappropriate procurement route and procedure
C2	Selection and assignment criteria
C3	Discrepancies and/or deficiencies in contract documents
C4	Inappropriate (Discrepancies and/or deficiencies) local/national data, regulation/policies, requirements, and political environment
C5	Difficult/Unstable/change in country's economic conditions
C6	Force majeure (strikes/weather/regulation changes/accidents, etc.).
C7	Changes in governmental regulations
C8	Risk and uncertainty (Unforeseen events)
C9	Fraudulent practices, kickbacks, corruption, Bribes.
C10	Social and cultural impacts
C11	Inadequate planning, preparation, and pre-construction process and studies
C12	Deficiencies in cost and time estimates prepared by public agencies
C13	Strategic misrepresentation
C14	Optimism bias
C15	Inadequate Inappropriate (Discrepancies and/or deficiencies) design process and documents
C16	Inadequate site and ground investigations
C17	Immature tender documents (drawings, bill of quantities, specifications, contracts and legal documents)
C18	Difference between selected bid and the consultants' estimate (Tender-winning prices are unrealistically low)
C19	Inaccurate cost and schedule estimates by contractor
C20	Inadequate planning and preparation by contractors
C21	Financial difficulty by client during construction phase
C22	Delay in payment of completed works
C23	Contractors' financial difficulties
C24	Changes in the project's scope, design, specifications
C25	Cost of penalties
C26	Schedule delay caused by contractors
C27	Schedule delay caused by client
C28	Schedule delay caused by external factor
C29	Poor communication and coordination between a project's parties
C30	Poor project/site controlling, monitoring, and management
C31	Conflicts, disputes, and lack of trust culture among the parties involved in the project
C32	Extra works not included in the contract
C33	Rework and wastage on site
C34	Increased material costs
C35	Shortage of materials
C36	Poor material quality
C37	Increase in labour cost
C38	Inadequate manpower productivity
C39	Shortage of labour
C40	Increased equipment costs
C41	Inadequate or inefficient equipment, tools and plants.
C42	Equipment availability and failure
C43	Lack of experience/ability/competence
C44	Lack of owner / owner representative / team experience/ability
C45	Lack of contractor / subcontractors / team experience/ability
C46	Project size
C47	Project location
C48	Project complexity
C49	High guarantee period of products

Table 65: Results of merging causes.

Cause code	Cost overrun cause	No. of study occurs in	No. of occurrence	Cause's order based on No. of study occurs in	Cause's order based on No. of occurrence
C1	Inappropriate procurement route and procedure	15	18	26	25
C2	Selection and assignment criteria	10	11	33	32
C3	Discrepancies and/or deficiencies in contract documents	18	22	19	20
C4	Inappropriate (Discrepancies and/or deficiencies) local/national data, regulation/policies, requirements, and political environment	18	22	20	21
C5	Changes in governmental regulations	26	37	7	4
C6	Difficult/Unstable/change in country's economic conditions	27	30	4	12
C7	Force majeure (weather) could include the (strikes/regulation changes/accidents, etc.).	3	4	46	46
C8	risk and uncertainty (Unforeseen events)	10	10	34	36
C9	Fraudulent practices, kickbacks, corruption, Bribes.	13	13	31	31
C10	social and cultural impacts	6	6	41	41
C11	Inadequate planning, preparation, and pre-construction process and studies	27	36	59	5
C12	Deficiencies in cost and time estimates prepared by public agencies	19	23	16	19
C13	Strategic misrepresentation	10	11	35	33
C14	Optimism bias	15	15	27	30
C15	Inadequate Inappropriate (Discrepancies and/or deficiencies) design process and documents	18	27	21	16
C16	Inadequate site and ground investigations	19	24	17	17
C17	Premature tender documents (drawings, bill of quantities, specifications, contracts and legal documents)	21	30	12	13
C18	Difference between selected bid and the consultants' estimate (Tender-winning prices are unrealistically low)	6	6	42	42
C19	Inaccurate cost and schedule estimates by contractor	26	30	8	14
C20	Inadequate planning and preparation by contractors	2	4	49	47

C21	Financial difficulty by client during construction phase	16	17	24	27
C22	Delay in payment of completed works	19	24	18	18
C23	Contractors' financial difficulties	8	8	39	40
C24	Changes in the project's scope, design, specifications	44	72	1	1
C25	Schedule delay caused by contractors	15	18	28	26
C26	Schedule delay caused by client	21	29	13	15
C27	Schedule delay caused by external factor	21	31	14	11
C28	Poor communication and coordination between a project's parties	18	19	22	23
C29	Poor project/site controlling, monitoring, and management	26	34	9	8
C30	Conflicts, disputes, and lack of trust culture among the parties involved in the project	27	55	6	2
C31	Extra works not included in the contract	15	16	29	29
C32	Cost of penalties	15	17	30	28
C33	Increased material costs	29	36	2	6
C34	Shortage of materials	29	33	3	10
C35	Poor material quality	21	49	15	3
C36	Increase in labour cost	3	3	47	48
C37	Inadequate manpower productivity	18	19	23	24
C38	Shortage of labour	16	21	25	22
C39	Increased equipment costs	24	34	11	9
C40	Inadequate or inefficient equipment, tools and plants.	8	9	40	39
C41	Equipment availability and failure	5	5	44	45
C42	Lack of experience/ability	10	10	36	37
C43	Lack of owner / owner representative / team experience/ability	11	11	32	34
C44	lack of contractor / subcontractors / team experience/ability	5	6	45	43
C45	Rework and wastage on site	26	35	10	7
C46	Project size	10	10	37	38
C47	Project location	10	11	38	35
C48	Project complexity	6	6	43	44
C49	High guarantee period of products	3	3	48	49
Total number of causes		786	1018		

Table 66: 49 causes analysis.

Ranking category	Causes
First Category	C5, C6, C11, C19, C24, C26, C27, C29, C30, C33, C34, C39, and C45.
Second Category	C15, C16, C17, C22, C28, C35, C37, and C38.
Third Category	C1, C3, C4, C12, C21, C25, C31, and C32.
Fourth Category	C9, C14, C42, C43, C46, C47, and C48.
Fifth Category	C2, C7, C8, C10, C13, C18, C20, C23, C36, C40, C41, C44, and C49.

Table 67: Causes' ranking categories.

4.5.7 Taxonomy System (Classification):

Causes can be classified in many ways, including controllable and uncontrollable causes which may vary by project type and project stakeholder, but the aim is to improve understanding in order to minimise cost overrun.

As Table 68 shows, there are many suggestions for classifying causes of cost overrun, which reflect different thoughts about the cost overrun problem and, therefore, cannot be universally accepted. Examples of the classification systems used in the literature are:

Study	Classification system
(Abdul Rahman et al., 2013)	The study categorises the cost overrun in 7 groups. These groups that investigated are the Contractor's Site Management related factors, Design and Documentation related factors, Financial Management, Information and Communication, Human Resource, Project Management, and Contract Administration.
(Flyvbjerg et al., 2002)	Categorised the sources of cost overruns on construction projects into four groups: technical (error), psychological, economic and political.
(Mahamid, 2014)	The factors were divided into five groups: cost estimating, construction items, construction parties, environmental, and financing.
(Le-Hoai et al., 2008a)	The causes are grouped into the following groups: Owner-related group, Contractor-related group, Consultants-related group, Project-related group, Material and labour group, and External factors-related group.
(Long et al., 2004)	The factor analysis in Long study identifies 7 category groups which are: slowness and lack of constraint, incompetence, design, market and estimate, financial capability, government, and worker.
(Radujkovic, 1999)	Causes in this study are divided into the main category based on the cause resource which are external sources and internal sources. The main groups subdivided into: External source into legal, political, economic, social, natural. Internal source into: management, technical documentation (design), human factor, supply and logistic, contract.
(Berechman and Wu, 2006)	In the Berechman and Wu study the factors are grouped into Technological, Construction, General economic and financial, Regulatory, Organisational and orient management, Political, and Contractual or legal.

Table 68: Examples of causes' classification systems in the literature.

As Table 68 shows, the literature pieces of evidence that different classification criteria have been used to classify cost overrun causes; nature of the cause, time of occurrence, contract’s reasonability and systemic criteria. However, this leaves other classification aspects, which might be important, outside of consideration. Studies from the Saudi context show another type of classification, such as the Assaf et al. (1995) study, which classified the delay causes into nine categories: Project, Owner, Contractor, Consultant, Design, Materials, Equipment, Labours, External. However, no definitions were given for each category.

The literature shows that developing a taxonomy system is essential for the following reasons:

- It is apparent that there are many causes of overruns and many share similar patterns of impact on overrun costs. Therefore, it will be functionally useful and conceptually meaningful to develop a classification/taxonomy of causes based on their impact on the overruns of construction projects.
- A classification/taxonomy of causes should be developed to aid the assessment of cost overrun causes for construction projects.
- The classification will reduce the complexity of understanding the causes by grouping number of them that may share similar patterns of how it impacts on cost overrun, and that help to facilitate effective management of such causes.
- The problem of the cost overrun is still occurring which could be the results of the bad classification.

Based on the themes and nodes that results of the context analysis of the interview and documents, and guided by the previous classification systems, the author proposes a classification (taxonomies) system comprising three levels.

A three levels taxonomy seeks to include all the possible causes of contractors' cost overrun in the Saudi construction industry. Although the taxonomy system does not intend to include all the causes for another context, other researchers could use the system as a generic framework to customise the causes for other contexts by adding or removing causes. Besides the causes, there were semi-causes which the researcher regarded as amplifiers; not a cause by it is nature rather than project characteristics. These characteristics have been identified in many previous studies, however, from the researcher point view they are not acting as a cause, rather they amplify the effects and impact of other causes and between causes relationship. For example, the project size, to which the impact of causes is positively linked; the impact of a cause such as Increase in labour cost is higher in a mega project compared to medium and small size projects. It is posited that the developed system covers the limitations of previous work for the following reasons:

- Definition and characteristics have been identified so any new causes could be classified in. Moreover, because of the complexity and novelty of the construction projects, it is impossible to cover all the causes that lead to cost overrun, so we need to identify the definition and characteristics for any clusters so as to accommodate new causes.
- The cost overrun causes taxonomy system provides a structured view that enables objective evaluation of decision methods. Therefore, the model can be used to aid the assessment of cost overrun causes for construction projects and to effectively mitigate risks of significant overruns.
- New perspective: the developed taxonomy system is from the contractors' perspectives while others are mostly from owner perspectives.

The three levels of the taxonomy system are:

Level One:

Causes are divided into external causes, organisational causes, project internal causes, and amplifiers.

Level Two:

External causes divided into Procurement, Regulation, Country's economy, Force majeure, Uncertainty, Fraudulent practices, and Social.

Organisational causes divided into Process and Behaviour.

Project internal causes divided according to their sources – client, design consultant, contractor and others.

Level Three:

Descriptions of Level 3 causes are self-explanatory.

4.5.7.1 External causes:

These factors are usually beyond the control of project teams. They exist and evolve independently of any individual project. External causes are divided into the sub-level which are: Procurement, Contract, Regulation, Country's economy, Force majeure, Uncertainty, Fraudulent practices, and Social.

External causes

Procurement

C1 Inappropriate procurement route and procedure

C2 Selection and assignment criteria

Contract

C3 Discrepancies and/or deficiencies in contract documents

C49 High guarantee period of products

Regulation

C4 Inappropriate (Discrepancies and/or deficiencies) local/national data, regulation/policies, requirements, and political environment

C7 Changes in governmental regulations.

Country’s economy

C5 Difficult/Unstable/change in country's economic conditions

C21 Financial difficulty by client during construction phase

Force majeure

C6 Adverse weather

Uncertainty

C8 Risk and uncertainty (Unforeseen events)

Fraudulent practices:

C9 Fraudulent practices, kickbacks, corruption, Bribes.

C13 Strategic misrepresentation

Social

C10 Social and cultural impacts

C14 Optimism bias

4.5.7.2 Organisational causes:

These factors are related to organisations directly involved in a project. Because most organisations are often involved in more than one project, organisational causes are also project independent. Organisational causes are divided into the sub-level which are: Process, and Behaviour.

Organisational causes

Process

C11	Inadequate planning, preparation, and pre-construction process and studies
C15	Inadequate Inappropriate (Discrepancies and/or deficiencies) design process and documents
C22	Delay in payment of completed works
C29	Poor communication and coordination between a project's parties

Behaviour

C31	Conflicts, disputes, and lack of trust culture among the parties involved in the project.

4.5.7.3 Project internal causes:

These factors are project specific and directly related to an individual project. Causes are divided into the sub-level (divided according to their sources) which are:

Project internal causes

Owner/ Owner representative related

C12	Deficiencies in cost and time estimates prepared by public agencies
C16	Inadequate site and ground investigations
C17	Premature tender documents (drawings, bill of quantities, specifications, contracts and legal documents)
C27	Schedule delay caused by client
C44	Lack of owner / owner representative / team experience/ability

Contractor related

C18	Difference between selected bid and the consultants' estimate (Tender-winning prices are unrealistically low)
C19	Inaccurate cost and schedule estimates by contractor
C23	Contractors' financial difficulties
C26	Schedule delay caused by contractors
C25	Cost of penalties

C20 Inadequate planning and preparation by contractors

C30 Poor project/site controlling, monitoring, and management

C45 Lack of contractor / subcontractors / team experience/ability

C33 Rework and wastage on site

C34 Increased material costs

C35 Shortage of materials

C36 Poor material quality

C37 Increase in labour cost

C38 Inadequate manpower productivity

C39 Shortage of labour

C40 Increased equipment costs

C41 Inadequate or inefficient equipment, tools and plants.

C42 Equipment availability and failure

Project related:

C24 Changes in the project's scope, design, specifications

Other

C28 Schedule delay caused by external factor

C32 Extra works not included in the contract

4.5.7.4 Amplifiers:

This category is not considered as a cause rather than factors influencing the causal relationship between the causes (discussed further in objective 5).

C46 Project size

C47 Project location

C48 Project complexity

C43 Lack of experience/ability/competence

4.6 Objective Five:

A casual model contains multi-casual chains. To understand the causal model, the casual chain needs to be understood. To explain the chain, Figure 40 shows the causal chains' components.

To build the initial model, paths were identified based on literature, Interviews, the case study, and the 49 causes identified in Objective Four. Based on the causes' types (Figure 40), four factors (C8 Risk and Uncertainty (Unforeseen events), C43 Lack of experience / ability / competence, C46 Project size, C47 Project location, and C48 Project complexity) have been classified as factors affecting causal relationships (Amplifiers). The rest of the 45 causes are classified as illustrated in Table 69. The smallest group of causes are the Root causes, followed by direct causes with10 causes, and the majority of the causes are intermediate causes.

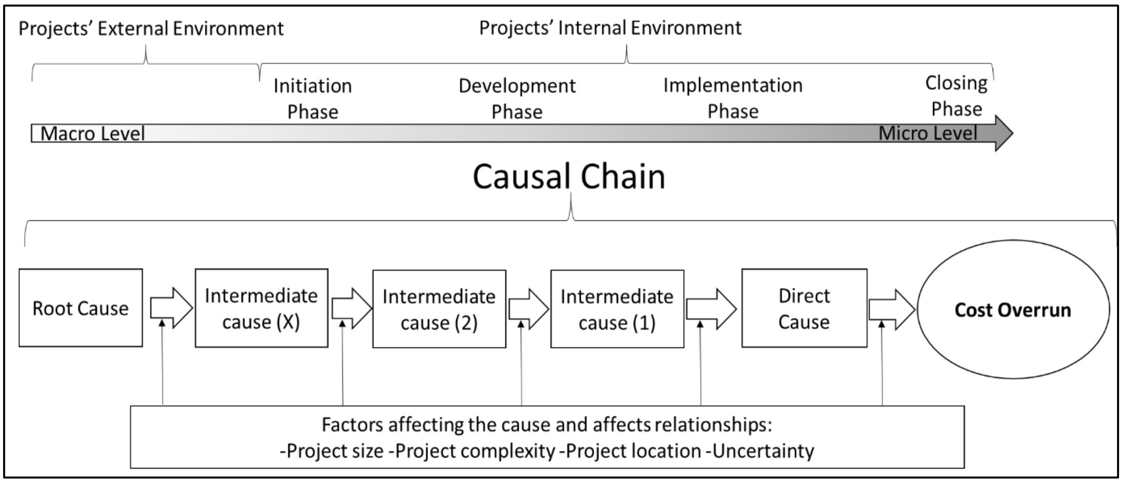

Figure 40: Casual chain's components.

Using both the causality model's classifications and the cause classification system, as identified in objective four, the researcher developed a cost overrun causes' matrix that is illustrated in Table 70. As it could be seen in the table, although the intermediate causes are distributed over the three classification categories (External, Organisational, and Internal), all the root causes are classified as external causes and mainly related to regulation. In addition, the direct causes are mainly internal causes and related to contractors.

Classification	Causes
Direct Causes	C9 Fraudulent practices, kickbacks, corruption, Bribes. C19 Inaccurate cost and schedule estimates by contractor. C23 Contractors' financial difficulties. C25 Cost of penalties. C31 Conflicts, disputes, and lack of trust culture among the parties involved in the project. C32 Extra works not included in the contract. C33 Rework and wastage on site. C34 Increased material costs. C37 Increase in labour cost. C40 Increased equipment costs.
Intermediate Causes	C1 Inappropriate procurement route and procedure. C2 Selection and assignment criteria. C3 Discrepancies and/or deficiencies in contract documents. C11 Inadequate planning, preparation, and pre-construction process and studies. C12 Deficiencies in cost and time estimates prepared by public agencies. C14 Optimism bias. C15 Inadequate Inappropriate (Discrepancies and/or deficiencies) design process and documents. C16 Inadequate site and ground investigations. C17 Premature tender documents (drawings, bill of quantities, specifications, contracts and legal documents) C18 Difference between selected bid and the consultants' estimate (Tender-winning prices are unrealistically low). C20 Inadequate planning and preparation by contractors. C21 Financial difficulty by client during construction phase. C22 Delay in payment of completed works. C24 Changes in the project's scope, design, specifications. C26 Schedule delay caused by contractors. C27 Schedule delay caused by client. C28 Schedule delay caused by external factor. C29 Poor communication and coordination between a project's parties. C30 Poor project/site controlling, monitoring, and management. C35 Shortage of materials. C36 Poor material quality. C38 Inadequate manpower productivity. C39 Shortage of labour. C41 Inadequate or inefficient equipment, tools and plants. C42 Equipment availability and failure. C44 Lack of owner / owner representative / team experience/ ability. C45 Lack of contractor / subcontractors / team experience/ ability. C49 High guarantee period of products.
Root Causes	C4 Inappropriate (Discrepancies and/or deficiencies) local / national data, regulation/ policies, requirements, and political environment. C5 Difficult / Unstable / change in country's economic conditions. C6 Adverse weather. C7 Changes in governmental regulations. C9 Fraudulent practices, kickbacks, corruption, Bribes. C10 Social and cultural impacts. C13 Strategic misrepresentation.

Table 69: Casual chain causes.

4.6.1 Building the causal chains (Paths):

The method that used to build the cause paths commences from the direct causes (Figure 41) that are linked directly to the contractors' cost overrun and then trace back to its origin's cause, which is normally the root cause. The tracing and causal relation extraction are based on the data analysed from the literature review, interviews, and context (case study). The casual chains are illustrated in sub-divisions based on the direct causes, moving from the less complex to the more complex direct cause casual chain.

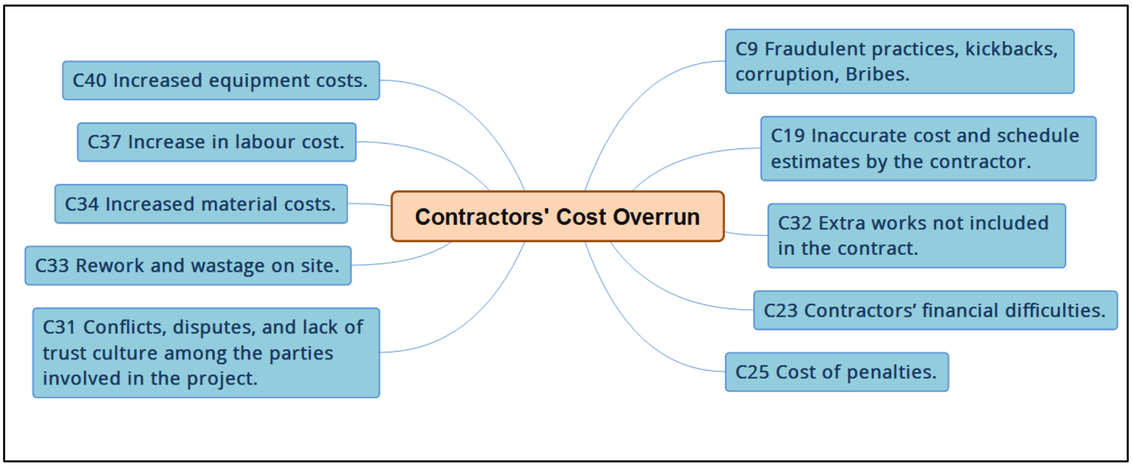

Figure 41: Direct causes of contractors' cost overrun.

Causality Model Classification / *Causes Classification*		Direct Causes	Intermediate Causes	Root Causes
External	*Procurement*		C1 Inappropriate procurement route and procedure. C2 Selection and assignment criteria.	
	Contract		C3 Discrepancies and/or deficiencies in contract documents. C49 High guarantee period of products.	
	Regulation			C4 Inappropriate (Discrepancies and/or deficiencies) local/national data, regulation/policies, requirements, and political environment. C7 Changes in governmental regulations.
	Country's economy		C21 Financial difficulty by client during construction phase.	C5 Difficult/Unstable/change in country's economic conditions.
	Force majeure			C6 Adverse weather.
	Fraudulent practices	C9 Fraudulent practices, kickbacks, corruption, Bribes.		C13 Strategic misrepresentation.
	Social		C14 Optimism bias.	C10 Social and cultural impacts.
Organisational	*Process*		C11 Inadequate planning, preparation, and pre-construction process and studies. C15 Inadequate Inappropriate (Discrepancies and/or deficiencies) design process and documents. C22 Delay in payment of completed works. C29 Poor communication and coordination between a project's parties.	
	Behaviour	C31 Conflicts, disputes, and lack of trust culture among the parties involved in the project.		
Project	*Owners' related*		C12 Deficiencies in cost and time estimates prepared by public agencies.	

			C16 Inadequate site and ground investigations. C17 Immature tender documents (drawings, bill of quantities, specifications, contracts and legal documents). C27 Schedule delay caused by client. C44 Lack of owner / owner representative / team experience/ability.	
	Contractors' related	C19 Inaccurate cost and schedule estimates by the contractor. C23 Contractors' financial difficulties. C25 Cost of penalties. C33 Rework and wastage on site. C34 Increased material costs. C37 Increase in labour cost. C40 Increased equipment costs.	C18 Difference between the selected bid and the consultants' estimate (Tender-winning prices are unrealistically low). C20 Inadequate planning and preparation by contractors. C26 Schedule delay caused by contractors. C30 Poor project/site controlling, monitoring, and management. C35 Shortage of materials. C36 Poor material quality. C38 Inadequate manpower productivity. C39 Shortage of labour. C41 Inadequate or inefficient equipment, tools and plants. C42 Equipment availability and failure. C45 lack of contractor / subcontractors / team experience/ability.	
	Projects' related		C24 Changes in the project's scope, design, specifications.	
	Other	C32 Extra works not included in the contract.	C28 Schedule delay caused by external factors.	

Table 70: Causes Matrix based on the causality model classification and causes the classification system.

4.6.1.1 First attempt:

In this section, the first attempt to build the causal model is illustrated. Figures and Tables will be used to draw the links, extract, and explain the causal relationship. Figure 42 and Table 71 illustrate examples of the figures and the Table that will be used to draw, explain and extract the casual relationships.

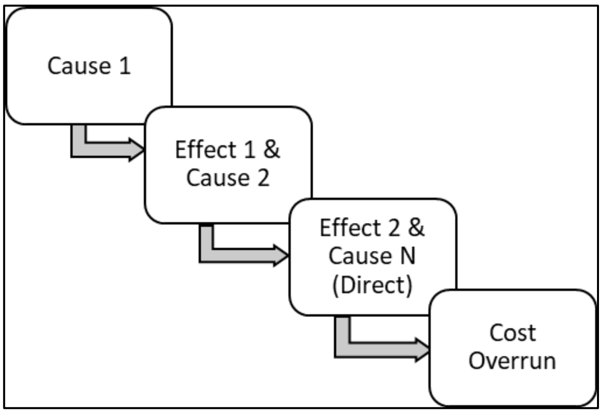

Figure 42: Causes Chain's Explanation.

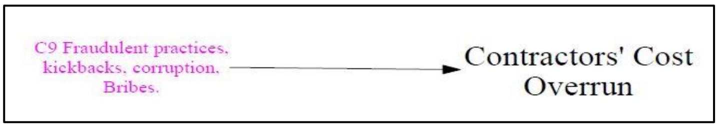

Figure 43: Causal chain for cause C9.

The total results of the first attempt are illustrated in Figure 44. The model contains a causal chain for the direct causes that has been traced back. The process of tracing is mainly based on multiple resources which are presented in sections 3.10.1 and 3.10.2. As the figure shows, the model contains a simple chain (Figure 43). However, most of the direct causes are a result of long and complex causal chains. For example, C25 contains over 25 causal chains, with the shortest chain containing 4 causes, and the longest chains containing over 12 causes (Figure 45). This was also mentioned by the 2 experts who reviewed the initial model in that they requested that the model needs to be less complex so as to be more welcomed in the Saudi construction industry and by the decision makers. Based on that, the model needs to be simpler, so the causal chain could be identified, presented, and extracted.

Causal Relation			Extraction			
			Non-Saudi Context	Saudi Context		
Chain No.	Causes	Next Level effects	Literature Review	Documents	Interviews	Literature Review
1	Cause 1	Effect 1 and cause 2 (Direct)				
	Effect 1 and cause 2 (Direct)	Cost Overrun				

Table 71: Causes Chains' extraction (Example).

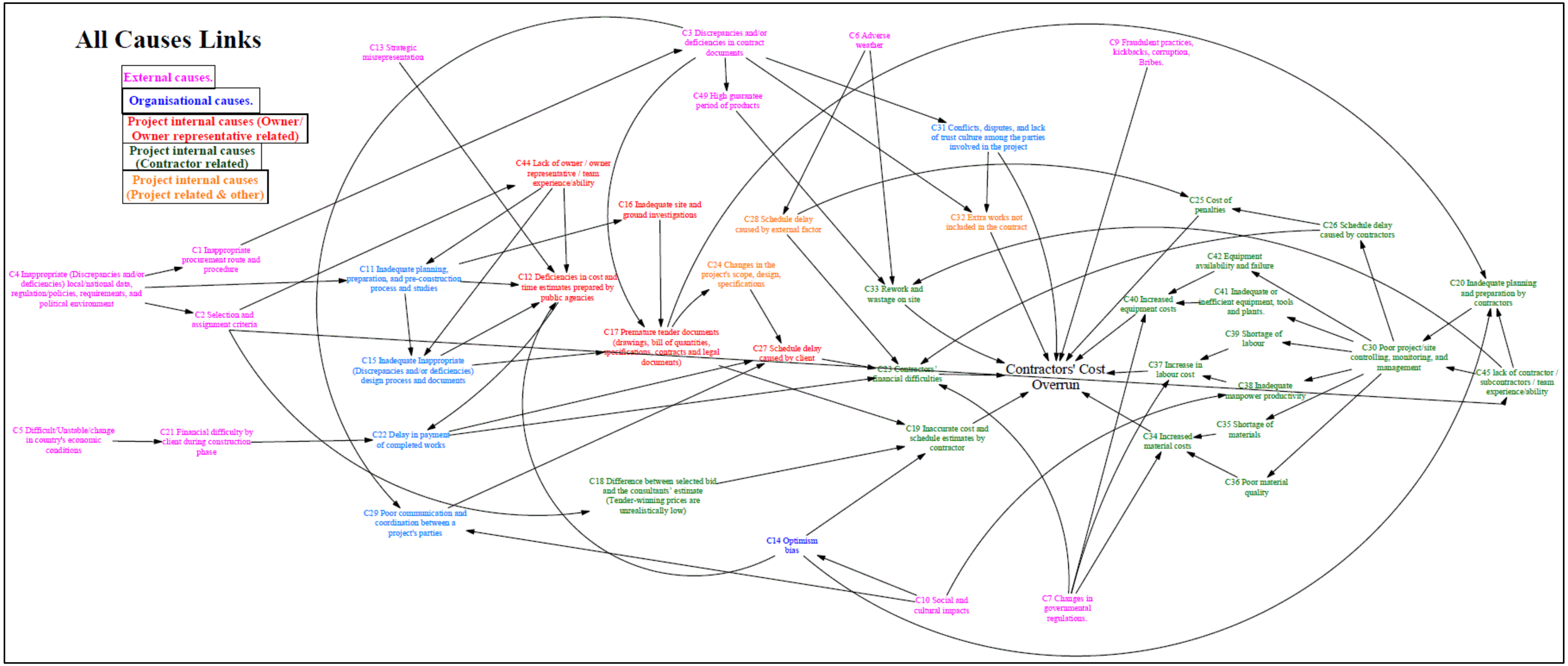

Figure 44: Causal chains for all the causes (First attempt).

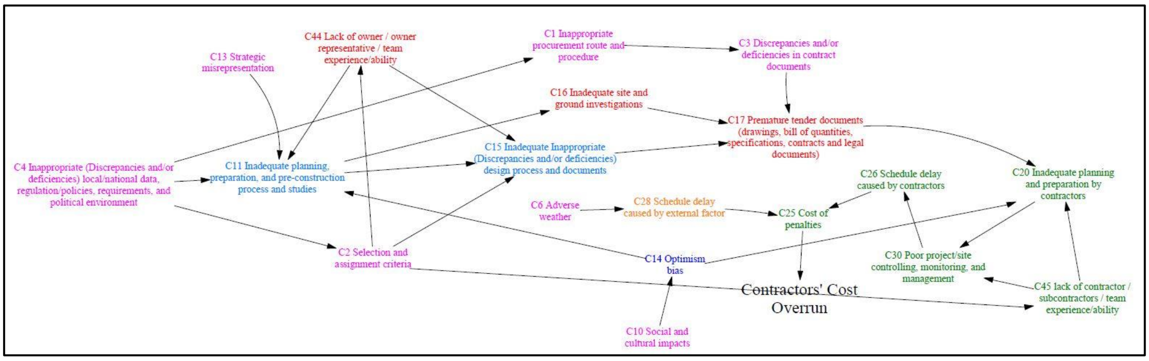

Figure 45: Causal Chains for cause C25.

4.6.1.2 Second attempt:

To reduce the model complexity, the researcher recognised that some of the late intermediate causes are linked to the root causes of a single causal chain, on which basis the intermediate cause could replace the root cause and the single causal chain between them be deleted. This action will reduce the complexity of the model through chains becoming shorter and containing a smaller number of causes. To illustrate, using Figure 45, it can be seen that the C3 intermediate cause is a result of the following chain (C3 – C1 – C4). Thus the C3 causal chain can be presented separately at the beginning and presented in the model as CO1. All the identified cycles are presented in Figure 46 to Figure 51. Figure 52 illustrates the cycles' links (in grey) as well as deleted causes (in box) which are C1, C2, C4, C5, and C21. The revised model is presented in Figure 53.

4.6.2 Part-chain explanation and causal chain extraction:

From Table 40 it can be seen that the root sources for all the replaced chains are C4 and C5. C4 (inappropriate regulation/policies, requirements, and political environment) is a direct cause for C1 (inadequate procurement route and procedure), C2 (Selection and assignment criteria), and C11 (Inadequate planning, preparation, and pre-construction process and studies). Both C1 (procurement route) and C2 (selecting consultants, designers, and contractors based on the lowest price) are good examples of the inappropriate regulation as discussed in Objective 1 (4.2.4). Moreover, inappropriate regulation also caused an inadequate preparation for the projects as the pre-design phases are not included in the regulation of public projects. C1 (procurement route) is linked to the inappropriate contract document, which is the public work contract. The contract has been assessed and its weaknesses illustrated in Objective 2 (4.3.3). The poor selecting criteria are directly linked to poor consultant experience (C44), poor contractor experience (C45), and accepting very low bidders (C18). On the financial side, an unstable national economy (C5), is a direct cause to the owner of financial difficulty during the construction phase (C21) which is a direct cause for delay in payment (C22). The country's unstable financial sources and how it could lead to such a problem was discussed in chapter two (2.2).

Intermediate cause	Root Cause	Chain	Deleted causes	New code for the intermediate causes
C3	C4	C4-C1-C3	C4-C1	CO1.
C11		C4-C11	C4	CO6
C44		C4-C2- C44	C4-C2	CO2
C45		C4-C2- C45		CO3
C18		C4-C2- C18		CO4
C22	C5	C5-C21-C22	C5-C21	CO5

Table 72: Part-chain explanation.

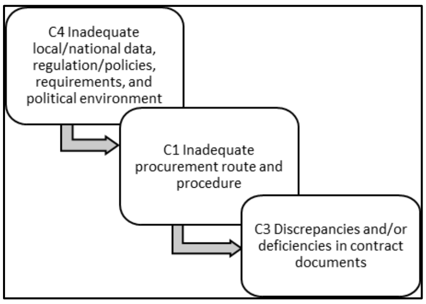

Figure 46: Cycle one CO1.

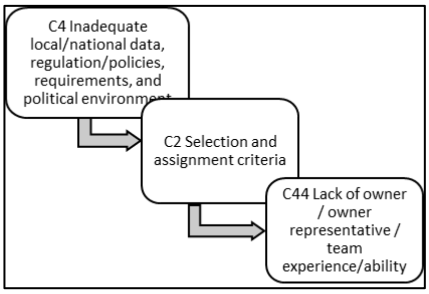

Figure 47: Cycle two CO2.

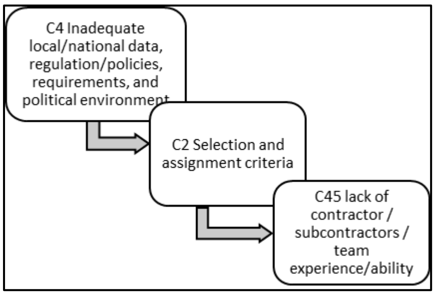

Figure 48: Cycle three CO3.

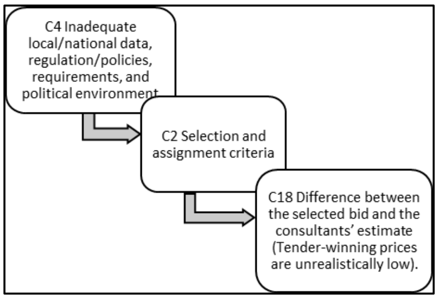

Figure 49: Cycle four CO4.

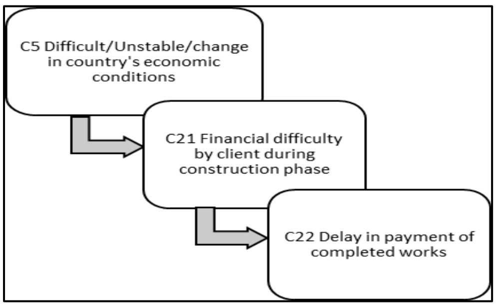

Figure 50: Cycle five CO5.

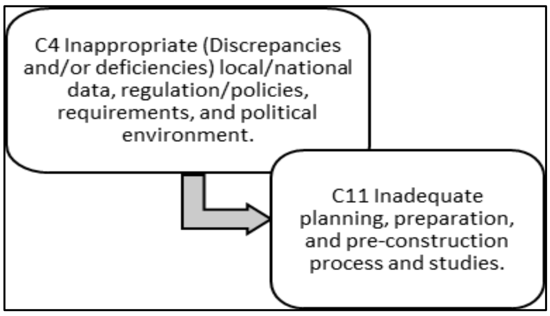

Figure 51: Cycle six CO6.

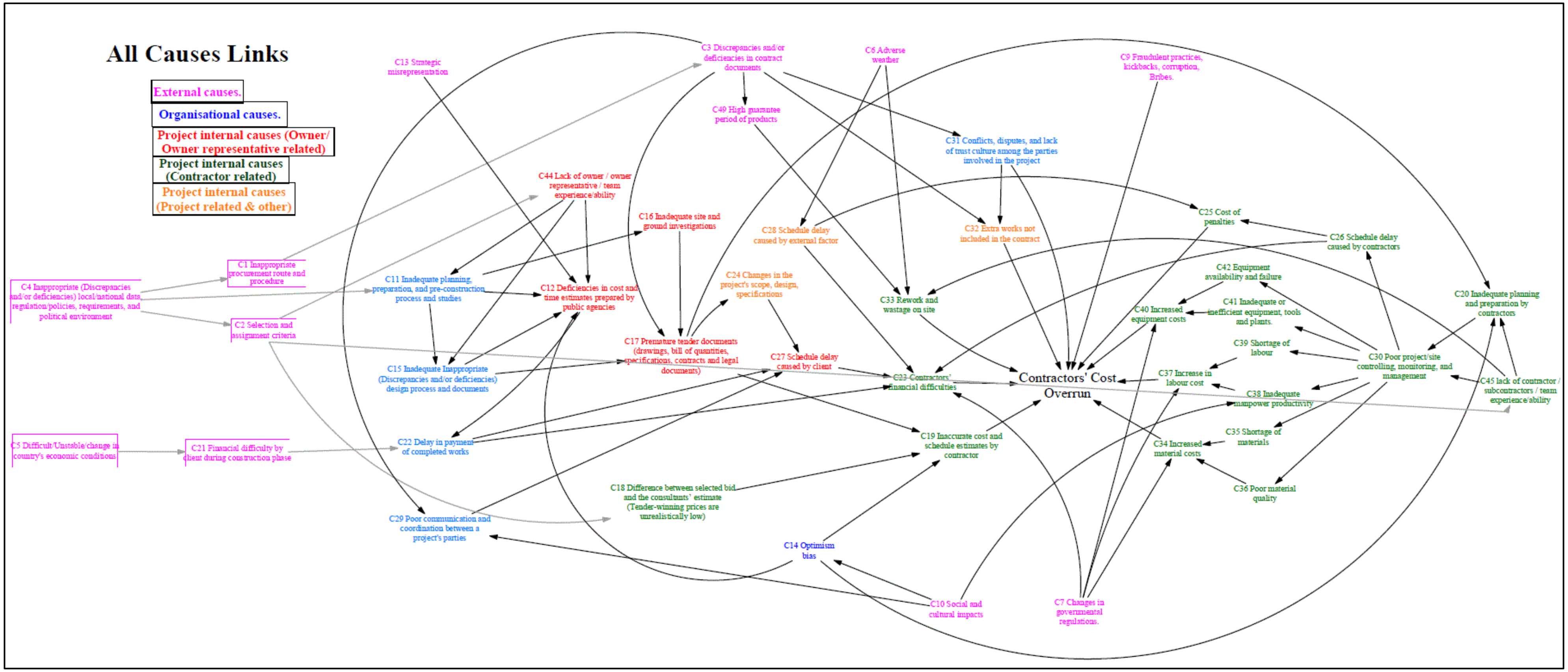

Figure 52: Causal chains for all the causes with the deleted links and causes.

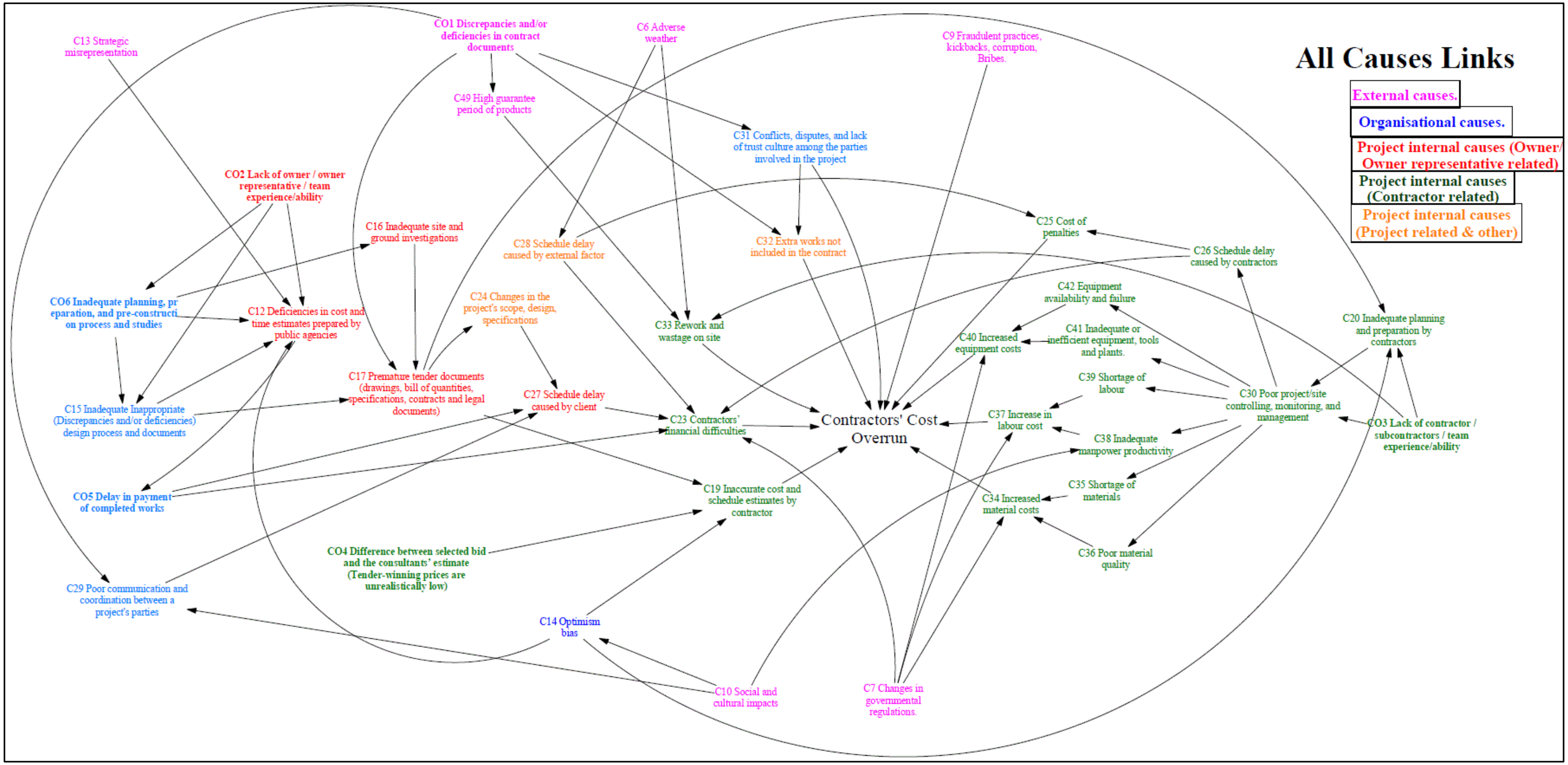

Figure 53: Causal chains for all the causes (Second attempt).

As shown in Figure 53, the model complexity reduced after applying the part-chains (cycles). For example, Figure 54 illustrates C25 causal chains which contain 10 chains (longest 9 causes chain) which are less complex compared to the earlier version (Figure 45). However, the model remains complex and this can be seen in other causes chains such as C23 in Figure 55. Thus, the model's complexity needs to be further reduced.

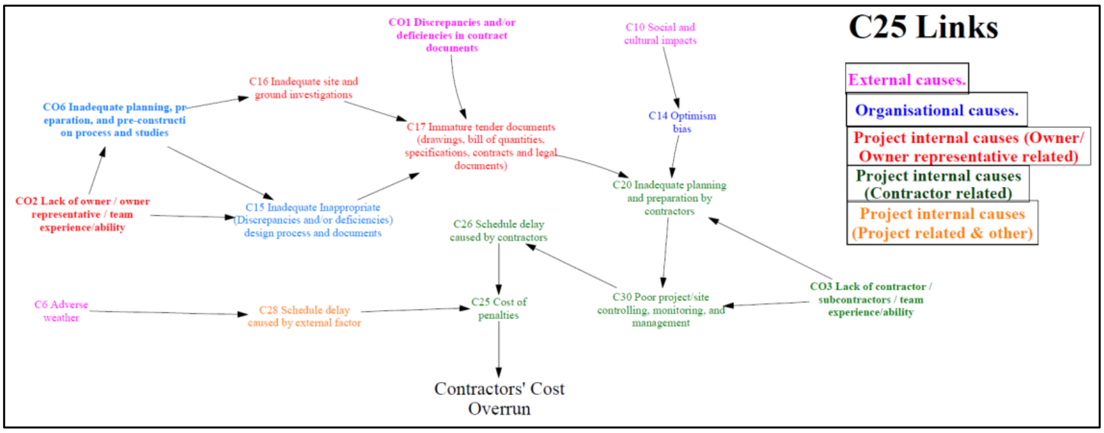

Figure 54: C25 causal chains using the cycles.

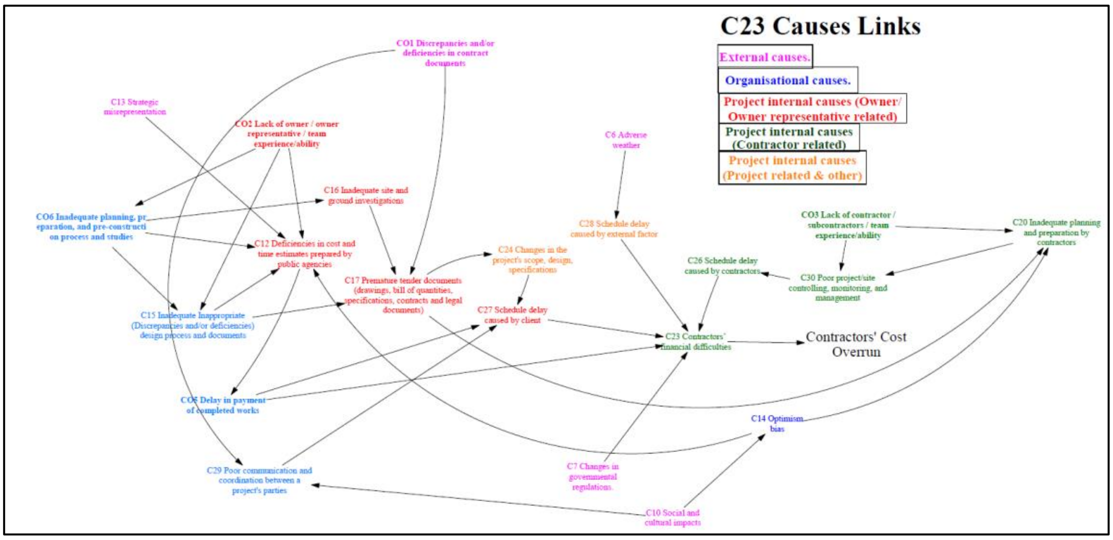

Figure 55: C23 causal chains using the cycles.

4.6.2.1 Third attempt:

After assessing different solutions to reduce the complexity of the whole causality model to produce less complex and more understandable individual causes' causality chains. It is believed that changing the starting point of a chain could be the best solution to reduce its complexity (i.e. starting from the intermediate causes rather than from root cause) and as a result, most of the chains could be divided into two chains. Such an action does not affect the buildability and constructability of the model as a whole as it simply reduces the number of repeated part-chains. To illustrate, from Figure 55 which presents C23 causal chains, the number of the repeated part-chains caused by C12 only is 12 as it is affected by five causes (C13, C14, C15, CO2, and CO6) and affects one cause (CO5). The 12 repeated part-chains are in C23 causality chains only (i.e. the total number of repeated chains caused by C12 is higher con). In other words, if the causal chains start from C12, for example, rather than causes affected by (i.e. C13, C14, C15, CO2, and CO6), 12 Chains will be shorter and less complex. However, applying this solution to a unified starting point for the whole model is needed. By Identifying this point, a cross-section line will be built; thus, the new starting causes for the chains can be identified.

After discussion with the two experts, it was agreed that the best-unified point is the point of the contractors' involvement with a project in the Saudi public sector. Moreover, this research focuses on the contractors' cost overrun thus starting from his involvement could give more value to the research by addressing the causes which are more likely to be under the contractor's control or they are involved in, and other causes which exist before the contractors' involvement. Moreover, both contractors and the public sector could then clearly see how each part-chain could cause problems for the other and then propose a solution each from his side that could work for both sides. In the normal public procedure, as it has presented earlier in Objective One (4.2.2), contractors are involved in the project at the tender stage, after the design stage is finished and construction stage not started. The cross-section line passes through the following causes: C12 (Deficiencies in cost and time estimates prepared by public agencies), C14 (Optimism bias), C17 (Immature tender documents; drawings, bill of quantities, specifications, contracts and legal documents), and CO4 (Difference between the selected bid and the consultants' estimate - Tender-winning prices are unrealistically low). As can be seen in Figure 56, these causes are linked with red arrows to the new starting causes which are: C19 (Inaccurate cost and schedule estimates by the contractor), C20 (Inadequate planning and preparation by contractors), C24 (Changes in the project's scope, design, specifications), and CO5 (Delay in payment of completed works). Because of such changes, some of the causes and links were deleted (shown in grey in Figure 56).

4.6.2.2 Part-chain explanation and causal chain extraction:

All the part-chain causal chains are presented in Table 73 and Figure 57. As can be seen, the sources are C10, C13, CO1, CO2, CO3, and CO4 and end in one of the four causes: CO7, CO8, CO9, and CO10. To explain, starting with the less complicated CO3 and CO4, CO3, the lack of contractors' experience is linked directly to C20 (Inadequate planning and preparation). This link is logical and has been found in the literature by (Larsen et al., 2015b; Aziz, 2013a; Nassar et al., 2005), as well as being pointed out by three interviewees (C1, C3, and O1). CO4 (Very low accepted tender) is directly linked CO7 (Inaccurate estimate by the contractors). Again, this link is logical and has been found in the literature by (Abdul Rahman et al., 2013; Aziz, 2013a; Nassar et al., 2005), as well as being pointed out by interviewees C4, C6, O1, O2, and O3. C14 (Optimism bias) is another cause for CO7 (Inaccurate estimate by the contractors) which has a C10 (Social and cultural) background as humane tend to exaggerate benefits and under-estimate risks (illusions) (Lovallo and Kahneman, 2003). This is one of the main findings by (Flyvbjerg et al., 2004; Flyvbjerg, 2008; Ansar et al., 2016) and it has been explained thoroughly in 4.4.4.1. Optimism bias is also a cause for C12 (Inaccurate estimate by the public agency) and CO8 (Inadequate planning and preparation). These links are logical and have been found in the literature (Alghonamy, 2015; Doloi, 2012; Famiyeh et al., 2017b; Park and Papadopoulou, 2012), as well as, by the following interviewees C5, C6, and C7.

The other two main factors on the pre-contractor’s involvement causal chains are C12 (Deficiencies in cost and time estimates prepared by public agencies), and C17 (Immature tender documents (drawings, bill of quantities, specifications, contracts and legal documents) which are both are linked to most causes. The inaccurate cost and time estimates by the public agency (C12) is a direct cause for delay payment for completed work (C10), arising from the public agency needing new funds (from the MOF) for the shortfall, caused by inaccurate estimation, to finish the project (Saudi Ministry of Finance, 2006). This casual relation has been identified by different interviewees (O1, O4, C1, C3, and C4), and the poor financing approach has been explained thoroughly for the context of Saudi Arabia in 2.4. The contractors’ inaccurate estimation is caused by four different causes which are CO2 (Lack of owner experience), C13 (Strategic misrepresentation), CO6 (Inadequate planning and preparation study), and C15 (Inadequate design process and document). Strategic misrepresentation has been identified mainly in the global context (Cantarelli et al., 2010; Flyvbjerg et al., 2009; Flyvbjerg, 2008), and is discussed more in section 4.4.4.1. However, this causal relation was not identified by any of interviewees, or by the Saudi literature review. The approach to financing (one financer for all the projects and different stages approval) and development (lack of pre-design studies) could be the main reason for lack of effective linking between C13 and C12. CO2 (Lack of owner experience) is a logical direct cause for the inaccurate estimation (C12), inadequate planning and preparation (CO6), and inadequate design (C15). These logical links are not only are identified by interviewees (O1 and O4) but also in the worldwide literature review (Memon et al., 2011a), and the Saudi literature review (Albogamy et al., 2012; Al-Khalil and Al-Ghafly, 1999; Assaf and Al-Hejji, 2006; Othman, 2009).

C17 (Immature tender documents) is a direct logic cause to inaccurate estimation by contractors. This logical relationship was identified by both literature ((Rosenfeld, 2014); (Larsen et al., 2015a), and (Hameed Memon et al., 2013) and interviews (O1, O4, and C4). Contractors' normally build their estimation on the tender documents which are more likely to contain errors when an unqualified designer and consultant is chosen. However, the lack of clarity of the document could lead contractors to inaccurately price the project, which could then lead to cost overrun (if the price very low) or to lose the competition (if the price is very high). C17 (Immature tender documents) is caused by C16 (Inadequate site and ground condition) (Eliufoo, 2017) and interviews (O2, O4, and C3)), and has a logical connection to C15 (Inadequate design process) (choosing designer on price factor only) (Al-Rabiah, 2013; ASSAF and AL-HAMMAD, 1992) and interviews (O1, O3, and O4)), and toCO1 (Poor contract documents). Poor contract document was assessed, and its weaknesses has been identified in section 4.3.3.

Intermediate cause	Root Cause	Chain	Deleted causes	New code for the intermediate causes
C24	CO1	CO1-C17-C24	CO1 and C17.	CO9
	CO2	CO2-C15-C17-C24	CO2, C15, and C17.	
		CO2-CO6-C15-C17-C24	CO2, CO6, C15, and C17.	
		CO2-CO6-C16-C17-C24	CO2, CO6, C16, and C17.	
CO5	CO2	CO2-C12-CO5.	CO2 and C12.	CO10
		CO2-CO6-C12-CO5.	CO2, CO6, and C12.	
		CO2-CO6-C15-C12-CO5.	CO2, CO6, C15, and C12.	
	C13	C13-C12-CO5.	C13 and C12.	
	C10	C10-C14-C12-CO5.	C14 and C12.	
C19	CO1	CO1-C17- C19	CO1 and C17.	CO7
	CO2	CO2-C15-C17-C19	CO2, C15, and C17.	
		CO2-CO6-C15-C17-C19	CO2, CO6, C15, and C17.	
		CO2-CO6-C16-C17-C19	CO2, CO6, C16, and C17.	
	CO4	CO4- C19	-	
	C10	C10-C14-C19	C14	
C20	CO1	CO1-C17-C20	CO1 and C17.	CO8
	CO2	CO2-C15-C17-C20	CO2, C15, and C17.	
		CO2-CO6-C15-C17-C20	CO2, CO6, C15, and C17.	
		CO2-CO6-C16-C17-C20	CO2, CO6, C16, and C17.	
	C10	C10-C14-C20	C14	
	CO3	CO3-C20	-	

Table 73: Part-chain explanation and causal chain extraction (Second attempt).

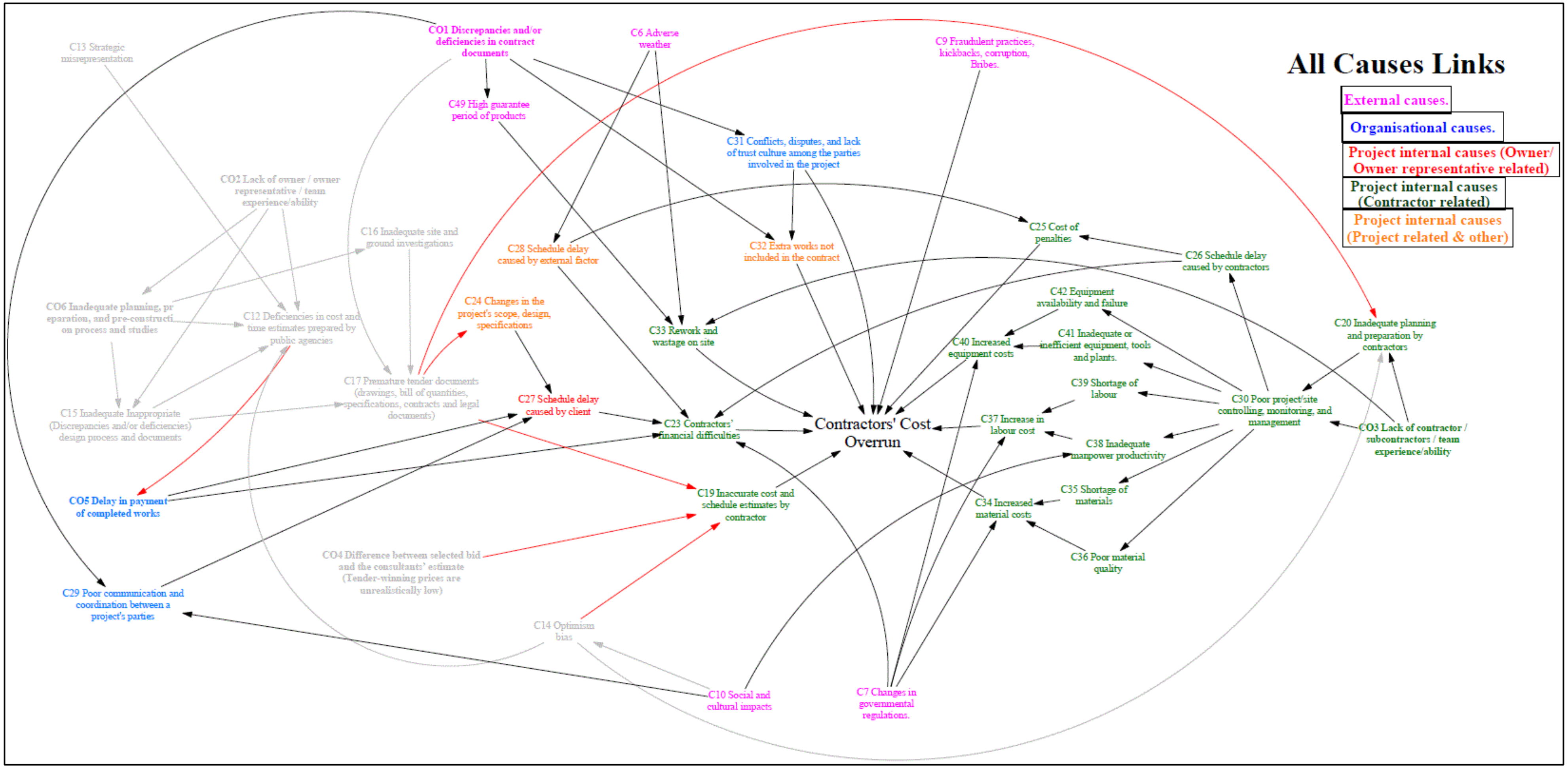

Figure 56: Causal chains for all the causes with the deleted links and causes.

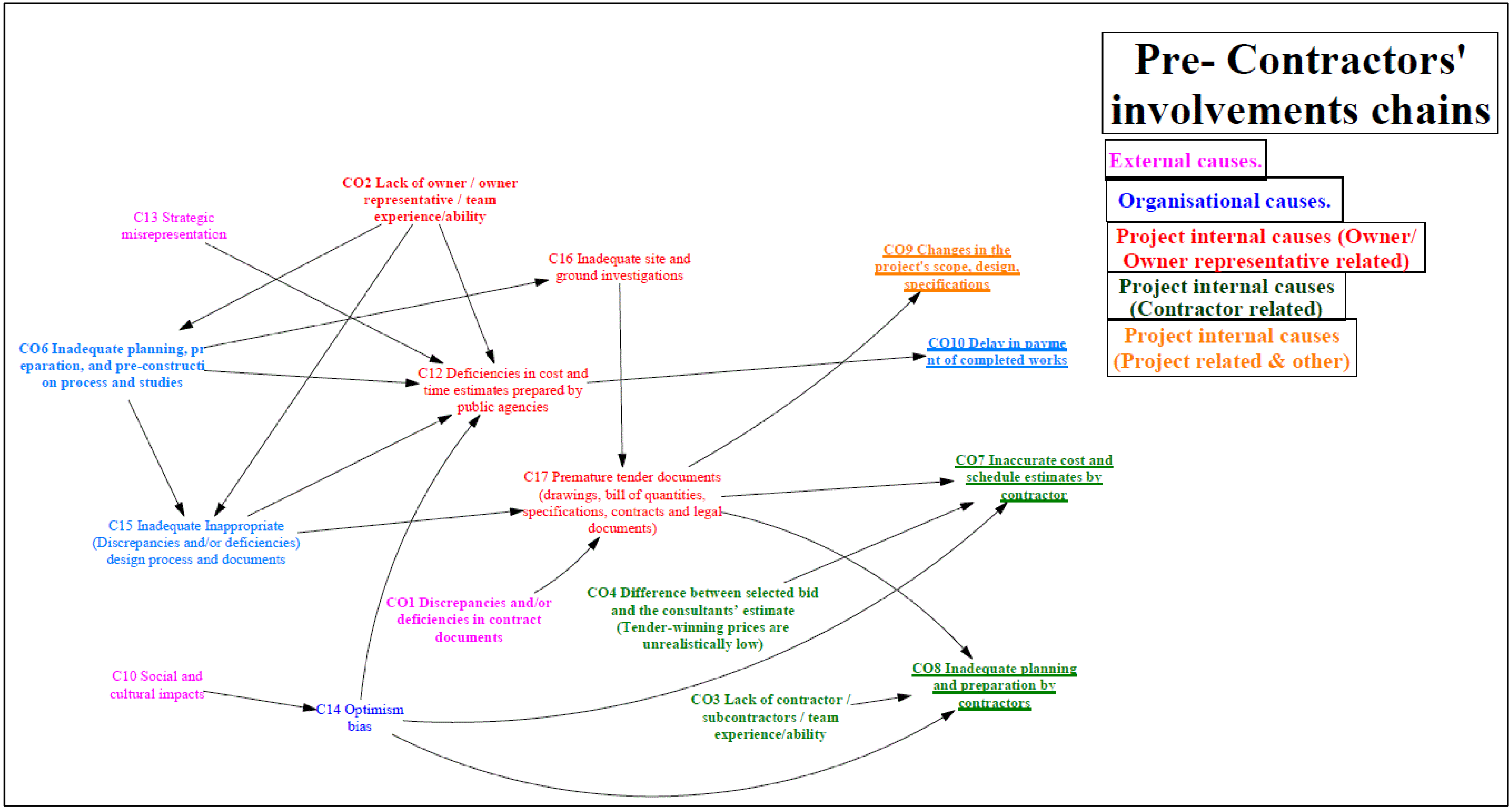

Figure 57: Pre-contractors' involvement causal chains.

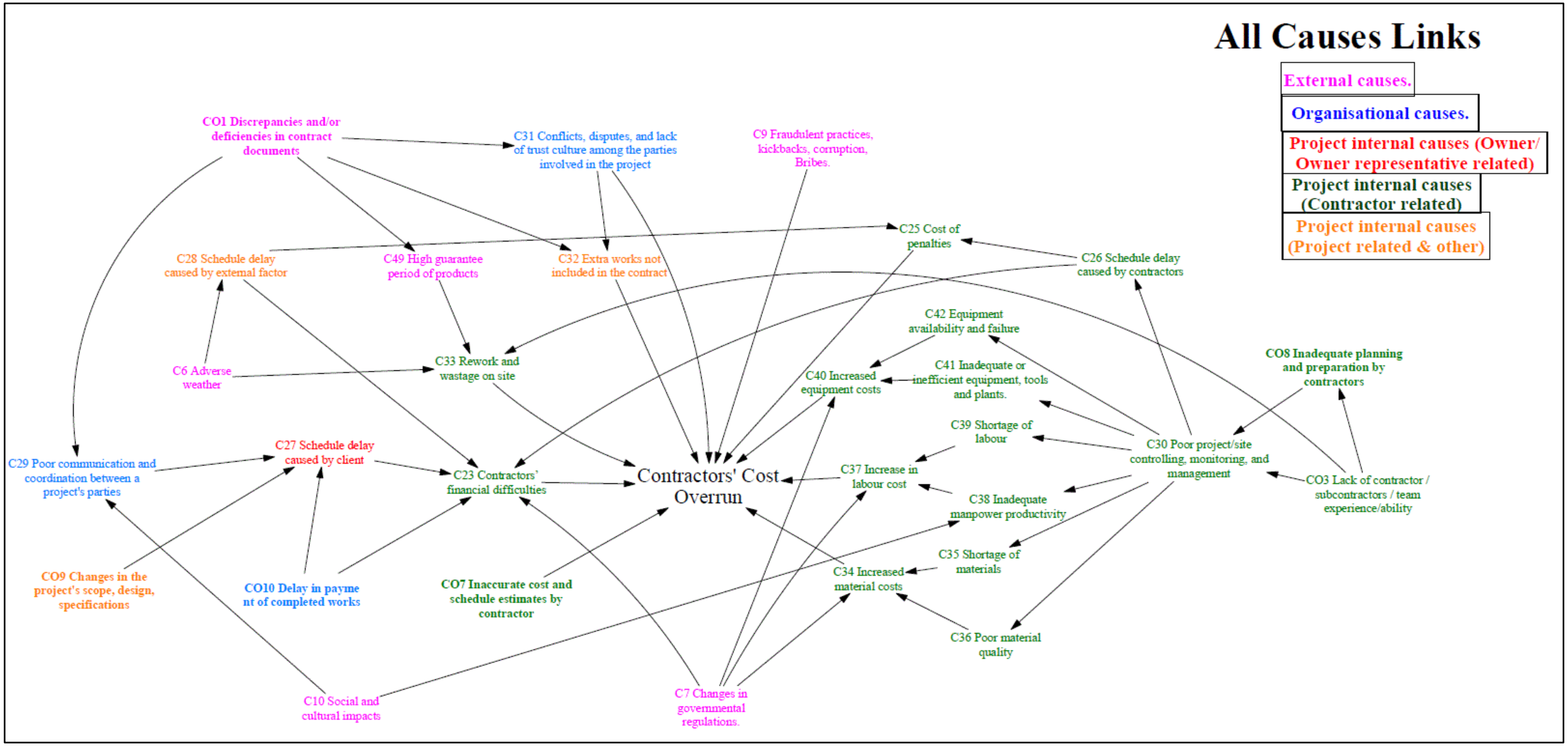

Figure 58: Causal chains for all the causes (Third attempt).

4.6.3 Final Model's Causal Chains Extraction:

Figure 58 presents the final model after eliminating the pre-contractor's involvement causal chains. Moreover, the researcher presents evidence for the causal chains in Table 74, with the evidence being extracted from a systematic literature review, interviews, documents, and the Saudi context literature. In the following sub-sections, direct causes and their chains will be explained.

4.6.3.1 Fraudulent practices, kickbacks, corruption, bribe's causal chain(s):

It is not unusual that the construction industry and corruption are mentioned together, with some of researchers and organisations viewing the construction sector and industry in general as dangerously corrupted (Transparency International, 2005; Transparency International, 2017; Krishnan, 2010).

Although the definition of corruption differs based on the context (Jain, 2001), in construction, corruption is defined as an abuse of authority power and project resources for personal gains (Le et al., 2014; Shan et al., 2016). Different studies identified the causes of corruption in construction (Brown and Loosemore, 2015; Zhang et al., 2016; Shan et al., 2017), and it has been concluded that corruption has the ability to be part of any construction projects' activity and could occur in different forms (Tabish and Jha, 2011; Stansbury, 2009). Thus, because of the unlimited causes of the corruption and the limited information of it in the context of Saudi Arabia and the research scope, the researcher negates the causes of corruption and focuses on the effect of corruption on contractors' cost overrun.

The research has discussed corruption and fraud in the Saudi business environment in section 2.3.4, and it has been explained that regulations and culture are the real triggers, and examples have been given. As can be seen in Table 74, corruption has been identified as a direct cause of contractors' cost overrun in the literature. However, this cause has not been identified by the interviews carried out within this research as a cause of cost overrun. The researcher posits that the interviewees would not admit being a part of the corruption procedure as it could affect their image. Another reason is that some forms of corruption (Favouritism and Nepotism) are generally accepted in the Saudi culture (section 2.3.2) and therefore not seen as corruption by the interviewees.

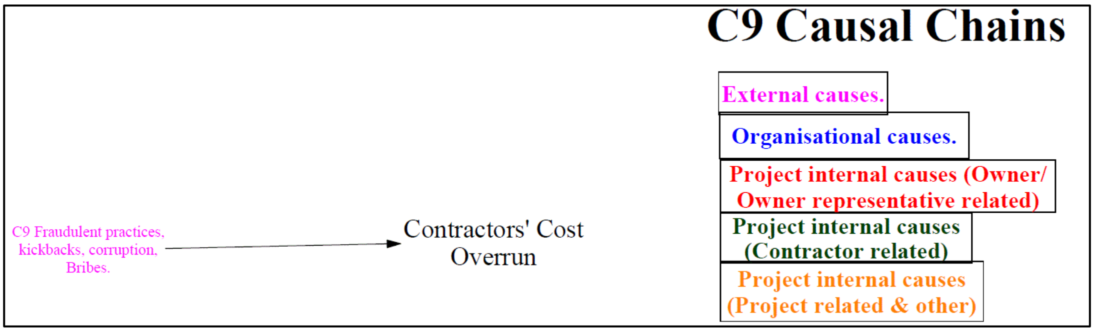

Figure 59: C9 causality chains.

4.6.3.2 (Inaccurate cost and schedule estimates by contractor)'s causal chain(s):

The accuracy of a contractor's estimate could be measured by comparing the final cost of projects (item) to the estimated price at the tender stage (Yang and Chen, 2015). The research defined the final scenarios of contractors' estimation accuracy in section 4.4.3. In the case of poor estimating of cost and/or time by a contractor, it will lead to cost overrun and/or time overrun (Bari et al., 2012). There is agreement over all the evidence' resources on this cause as it has been identified as a direct cause of cost overrun in more than half of the SLR. Moreover, poor estimating of cost and time was identified as the cause of cost overrun by almost all interviewees. Nevertheless, the contract document used is a fixed price contract.

In the international context, over the years different studies have identified the causes of inaccurate estimation, especially from the owner perspective, such as (Oberlender and Trost, 2001) and (Flyvbjerg et al., 2004). In the Saudi context, there is not a study to identify the causes directly; rather it has been discussed while investigating other issues such as (Shash and Abdul-Hadi, 1992) and (Assaf and Al-Hejji, 2006). The causes of the inaccurate estimation have been explained in pre-contractor's involvement cycles in section 4.6.2.2.

Although contractors are mainly responsible for their poor estimation, owners and consultants are also responsible, as suggested by Long et al. (2004). In general, contractors are under pressure to reach a level of highly accurate estimation by including all the possible risks so as to allow them to win the project tender as well as to make a profit. In the Saudi context, the pressure is higher, as the STPL accepts the lowest bid even if it is lower than the market price by 35%, at which point normally such tenders are rejected in other contexts. Such an environment, where most of the risks are the contractors' responsibility, encourages contractors to neglect some risks to win the business (Ahiaga-Dagbui and Smith, 2012). In some cases, this leans towards suicide bidding (Figure 60) which typically results in abandoned projects by contractors. This poor situation is expected to continue unless the owner changes his attitude by refusing to accept suicide estimation, change the risk appropriation, and encourage contractors to identify risks major risks and deal with them early (Ahiaga-Dagbui and Smith, 2014).

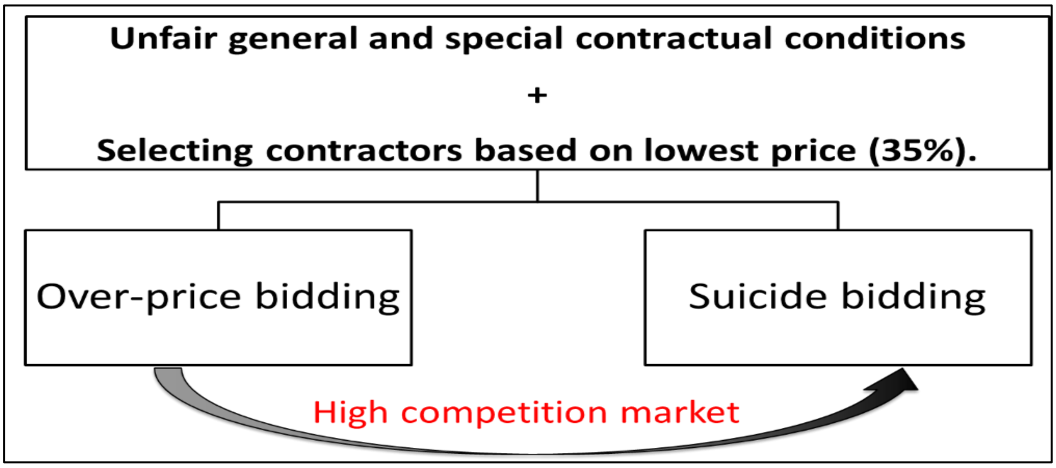

Figure 60: Contractors' estimation conditions.

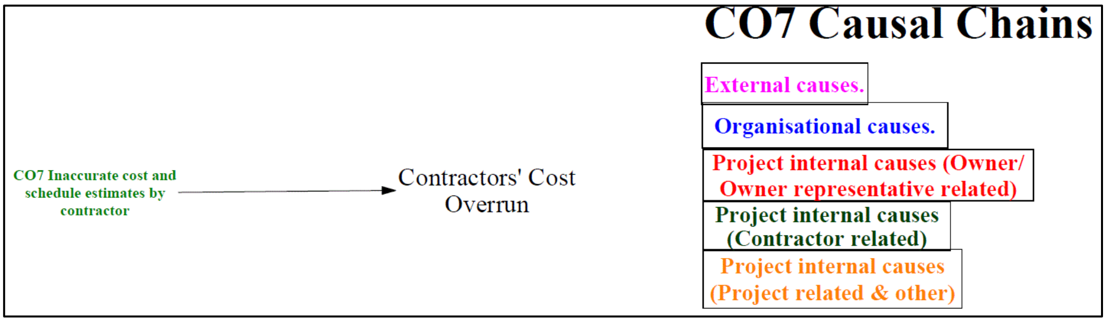

Figure 61: CO7 causality chains.

4.6.3.3 (Conflicts, disputes, and lack of trust culture among the parties involved in the project)'s, and (Extra works not included in the contract's) causal chain(s):

As Figure 62 shows, Conflicts, disputes, and lack of trust culture among the parties involved in the project, and Extra works not included in the contract, are direct causes of contractors' cost overrun. Both causes are triggered by the poor contract (PWC) that is used in all Saudi public projects. The PWC has already been assessed when discussing Objective Two (4.3.3).

Poor contract documents, in general, has been found to encourage conflicts between contractors and owners, as assumptions are found to "lead" the contractors' estimation (Harbuck, 2004). Nevertheless, the PWC encourage the low commitment of MoF to the compensation of contractors' financially, which will be shown in the next sections as another reason for conflict. The PWC also puts the owner in a powerful position where contractors admit doing extra work to make him happy and avoid conflicts.

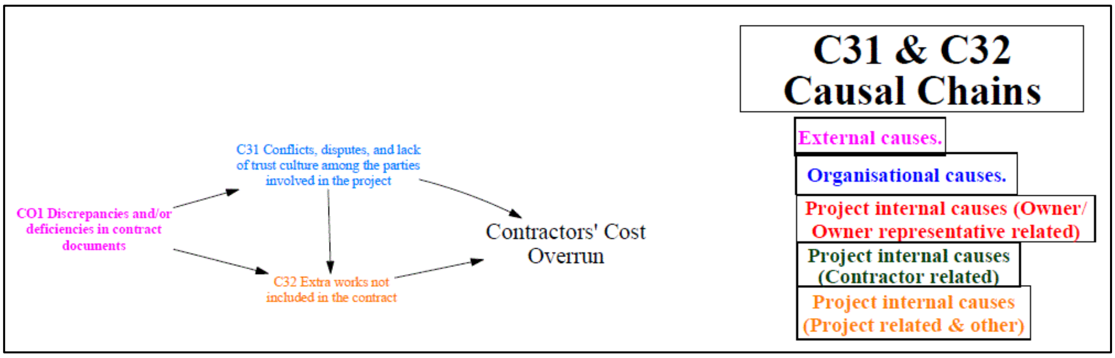

Figure 62: C31 and C32 causality chains.

4.6.3.4 (Rework and wastage on site)'s causal chain(s):

As the final model and Figure 63 described, Rework and wastage are results of the three intermediate causes: lack of contractors' experience, adverse weather, and the long period of guaranteeing works. Redoing the work will lead to cost overrun as contractors normally price for work to be done only once. Out of the three triggers for rework, the guarantee period is the weakest trigger as it been identified in only three resources of SLR (ranked 48 out of 49), and has not been mentioned by the interviewees. This could be related to the fact that contractors are fully aware of the guarantee period ahead of pricing their bid. The adverse weather and lack of experience followed as they were identified more in the SLR and interviews as Table 74 shows. For Saudi Arabia, the natural climate, in general, is good and predictable. However, recent years have shown dramatic changes in weather such as snowfall and flooding, which when combined with an unprepared infrastructure, impact heavily and could destroy the whole project (Al-Ahmed, 2009).

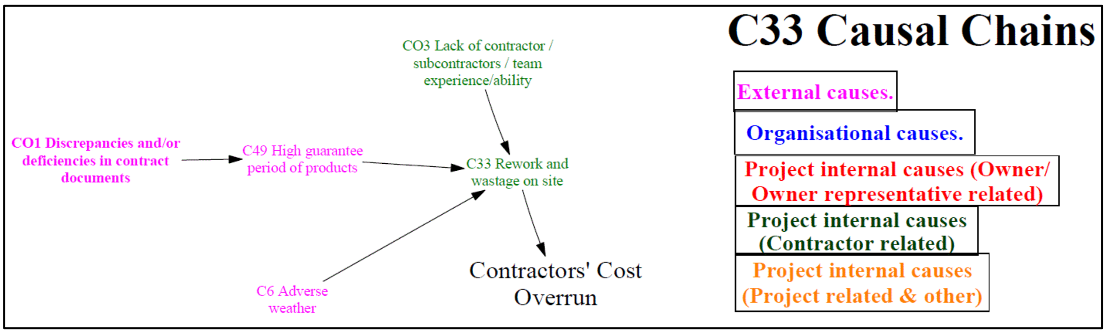

Figure 63: C33 causality chains.

4.6.3.5 (Cost of penalties)'s causal chain(s):

Cost of penalties is the sixth direct cause for the contractors' cost overrun. As shown in Figure 64, the extra cost comes as a result of the delay caused by the contractor or an external factor, as the PWC points out only one type of penalty (delay penalty). Besides daily extra cost caused by delay such as the cost of overhead (Morris, 2003), according to PWC, the total delay penalties could be as high as 10% of the projects' price, which also includes the consultation cost. Although the penalties are limited to 10%, for contractors who work in a competitive environment this could eat the whole profit and mark-up (Shash and Abdul-Hadi, 1992).

In term of SLR, the direct cause itself ranked as arguably low (30 out of the 49) compared to the two triggers (13 and 14 out of 49). This is caused by the limitation of the previous works (discussed in section 4.4.2), as most of the previous studies have issues with the wording of the direct cause of cost overrun. Moreover, the different views on the cost overrun (owners' and contractors' perspectives) typically mean that words such as "penalties" are normally not used against owners.

The delay causes as discussed in a large volume of studies (Larsen et al., 2016); (Singh, 2009a), and in the Saudi context (Al-Kharashi and Skitmore, 2009) reflect the limitations of these studies. However, both the literature and the interviews agree that contractors' poor management of the project and its site and adverse weather are the main triggers for delay, as Table 74 shows.

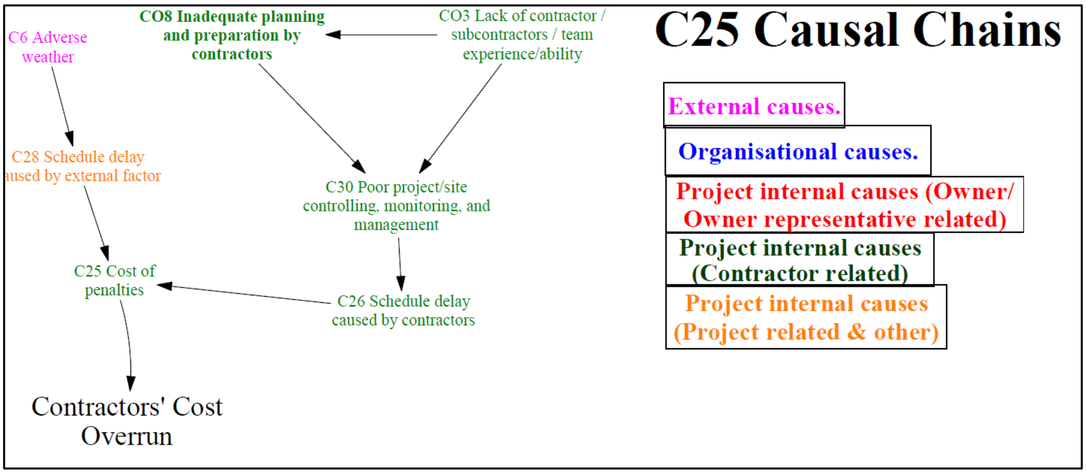

Figure 64: C25 causality chains.

4.6.3.6 (Increased material costs)'s, (Increase in labour cost)'s and (Increased equipment costs)'s causal chain(s):

The increased cost of the main contractors' work resources (materials, labour, and equipment) are other direct causes of the contractors' cost overrun. The three causes are affected by the same root causes which are poor contractors' project and site management as well as a change in the government regulations (Figure

65). The intermediate causes are mainly a shortage of resources or poor quality/productivity.

From the cost overrun SLR, an increase in material and equipment cost ranked high (2 and 11 respectively), while, the increase in labour cost ranked very low (47 from 49). However, interviewees recognised them as being at the same level of importance. The difference in perceived importance is more likely related to the uniqueness of the Saudi context that has been illustrated in section 2.4.

The importance of these direct causes is coming from a combination of material, equipment, and labour costs representing over 90% of the bid price (Shash and Abdul-Hadi, 1992) and small cost increases impacting on contractors' cost performance. Nevertheless, the PWC does not protect nor compensate for the increase in the resources cost, even in the case of changes in government regulation.

In the Saudi context, as was explained in section 2.4, contractors are dependent mainly on foreign resources (labour and materials) which are directly impacted on by government regulation changes. However, interviewees working in road projects placed more emphasis on equipment cost, while those who work in building projects focused on materials cost both groups gave the labour resource a similar level of importance.

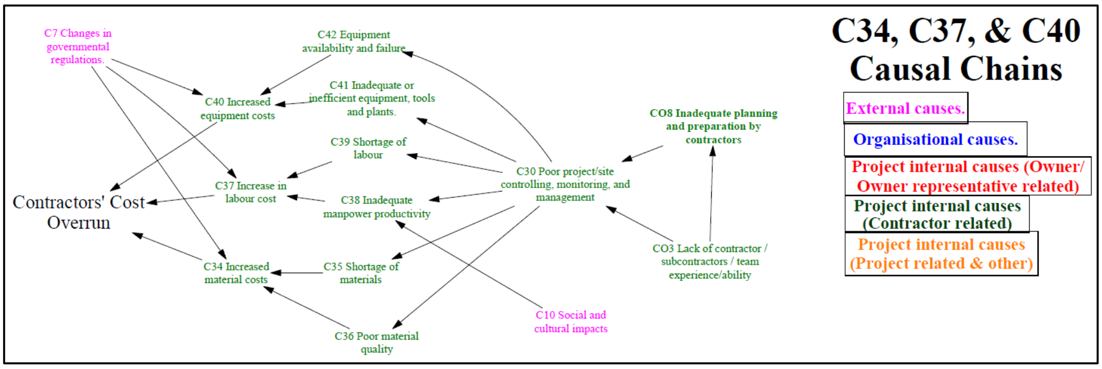

Figure 65: C34, C37, and C40 causality chains.

4.6.3.7 (Contractors' financial difficulties)'s causal chain(s):

Table 74 presents contractors' financial difficulties as the last direct cause and represented by nine causal chains. The financial difficulties mainly result from delay, payment delay, and change in government regulations.

The delay caused by contractors and external factors and their effects on cost have been discussed in section 4.6.3.5. Although the PWC mentioned that contractors are compensated by the awarding of extra time equal to the delay caused by the owner, they are not compensated financially regarding the extra cost caused by delay, suspensions, or overheads and changes in resources price.

The payment delay for completed work is also going to cause financial difficulties because of the limited cash flow. According to the PWC, contractors are expected to continue working and perform normally, even in the case of payment delay. However, in reality, contractors are going to perform poorer, leading to delay penalties or borrowing money from a third source to keep going. Both options lead to extra cost.

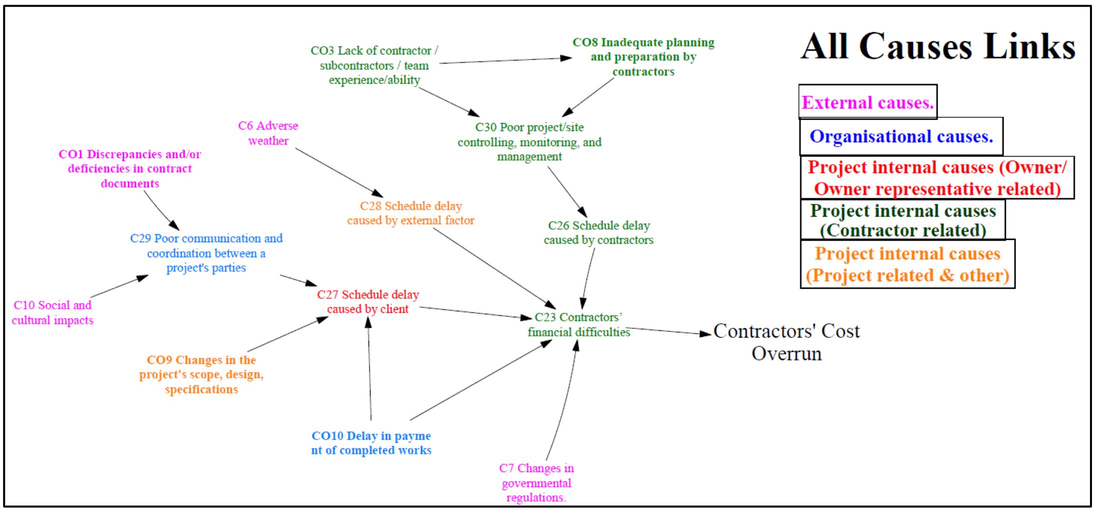

Figure 66: C23 causality chains.

Causal Relation			Extraction			
			Non-Saudi Context	Saudi Context		
Chain No.	Causes	Next Level effects	Literature Review	Documents	Interviews	Literature Review
C9 Fraudulent practices, kickbacks, corruption, bribes.						
1	C9 Fraudulent practices, kickbacks, corruption, bribes.	Cost overrun	(Park and Papadopoulou, 2012), (Wanjari and Dobariya, 2016), (Polat et al., 2014), (Aziz, 2013a), (Kim et al., 2017), (Eliufoo, 2017), (Allahaim and Liu, 2015), and (Cantarelli et al., 2010)	PWC		(Al-Kharashi and Skitmore, 2009) and (Alsaqer, 2011)
CO7 Inaccurate cost and schedule estimates by contractor.						
2	CO7 Inaccurate cost and schedule estimates by contractor	Cost overrun	(Famiyeh et al., 2017b), (Park and Papadopoulou, 2012), , (Nassar et al., 2005), (Abdul Rahman et al., 2013), (Knight and Fayek, 2000), (Allahaim and Liu, 2015), (Memon et al., 2011b), (Abusafiya and Suliman, 2017).	PWC	C1, C2, C3, C4, C5, C6, and C7. O1, O2, O3, O4, and O5.	(Shash and Abdul-Hadi, 1992), (Al-Harbi et al., 1994), (Assaf and Al-Hejji, 2006), and (Assaf et al., 2013)
C31 Conflicts, disputes, and lack of trust culture among the parties involved in the project.						
3	CO1 Discrepancies and/or deficiencies in contract documents	C31 Conflicts, disputes, and lack of trust culture among the parties involved in the project.	(Park and Papadopoulou, 2012), (Aziz, 2013a), (Cantarelli et al., 2010), (Wanjari and Dobariya, 2016), and (Polat et al., 2014).	PWC	C2, C5, and O3.	(Baghdadi and Kishk, 2015), (Medallah, 2015), (Assaf and Al-Hejji, 2006), and (Assaf et al., 1996).
	C31Conflicts, disputes, and lack of trust culture among the parties involved in the project.	Cost overrun	(Kim et al., 2017), (Eliufoo, 2017), and (Allahaim and Liu, 2015)		C1, C3, C4, and C5.	
C32 Extra works not included in the contract.						
3	CO1	C31				

Causal Relation			Extraction			
			Non-Saudi Context	Saudi Context		
Chain No.	**Causes**	**Next Level effects**	**Literature Review**	**Documents**	**Interviews**	**Literature Review**
	C31 Conflicts, disputes, and lack of trust culture among the parties involved in the project.	C32 Extra works not included in the contract.	(Polat et al., 2014), and (Yang and Chen, 2015).		C1, C3, C4, and C5.	(Assaf et al., 2013),(Al-Kharashi and Skitmore, 2009)
	C32 Extra works not included in the contract.	Cost overrun	(Polat et al., 2014)	PWC		
4	CO1 Discrepancies and/or deficiencies in contract documents.	C32 Extra works not included in the contract.		PWC	C1, C3, C4, and C5.	
	C32	Cost overrun	-			
C33 Rework and wastage on site.						
5	C6 Adverse weather.	C33 Rework and wastage on site.	(Famiyeh et al., 2017b), (Kaliba et al., 2009), (Alinaitwe et al., 2013), (Knight and Fayek, 2000)		C3, C4, C5, and O1.	
	C33 Rework and wastage on site.	Cost overrun	(Kim et al., 2017), (Knight and Fayek, 2000), (Iyer and Jha, 2005b), (Abu El-Maaty et al., 2017).			
6	CO3 Lack of contractor / subcontractors / team experience/ ability.	C33 Rework and wastage on site.	(Park and Papadopoulou, 2012), (Nassar et al., 2005), (Rahman et al., 2013a), and (Abusafiya and Suliman, 2017).		C5, C6, and O3.	
	C33	Cost overrun	-			
7	CO1 Discrepancies and/or deficiencies in contract documents.	C49 High guarantee period of products.	(Polat et al., 2014), (Abu El-Maaty et al., 2017)	PWC		
	C49 High guarantee period of products.	C33 Rework and wastage on site.	(Polat et al., 2014) and (Abu El-Maaty et al., 2017).	PWC		
	C33	Cost overrun				
C25 Cost of penalties.						
8	C6 Adverse weather.	C28 Schedule delay caused by external factor.	(Rosenfeld, 2014) and (Wanjari and Dobariya, 2016)	PWC	C3, C4, C5, and O1.	(Al-Kharashi and Skitmore, 2009),

Causal Relation			Extraction			
			Non-Saudi Context	Saudi Context		
Chain No.	**Causes**	**Next Level effects**	**Literature Review**	**Documents**	**Interviews**	**Literature Review**
	C28 Schedule delay caused by external factor.	C25 Cost of penalties.	(Cheng, 2014) and (Allahaim and Liu, 2015)			(Al-Khalil and Al-Ghafly, 1999), and (Assaf and Al-Hejji, 2006).
	C25 Cost of penalties.	Cost overrun	(Polat et al., 2014), (Nassar et al., 2005), and (Rahman et al., 2013a).	PWC		
9	CO3 Lack of contractor / subcontractors / team experience/ ability.	C30 Poor project/site controlling, monitoring, and management.	(Alghonamy, 2015) and (Eliufoo, 2017).		C4, C5, and C7.	(Al-Kharashi and Skitmore, 2009), (Al-Khalil and Al-Ghafly, 1999), and (Assaf and Al-Hejji, 2006).
	C30 Poor project/site controlling, monitoring, and management.	C26 Schedule delay caused by contractors.	(Chimwaso, 2000), (Abusafiya and Suliman, 2017), (Nassar et al., 2005), and (Rahman et al., 2013a).			
	C26 Schedule delay caused by contractors.	C25 Cost of penalties.		PWC		
	C25	Cost overrun				
10	CO3 Lack of contractor / subcontractors / team experience/ ability.	CO8 Inadequate planning and preparation by contractors.	(Cheng, 2014), (Memon et al., 2011a), and (Abusafiya and Suliman, 2017)		C4, C5, and C7.	(Al-Kharashi and Skitmore, 2009), (Al-Khalil and Al-Ghafly, 1999), and (Assaf and Al-Hejji, 2006).
	CO8 Inadequate planning and preparation by contractors.	C30 Poor project/site controlling, monitoring, and management.	(Love et al., 2016) and (Eliufoo, 2017)			
	C30	C26				
	C26	C25				
	C25	Cost overrun				
C40 Increased equipment costs.						
11	C7 Changes in governmental regulations.	C40 Increased equipment costs.	(Alzebdeh et al., 2015)	PWC	C1, C2, C3, C5, C6, and C7.	(Shash and Abdul-Hadi, 1992), (Al-Barrak,

Causal Relation			Extraction			
			Non-Saudi Context	Saudi Context		
Chain No.	Causes	Next Level effects	Literature Review	Documents	Interviews	Literature Review
	C40 Increased equipment costs.	Cost Overrun.	(Park and Papadopoulou, 2012), (Alzebdeh et al., 2015), (Aziz, 2013a), and (Memon et al., 2011b).			1993), (Al-Harbi et al., 1994), and (Bageis and Fortune, 2009).
12	CO3	CO8				
	CO8	C30				
	C30 Poor project/site controlling, monitoring, and management.	C42 Equipment availability and failure.	(Nassar et al., 2005),(Abdul Rahman et al., 2013), and (Baloyi and Bekker, 2011).		C5, C6, and C7.	
	C42 Equipment availability and failure.	C40 Increased equipment costs.	(Abusafiya and Suliman, 2017), and (Abu El-Maaty et al., 2017).			
	C40	Cost Overrun.				
13	CO3	CO8				(Shash and Abdul-Hadi, 1992), (Al-Barrak, 1993), (Al-Harbi et al., 1994), and (Bageis and Fortune, 2009).
	CO8	C30				
	C30 Poor project/site controlling, monitoring, and management.	C41 Inadequate or inefficient equipment, tools and plants.	(Alinaitwe et al., 2013), (Allahaim and Liu, 2012), and (Rahman et al., 2013b)		C5, C6, and C7.	
	C41 Inadequate or inefficient equipment, tools and plants.	C40 Increased equipment costs.	(Chimwaso, 2000), (Vu et al., 2016), and (Doloi, 2013).			
	C40	Cost Overrun.				
14	CO3	C30				
	C30	C42				
	C42	C40				
	C40	Cost Overrun.				
15	CO3	C30				
	C30	C41				
	C41	C40				
	C40	Cost Overrun.				
C37 Increase in labour cost.						

Causal Relation			Extraction			
			Non-Saudi Context	Saudi Context		
Chain No.	Causes	Next Level effects	Literature Review	Documents	Interviews	Literature Review
14	C7 Changes in governmental regulations.	C37 Increase in labour cost.	The dependency of the industry on the foreign labour. Sometimes not affect the labour but their families (social)	PWC	C1, C2, C3, C5, C6, and C7.	(Shash and Abdul-Hadi, 1992), (Al-Barrak, 1993), (Al-Harbi et al., 1994), and (Bageis and Fortune, 2009).
	C37 Increase in labour cost.	Cost Overrun.	(Baloyi and Bekker, 2011), (Alzebdeh et al., 2015), and (Muya et al., 2013).	PWC		
15	C10 Social and cultural impacts.	C38 Inadequate manpower productivity.	(Wanjari and Dobariya, 2016), (Alghonamy, 2015), and (Baloyi and Bekker, 2011). Different nationalities		C3, O1, and O3	(Shash and Abdul-Hadi, 1992), (Al-Barrak, 1993), (Al-Harbi et al., 1994), and (Bageis and Fortune, 2009).
	C38 Inadequate manpower productivity.	C37 Increase in labour cost.	(Lu et al., 2017), (Nasina and Nallam, 2016), and (Yang and Chen, 2015).			
	C37	Cost Overrun.				
16	CO3	CO8				
	CO8	C30				
	C30 Poor project/site controlling, monitoring, and management.	C39 Shortage of labour.	(Alinaitwe et al., 2013), (Allahaim and Liu, 2012), and (Rahman et al., 2013b)		C3, C5, C6, and C7	
	C39 Shortage of labour.	C37 Increase in labour cost	(Barinov, 2007), (Allahaim and Liu, 2015), and (Jennings, 2012).			
	C37	Cost Overrun.				
17	CO3	CO8				
	CO8	C30				
	C30 Poor project/site controlling, monitoring, and management.	C38 Inadequate manpower productivity.	(Shing-Tao Chang, 2002), (Alinaitwe et al., 2013), and (Shane et al., 2009).		C3, C5, C6, and C7	
	C38	C37				
	C37	Cost Overrun.				
18	CO3	C30				

Causal Relation			Extraction			
			Non-Saudi Context	Saudi Context		
Chain No.	Causes	Next Level effects	Literature Review	Documents	Interviews	Literature Review
	C30	C39				
	C39	C37				
	C37	Cost Overrun.				
19	CO3	C30				
	C30	C38				
	C38	C37				
	C37	Cost Overrun.				
C34 Increased material costs.						
20	C7 Changes in governmental regulations.	C34 Increased material costs.	(Famiyeh et al., 2017b), (Yang and Chen, 2015), and (Creedy et al., 2010a). Most advanced material are imported.	PWC	C1, C2, C3, C5, C6, C7, O1, and O3	(Shash and Abdul-Hadi, 1992), (Al-Barrak, 1993), (Al-Harbi et al., 1994), and (Bageis and Fortune, 2009).
	C34 Increased material costs.	Cost Overrun.	(Park and Papadopoulou, 2012), (Lee, 2008b), (Polat et al., 2014), and (Alzebdeh et al., 2015)			
21	CO3	CO8				(Shash and Abdul-Hadi, 1992), (Al-Barrak, 1993), (Al-Harbi et al., 1994), and (Bageis and Fortune, 2009).
	CO8	C30				
	C30 Poor project/site controlling, monitoring, and management.	C35 Shortage of materials.	(Cheng, 2014), (Adafin et al., 2016), and (Terrill et al., 2016).			
	C35 Shortage of materials.	C34 Increased material costs.	(Chimwaso, 2000), (Ahiaga-Dagbui and Smith, 2014), and (Alghonamy, 2015)		Here	
	C34	Cost Overrun.				
22	CO3	CO8				
	CO8	C30				
	C30 Poor project/site controlling, monitoring, and management.	C36 Poor material quality.	(Famiyeh et al., 2017b), (Memon and Rahman, 2014), (Vu et al., 2016), and (Abusafiya and Suliman, 2017).		C3, C5, C6, and C7	

Causal Relation			Extraction			
			Non-Saudi Context	Saudi Context		
Chain No.	Causes	Next Level effects	Literature Review	Documents	Interviews	Literature Review
	C36 Poor material quality.	C34 Increased material costs.	(Kim et al., 2017), (Knight and Fayek, 2000), and (Dada and Jagboro, 2007).			
	C34	Cost Overrun.				
23	CO3	C30				
	C30	C35				
	C35	C34				
	C34	Cost Overrun.				
24	CO3	C30				
	C30	C36				
	C36	C34				
	C34	Cost Overrun.				
C23 Contractors' financial difficulties.						
25	C7 Changes in governmental regulations.	C23 Contractors' financial difficulties.	(Kaliba et al., 2009), (Alinaitwe et al., 2013), (Enshassi et al., 2006), and (Dissanayaka and Kumaraswamy, 1999).	PWC	C1, C2, C3, C5, C6, C7, O1, and O3.	
	C23 Contractors' financial difficulties.	Cost Overrun.	(Abdul Rahman et al., 2013), (Vu et al., 2016), (Meeampol and Ogunlan, 2006), and (Frimpong et al., 2003).			
26	CO10 Delay in payment of completed works.	C23 Contractors' financial difficulties.	(Larsen et al., 2015a), (Nassar et al., 2005), (Mahamid, 2014), (Ramabodu and Verster, 2013), and (Okpala and Aniekwu, 1988).		C1, C2, C3, C5, C6, C7, O1, and O3. Lack of flow	
	C23	Cost Overrun.				
27	CO10 Delay in payment of completed works.	C27 Schedule delay caused by client.	(Vu et al., 2016), (Cunningham, 2017), and (Jarkas and Haupt, 2015).	PWC	C3, C5, and C7.	
	C27 Schedule delay caused by client.	C23 Contractors' financial difficulties.	(Lee and Kim, 2016), (Derakhshanalavijeh and Teixeira, 2017), and (Niazi and Painting, 2017).	PWC		

Causal Relation			Extraction			
			Non-Saudi Context	Saudi Context		
Chain No.	Causes	Next Level effects	Literature Review	Documents	Interviews	Literature Review
			Can’t work cause to penalties			
	C23	Cost Overrun.				
28	C6	C28				
	C28 Schedule delay caused by external factor.	C23 Contractors’ financial difficulties.	(Famiyeh et al., 2017b), (Cheng, 2014), (Singh, 2009a), and (Bhargava et al., 2017). Can’t work cause to penalties		C1, C2, C3, C4, and C5	
	C23	Cost Overrun.				
29	CO9 Changes in the project's scope, design, specifications.	C27 Schedule delay caused by client.	(Alinaitwe et al., 2013), (Shane et al., 2009), and (Niazi and Painting, 2017).	PWC	C1, C3, and C5.	(Assaf et al., 1995), (Assaf and Al-Hejji, 2006), and (Arain et al., 2006).
	C27	C23				
	C23	Cost Overrun.				
30	CO1 Discrepancies and/or deficiencies in contract documents	C29 Poor communication and coordination between a project's parties.	(Famiyeh et al., 2017b), (Muya et al., 2013), and (Radujković and Car-Pušić, 2004). No communication procedure in the contract and time limits.	PWC	C2, C3, C5, and O2.	
	C29 Poor communication and coordination between a project's parties.	C27 Schedule delay caused by client.	(Alinaitwe et al., 2013), (Alzebdeh et al., 2015), and (Nassar et al., 2005).			
	C27	C23				
	C23	Cost Overrun.				
31	C10 Social and cultural impacts.	C29 Poor communication and coordination between a project's parties.	Here Different nationalities		C2, C3, C5, and O2.	
	C29	C27				
	C27	C23				

Causal Relation			Extraction			
			Non-Saudi Context	Saudi Context		
Chain No.	Causes	Next Level effects	Literature Review	Documents	Interviews	Literature Review
	C23	Cost Overrun.				
32	CO3	CO8				
	CO8	C30				
	C30	C26				
	C26 Schedule delay caused by contractors.	C23 Contractors' financial difficulties.	(Kaliba et al., 2009), (Yang and Chen, 2015), (Barinov, 2007), and (Adafin et al., 2016)	PWC		
	C23	Cost Overrun.				
33	CO3	C30				
	C30	C26				
	C26	C23				
	C23	Cost Overrun.				

Table 74: Causal chains extraction evidences.

4.7 Conclusion:

The aim of this chapter is to analyse the data collected in this thesis and discuss the meaning of the results. The data has been analysed and discussed for each objective separately; however, the interaction between the results is discussed.

As a continuation to achieve objective one, which partly started in the literature review in Chapter Two by exploring the Saudi Arabian context, the data analysis and discussion related to exploring the process and practises of developing a construction project in a Saudi public agency were presented. The organisational structure, project life cycle, the process to develop construction projects, and procurement methods were explored and evaluated to achieve objective one. A Saudi public ministry adopts a vertical organisational structure so that its complexity increases with the increase in the agency size. Construction projects are developed under different departments and in different organisational levels which leads to fragmentation and reduces the communication and lessons learnt among stakeholders. In addition, ministries do not assign a single person to supervise a project throughout its development.

Regarding the project life cycle, a construction project in the Saudi public sector goes through four main phases: planning, development, construction, and closure. As the Saudi public sector is adopting the DBB procurement, there is no overlapping between the phases or interaction between the projects' developers, constructor, maintainers, and users. The processes and practices are summarised in Table 33 which presents the main inputs, stakeholders, and output for every single phase. The last part of the exploration is related to the procurement method that is used to deliver the construction projects in the Saudi public projects. The data showed that a single awarding method based on the lowest price is used for outsourcing works (design, consulting, and construction). However, three types of contracts were used for each service which its evaluation showed that risks are transferred away from the owner to other parties. A comparison with the FIDIC contract showed differences in the core of the risk apportion and compensation understanding.

Comparing it to the best practices, Objective Two identifies the weaknesses of these data that could affect the contractors’ cost performance. Evaluating and comparing each component that has been explored in Objective One, the research identified the patterns that are able to affect the contractors' cost performance. A matrix was developed by the end of Objective Two which illustrated how the different weaknesses within the context, process and practices would combine leading to factors that affect contractors' cost performance. The findings of Chapter Two will be used later (in Objectives Four and Five) in identifying the causes of the contractors’ cost overrun and build the causal chains.

Objective Three was focused solely on the cost overrun literature review and evaluation of the cost overrun literature. The literature showed that the cost overrun causes had been studied for over 50 years, and the problem still exists in the construction industry. The definition of cost overrun that are adopted between the studies affects the amounts of the cost overrun. Moreover, the data shows that three schools of thought exist in identifying and understanding the cost overrun causation. However, all three studies have their limitations. The research proposes a new understanding of the cost overrun that considers the context that the project was developed in as well as interactions between factors over the project life cycle.

In Objective Four, the research identified the causes of the contractors' cost overrun based on the literature and the interviews. Over 200 causes have been identified and go through a number of sieves reducing the causes to 49 causes. Finally, the causes have been ranked based on their appearance in the data.

The 49 causes have been used to develop the model in Objective Five using the CLD tool. To develop the chains, causes have been divided into three main types which are direct, intermediate, and root causes. The chain has been developed based on evidence extracted from the literature, documents, and interviews. Moreover, the chains have been explained thoroughly.

Chapter 5: Conclusion and Recommendations

5.1 Introduction:

As chapter one stated, the study aims to build a causality model of the contractors' cost overrun in the Saudi public sector based on the weaknesses that have been explored and identified within the industry's nature and current practices.

As presented in Chapters Two and Four, the study commenced by presenting an analysis of the nature of the legislative, cultural and commercial environments within which a Saudi public project is delivered. Moreover, the practices and processes that are used to deliver a construction project in the Saudi public sector were explored and illustrated. Based on these illustrations, the weaknesses within the environment, practices, and processes that affect contractors' cost performance were identified. Based on that and analysis of the cost overrun literature, the main causes of cost overrun were identified and paths linking causes and effects have been built.

This chapter summarises the main findings and discusses the process by which objectives were achieved in order to explain how each individual objective was addressed and its contribution to the research aim. Finally, the contribution to knowledge from the research as well as future research recommendations will be presented.

5.2 Research questions/objectives revisited:

5.2.1 Research questions:

Chapter One presented two questions that the research was built to answer. The first question being:

- What are the nature of the environments around the construction industry and the construction project processes and practices that a Saudi public sector uses to deliver a construction project? Related to this, How do the environments, processes, and practices lead to contractors' cost overrun?

Grouped under four main profiles (Economic, Business, Resources, and Regulation), the nature of the environment within which a public project is delivered was explored. The profiles were presented in sections 2.2, 2.3, 2.4, and 2.6 respectively. On the other hand, the process and practices were presented in sections 4.2.1, 4.2.2, 4.2.3, and 4.2.4. The contexts' exploration includes:

- Economic profile,
- Business profile, with sub-profiles of governance and regulatory, culture, disputes, and corruption;
- Resources profile, with sub-profiles of finance, material, labour, and plant.
- Regulation profile,
- Process and practices, which include organisation structure, construction project phases, public project process, and procurement delivery method.

In general, the context, process, and practices have been explored and explained. Although the data shows some similarity in the project development process as it has been discussed in section 4.2.3, the context that a project within which is developed shows a high degree of uniqueness. The uniqueness comes from economic, business, and resources profiles mainly as it has been discussed in section 2.2, 2.3, and 2.4.

- What are the main causes of contractors' cost overrun? How are the causes interacting within the context of the Saudi public sector to lead to contractors cost overrun?

The first part of the question, which is related to the identification of the causes, was presented in sections 4.5.2 and 4.5.3. The causes identification step used mainly data from the systematic literature review and interviews. As a result, over 500 causes were identified. The exclusion step was followed whereby the identified causes go through several sieves to exclude unrelated causes, as is presented in section 4.5.4. Finally, those causes with a high level of similarity were merged, and as a result, 49 causes have been identified, as sections 4.5.5 and section 4.5.6 show.

In general, the data shows three schools of thought regarding the causality of cost overrun, with each of them having its limitations as presented in section 4.4.4. The literature suggested a new way of considering the causality of cost overrun, whereby the causes are traced back to their origins, as presented in section 4.4.5.

For the second part of the question, the mechanism by which the interaction takes place was presented across several different sections, commencing with the identification of weaknesses in the Saudi public-sector context profiles, as presented in section 4.3 and progresses to the interaction between the causes as presented in section 4.6.3, where the evidence for causality was divided into Non-Saudi and Saudi data. The non-Saudi data are the data extracted from the

Systematic Literature Review. The Saudi data are extracted from the literature review, documents, and interviews, as presented in section 4.6.3. The causal chains are presented based on direct causes, of which ten are identified and each one is followed with a number of chains. The contribution of the context's weaknesses, which have been presented earlier, are also illustrated in the extraction process.

In general, a causality model has been successfully developed, as discussed in section 4.6.3. However, because of the model complexity and very long paths, the researcher developed a method to reduce the complexity and path length, as is presented in section 4.6.2.

5.2.2 Research objectives:

Besides the research questions; the research set five objectives. In this section, discussion of whether the research achieved each individual objective and, if so, how it was achieved, is presented. The research set the following objectives:

5.2.2.1 Objective 1: To explore the commercial context of the Saudi public construction projects procurement:

Exploring the context, current practices and process of delivering construction projects in the Saudi public sector is an important objective of this study. The literature shows that construction projects are affected by and in turn affect the context within which they are delivered. Accordingly, using the Saudi public sector as its case, the research at first explored the main profiles that could affect construction project performance and expressed the uniqueness of the Saudi public sector. Economic, Business, Resources, and Regulation profiles have been explored in-depth in Chapter Two of this study. Second, the practices and the process of delivering construction projects have been explored and illustrated under Objective One in Chapter Four. Exploring the process is very important in developing the causality paths and model regarding the responsibility and order of the causes. Nevertheless, literature shows that the causes of the cost overrun differ based on the process and practises of delivering the projects.

5.2.2.2 Objective 2: To establish the linking between the commercial context of the Saudi public construction projects procurement and contractors' performance:

Based on the exploration of the context, practises, and process in Objective One, the weaknesses within them that affect contractors' cost performance have been identified. The weaknesses either work as causes themselves or encourages the action of other causes; thus, identifying them is very important, as evidenced while extracting the causes' paths. The mechanisms of the weaknesses were also identified under Objective Two. Nevertheless, identifying the weaknesses within the Saudi practises, when compared to the international practices, allows the opportunity to improve the practices in future work. Data from the interviews and the documents have been used in the process of the identification. Objective Two is therefore considered as having been achieved.

5.2.2.3 Objective 3: To critically review and establish the causalities of cost overrun in Saudi Arabian construction projects:

Exploring and evaluating the previous research on the causes of cost overrun is a very important stage of the research as this research is intended to take the previous work further, rather than simply repeating previous research and thereby not addressing any limitations within that work. To achieve this research, a systematic literature review was adopted where over 105 resources were identified based on the inclusion and exclusion criteria, which has been discussed in section (3.6.1.2.1), out of the thousands of resources available as data analysis under Objective Three shows. However, the deep analysis shows that only 50 papers were suitable for this research. In the beginning, the 50 papers were analysed based on different factors such as their resources and country of focus.

Based on the 50 papers, cost overrun definitions were identified and evaluated, and the definition for this research was illustrated. Moreover, the analysis of the papers identified three main schools of thought. The first school of thought identified optimism bias and data misrepresentation as the causes of cost overrun and eliminated technical causes such as poor contractors' experience. However, the limitation of this school was shown to be that only two causes could not accurately explain the cost overrun in different projects' phases and context. The second school of thought believes that the causes of cost overrun are generated from "pathogens" in the systems. The pathogens explanation avoids the limitation of the first school of thought, where a limited number of causes has been identified. However, the limitation of such an explanation also identified in section 4.4.4.1, which does not illustrate the intermediate causes between four main explanations and the cost overrun.

The majority of the papers are under the third school of thought which lists causes that were ranked by responders as the causes of cost overrun. The papers show that the literature repeatedly identifies similar causes, but that a different rank is shown in a different context or following the use of other statistical analysis tools. Similar to the first and second schools the limitation of this school was presented in section 4.4.4.3 which, besides not showing the interaction between the causes and ambiguity in terminologies, another ten points of limitation have been identified.

The evaluation of the 50 papers/studies shows that cost overrun causes are not fully identified yet, although different tools have been used in order to attempt to achieve that. The literature suggested a new way of looking into the problem by moving from the individual causes' identification to an approach where the causes are traced back to their origins and thereby show the interaction between the causes of cost overrun.

5.2.2.4 Objective 4: To classify and evaluate the possible causalities of cost overrun in Saudi Arabian construction projects:

As a first step of developing the causality model of the contractors' cost overrun in the Saudi public sector, the causes that form the paths (links) and model were identified. The approach used to identify the causes of the contractors' cost overrun was a detailed literature review combined with the analysis of interviews and other relevant documents.

- Initially, the resources of the causes have been identified which are based on literature and interviews. The literature resource is based on the 50 papers used to achieve Objective Three. The 50 resources were classified in Table 61 based on different factors such as project type, and focus. Moreover, a limitation related to the different wording used to describe both costs overrun and causes has been identified in literature resources. The initial pool of the causes contains over 300 causes from all sources.
- The causes in the initial pool go through different sieves related to their suitability to the Saudi public projects on one hand and being under contractor's responsibilities on the other hand, and the unrelated causes were removed.
- Finally, the similar causes out of the sieves are merged resulting in 49 causes of contractors' cost overrun. The causes analysis based on their occurrence in the data was the last step of the contractors' cost overrun identification.

The research developed a taxonomy system comprising three levels to classify the causes of contractors' cost overrun as presented for Objective Four in Chapter Four. The system was built based on the data extracted from the literature review as well as from the themes extracted from the context analysis. The system can be used for any new causes that will be identified in the future. Based on the above discussion, Objective Four is considered to have been achieved.

5.2.2.5 Objective 5: To develop a causality model that illustrates the interdependency between the causes of the contractors' cost overrun within the Saudi construction public projects based on the evaluation of the context and process:

The developing model was the objective of this study. The 49 causes identified in the previous step were used to develop the paths and model. Initially, the causes were divided based on their location within the chain, i.e. direct cause, intermediate cause, or root causes. From three types the contractors' cost overrun causality paths were formed based on four sources of data; SLR, interviews, documents, and Saudi context literature review. Another resource is the weakness within the context and process that has been identified in Objective Two.

After the model was initially formed, it emerged that some of the direct causes' paths were very complex and lengthy and therefore difficult to be presented to and understood by non-professionals. It was therefore decided to reduce the initial level of complexity for the sake of presenting the paths in a less complex model that would be more readily understood by decision-makers with the capacity to change the case of the poor contractors' cost performance. Thus, the identified chains have been divided based on a contractors' involvement point resulting in shorten the length and complex of the chains as illustrated in the discussion in sections 4.6.1.1, 4.6.1.2, 4.6.2, and 4.6.3. The simplified model was developed and comprised 49 causal paths that are linked to 10 direct causes.

In general, the model was different from the previous research outputs of identifying the causes of cost overrun in that it shows the whole picture of the mechanism of direct causes development from the trigger 'event', which is normally a root cause. Through the model development, the processes and results were shared with two experienced persons from the Saudi public sector. Their feedback was used to guide the structuring of developed paths and the overall model in a more understandable way. Moreover, the model was presented during the biggest engineering conference that takes place in Saudi Arabia. Feedback from the conference delegates was also used to confirm the majority of paths as identified and change a small number to reflect feedback. Based on the above discussion, Objective Five is considered to have been achieved.

5.3 Contributions to theory:

In this section, the impact of the research on the body of knowledge will be discussed.

5.3.1 Exploring the uniqueness of the Saudi public-sector context environment and the process and practices of developing a construction project:

The knowledge contribution of this objective, with regard to the Saudi public-sector context and processes of developing public construction projects, is discussed along with insights into the uniqueness of the context and practices in the Saudi public project environment.

As Chapter Two highlighted, the construction industry in general, and project development process and practices specifically, are influenced by different factors and an important one is the national business context as the literature showed very few resources that investigate the national context in general and no resource in relation to the construction project context. Thus, exploring the context was an essential step in the investigation of the cost overrun problem. Through the investigation, the uniqueness of the context of the Saudi Arabian public sector construction projects was illustrated, with this being used later in justifying the use of the Saudi Arabian public sector as a case study for this research.

An additional factor, the practices and the process of developing a public sector construction project, was also considered. The maturity of these practices affects both the construction industry and developing projects. Moreover, as this study is from the contractors' perspective, the identification of the process shows the point of the contractor's involvement in the project and the contractors' responsibilities.

The findings under this contribution could also be used to tackle other problems which are related to the poor Saudi public construction project such as delay in public projects which a problem affect 70% of projects as it has been illustrated in section 2.6.1.

5.3.2 Delineating the affecting mechanism of weaknesses of the context and process of contractors' cost performance:

Guided by internationally accepted practices for the development of construction projects, the weaknesses within the explored context and practices in the Saudi public sector are presented under Objective Two. Relevant literature shows that

Saudi public-sector context and practices used in developing projects had not been evaluated before in general and not in terms of their affecting the contractors' cost performance. Similar to the context, the results showed uniqueness of the weakness point of the context and practises. This could affect the process of find solutions to these weaknesses and encourage the researchers to provide unusual (out of the box) solutions that suit the context.

The identification of weakness points in the project development systems and describing the affecting mechanism are a contribution to the body of knowledge which could be used in investigating and understanding other problems related to the Saudi public sector such as projects' delay.

5.3.3 Systematically evaluate the current cost overrun causes literature review and identify their limitations:

Although a large amount of literature investigates the root of the cost overrun causes, the problem still exists and thereby suggests limitations in the previous studies. As no study has systematically investigated the literature, this research completed a systematic literature review and identified the limitations of the previous research / studies. The step was an essential part of achieving the aim of the research to avoid any repetition and weaknesses of previous work.

The evaluation of the previous literature is a contribution to the body of knowledge as well as facilitating the avoidance, in the context of future research, of the same limitation of previous works. As a result of the evaluation of previous studies, a new method of looking into the problem was suggested to avoid the limitations of the previous literature.

5.3.4 Identifying the causes of contractors' cost overrun and the interaction between the causes in the context of the Saudi public sector:

As discussed under Objective Three, existing attempts to understand the cost overrun causality have tended to focus on the causes of cost overrun individually while ignoring the interaction between them. Thus, this research identified the causes collectively and then adopted the causality model to present the interaction between those causes.

The causality model combines both the identification and interaction of the contractors' cost overrun causes rather than only identifying the causes individually. Moreover, the causality model highlights the importance of context, responsibilities, and the process of developing construction projects. Therefore, the model gives a context-based comprehensive approach to understand the causality of cost overrun that could be used as the foundation for future research on the causes of cost overrun in a different context or/and point of view.

5.4 Contributions to practice:

In this section, the discussion focuses on the contributions of the research to construction industry practice in Saudi Arabia.

5.4.1 Exploring the context and process of developing construction projects in Saudi public sector and identifying its shortcoming:

As mentioned earlier, the context and process of developing construction projects in the Saudi public sector have not been explored through research before. Identifying the shortcomings of the context and process contributes to practice by allowing stakeholders to identify and include risks that could be produced from those shortcomings. This is important, especially to small and international contractors who are not familiar with the Saudi public sector context.

5.4.2 Contractors' cost overrun causality model:

Developing the model and extracting the causality paths is believed to add value to professional practice within the Saudi public sector by allowing the decision maker to understand the effects of such decisions on the contractors' cost performance. The data shows that different stakeholders are involved in developing construction projects from the owner’s side. Every stakeholder tries to protect their own interest without giving attention to such actions. By developing the paths, different stakeholders are able to see the later effect(s) of their decision. This is important, especially for those stakeholders who are involved in the early stages of the project development.

5.5 Limitations of the study and recommendation for future studies:

The limitation of the studies and recommendation for further studies are combined under one subsection; during the examining of the previous works; it was found that most of the future studies are triggered by a limitation of the research.

In exploring the context and the process of development of construction projects in the Saudi public sector, the research takes place at the general (meso) level of the organisational levels (different level has been presented in section 4.2.1). This level is the level where most of the Saudi public agencies are sharing the same process and practices. For example, during the investigation of the process of developing a project, the research took the investigation focus within the meso (strategic) level instead of a macro (institutional) or micro (technical) levels. In light of this, future studies could be recommended to investigate and explore the context, environment, and project development process in the macro and micro levels. Moreover, other causes for contractors' cost overrun might be identified from such an investigation.

The Saudi public project context exploration covered four main profiles: economic, business, resources, and legalisation. As possible further studies, each profile could be investigated in more detail and analysis of its impact on the project's performance in general, or in specific to stakeholders such as owner or contractors, undertaken.

The exploring of the research development process could be investigated at the technical level by taking a public agency as a case study. It is believed the results from such an approach would be more detailed than from the current approach, as the micro level is more related to the technical level. Moreover, focusing on a lower level could provide beneficial outcomes for the participating case study agency as the results may reveal significant shortcomings in the process that will help to improve the performance for all the stakeholders. In this regard, although the study presented the causes and the interaction between them, the amount/impact of the effective force between the causes or for the causal path was nor illustrated. Such output could be useful so as to identify the most powerful/significant causal relationship or paths. Thus, it will be useful for the public construction industry if further studies are conducted that focus on the quantitative side of the research where the effect forces between causes are measured, and the implications are tested in practice.

Regarding data, some of the challenges that this research faced were the limited ready-made sources of data about the Saudi public sector and contractors and a lack of an established knowledge base, which forced the research to focus on the issue at a general level rather than a detailed one. These challenges usually exist in studies that investigate construction issues in developing countries and immature national business contexts (Duy Nguyen et al., 2004). Moreover, with such shortcomings with respect to data, the reliability of the research might be affected as the findings of cost overrun causes might not readily replicate under such shortcomings in data (Miles et al., 2014). Thus, further studies could apply a mixed method to conduct similar research and compare the results of both data. This could be helpful to strengthen the reliability of the research.

5.6 Conclusion:

This chapter aimed to summarise the significant findings and present the conclusions reached and recommendations made.

At the beginning of the chapter, the research questions and objectives are presented, and explanations were given on how the questions were answered and the objectives were achieved. The chapter then discussed the contribution of the study to the body of existing knowledge and the practice. Finally, the limitations of the study and recommendations for further studies were presented.

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Appendix A:

Cost overrun cause/ Factor causing	No. 1	No. 3	No. 8	No. 15	No. 16	No. 20	No. 23	No. 23	No. 27	No. 28	No. 28	No. 32	No. 33	No. 34	No. 35	No. 37	No. 41	No. 46	No. 47	No. 51	No. 55	No. 59	No. 61	No. 62	No. 65	No. 66	No. 71	No. 72	No. 73	No. 77	No. 81	No. 88	No. 95	No. 96	No. 97	No. 101	No. 103
Inappropriate procurement route and procedure		*								*								*	*								*					*					
Insufficient time for bidders to study and prepare the tender																																					*
Inappropriate contractual procedure																								*													
Long period between design and time of bidding/tendering.																			*					*													
Bureaucracy in bidding/tendering method	*																		*										*	*							
Selection and assignment criteria																*																					
Contract awarded to lowest bidder		*																	*					*				*									
Level and number of competitors																								*											*		
Discrepancies and/or deficiencies in contract documents									*																												
Scope for the contractor not well defined																											*										
Unclear, ambiguous, and contradicting terms in the tender documents.										*		*			*				*								*										
Unbalanced distribution of risk between owner and contractor.												*					*																				
The owner's disinterest in paying any compensations due to the decline in the economic and political conditions																																					*
Severe contract conditions																	*																				

Mode of financing and payment for completed work																		*											*							
Clearly define the scope of project in the contract																	*																			
Unclear division of responsibilities and lack of clear requirements for professional management.											*																									
Project conditions															*																					
Inappropriate (Discrepancies and/or deficiencies) local/national data, regulation/policies, requirements, and political environment		*															*		*																*		
Laws and regulatory frameworks																											*									
Absence of construction cost data																		*																		
Lack of standard requirements from designers and poorly enforced professional liability of designers.											*																									
Political insecurity and instability								*									*										*							*		
Obstacles from government																											*									
Unforeseeable authority requirements or restrictions															*																					
Local government				*																																
Deficiencies in the infrastructure																											*									
Local concerns and requirements									*																											
Difficult/Unstable/change in country's economic conditions																																				*
Economic Instability																							*											*		
Gross domestic products (GDP)																	*																			
High interest rates charged by bankers on loans received by contractors																	*	*					*				*				*					*

High inflation, insurance and interest rates.				*					*								*						*														
Effects of inflation										*									*									*									
Inflationary pressure																								*													
Market conditions										*						*												*									
Increase in tax/change in government fiscal/monetary policies																											*										*
Change in foreign exchange rate.		*												*														*				*					
Inadequate planning, preparation, and pre-construction process and studies																*			*	*				*									*				
Inattention to risk inside government.							*																														
Lack of planning and coordination or less emphasis to planning																											*										
Inadequate planning and scheduling																					*									*					*		
Inadequate pre-construction study		*																	*																		
Lack of preliminary examination before design or tendering																*																					
Inadequate preparation of the project concerning planning and execution.																																					*
Wrong / inappropriate choice of project site																																					*
Failure of land expropriation																																*					
Land acquisition costs																			*																		
Late start of the planning process, and with too low a budget												*																									
Insufficient, unstandardized owner's brief												*				*				*																	
Lack of end user's involvement																											*										
Inadequate project objectives																											*										

The gap between the construction plan and the reality is too great.																	*																				
No practical use of the earned value management system												*																									
Poor feasibility and project analysis	*																																				
Deficiencies in cost and time estimates prepared by public agencies																											*										
Inaccurate estimates by consultant	*																																				
Inadequate planning for the project costs and the lack of following-up costs during the project execution.																																					*
Unreasonable estimation and adjustment of project costs												*																									
incompleteness of estimations																																*					
unreasonable project time frame																							*		*		*		*								
Inadequate duration of contract period		*														*							*														
Cost underestimation																										*											
Strategic misrepresentation																											*										
Deliberate cost underestimation																																*					
Manipulation of forecasts																																*					
consciously manipulated						*																															
Political focus on reduced project costs or time															*																						
Political interference	*																																				
Optimism bias							*			*																	*					*					
Cognitive bias of people																																*					
unconsciously manipulated						*																															
Optimistic expectation regarding time, cost, and quality														*	*		*													*							

Inadequate Inappropriate design process and documents																																					
Too small design budget												*																									
Mistakes and errors in design																				*	*			*			*			*					*		
Unconstructable design.												*																									
Poor design																					*									*			*		*		
Difficulties and feasibility that design does not consider construction																																*					
Noncompliance of design with client's requirements																											*										
Noncompliance of design with government regulations																											*										
Design problems																	*																				
Delay of drawings and site instructions		*																																			
late design work																								*													
Impractical and complicated design																														*							
Discrepancies between design and technical standards																																*					
Inadequate site and ground investigations		*																	*								*			*							
Insufficient information about ground conditions												*																									
Differing site conditions									*																		*									*	
Unforeseen conditions										*																											
Geological conditions of actual construction are inconsistent with geological conditions of survey and design.																																*					
Unforeseen site conditions		*																*	*							*				*							
Fossils or things of geological interest																											*	*									

Immature tender documents												*						*		*	*									*							
Errors or inconsistencies in project documents																*																					
Insufficient/incomplete drawings																										*											
Inaccurately estimated quantities					*															*	*						*		*	*					*		*
Omissions and errors in the bills of quantities																														*							
Inaccurate material estimates																													*								
Unclear drawings and specifications					*																																
Unclear technical specifications																*	*										*										
Unclear project scope																	*																				
Difference between selected bid and the consultants' estimate					*																								*								
Contract tender price higher than original estimate																							*														
Tender-winning prices are unrealistically low												*																									
Inaccurate cost and schedule estimates by contractor	*	*																	*	*	*					*		*		*					*		
Forecasting errors including price rises																																	*				
Poor estimating										*				*																							
Missed item in estimate					*																																
Inaccurate tender offer																																*					
Inefficient scheduling process																	*																				
Failure to identify risks and institute necessary and timely remedy and control program																											*										
Wrong method of cost estimation																			*																		
Mistakes in cost estimates																	*																				
Failure to price in certain risks																												*									
Inconsistent application of contingencies										*																											

Inadequate planning and preparation by contractors																																					
Inaccurate review for drawings and contract documents																																					*
The contractor doesn't carry out a field visit to the site during the bidding process.																																					*
Contractor's ignores of conducting a technical study before introducing the tender.																																					*
Financial difficulty by client during construction phase	*																			*	*						*								*		
The client's financial capability																		*																			
Unreasonable use and allocation of fund																																*					
Financing problems																*	*		*																		
Owners' financial difficulties																																*					
Delay in payment of completed works	*	*															*			*	*			*				*		*		*			*		
Delayed payment to contractors, subcontractors and/or suppliers									*									*		*	*									*					*		
Monthly payment difficulties from agencies (e.g., contractor, owner)																												*									
Contractors' financial difficulties																																*					
Cash flow and financial difficulties faced by contractors																					*							*		*					*		
Changes in the project's scope, design, specifications									*	*			*			*		*	*	*	*		*	*			*	*		*	*						
Variations	*																																				
Additional work.															*				*				*	*		*		*		*							
Addition or enhancement required by client or end users																											*										
Supplementary/additional agreement										`																	*										

Change orders by client leading to variations.		*			*																								*								
Project scope creep.										*																		*		*					*		
scope changes, whether mandated by circumstances or requested by client.																																	*			*	
Too many changes in owners' requirements or definitions.												*																									
Frequent change orders														*		*		*	*	*																	
Design changes during the construction phase													*					*					*			*	*		*		*			*			
Technology change																										*											
Quantity increased measure																						*															
Design scope change—design error.																						*					*										
Design/project scope change — environmental issues.																						*															
Design scope change—safety audit requirement.																						*															
Late user changes affecting the project or function															*																						
Schedule delay caused by contractors				*	*								*	*						*	*		*							*					*		
Delay in project implementation	*																																				
Delays in site mobilization																	*																				
Delays in material procurement																	*													*							
Delays in material delivery														*			*			*	*							*		*					*		
Delay in planned activity															*																						
Schedule delay caused by client	*																																				
Delay in decision making by client.	*															*	*			*	*					*	*			*					*		*
Delay preparation and approval of drawings																				*	*						*	*		*					*		
Delay in inspection and approval of completed works		*															*													*		*					

Delay in preliminary handing over of the project by the owner																																					*
Failure on the part of the employer to give possession of the site to contractor as agreed in the contract																											*										
Schedule delay caused by external factor																																					
Stagnant project																		*																			
Site constraints																												*									
Slow permits by government agencies	*															*										*											
Difficulty in obtaining work permits from governmental institutions																																					*
Obstacles from other contractors																	*																				
Bureaucracy in government agencies	*								*																		*										
Work suspension owing to conflicts		*																	*																		
Poor communication and coordination between a project's parties	*								*					*						*							*										
Lack of communication between parties.		*														*					*									*					*		
Slow information flow between parties																					*									*					*		
the high-level management decentralizes the power																		*																			
Lack of coordination between construction parties.															*			*	*	*	*			*						*					*		
Difficult relationship with local government																																*					
How well crew works together																										*											
Poor project/site controlling, monitoring, and management	*																			*	*										*				*		
Poor contract management by consultant.	*	*																	*					*						*							

Inadequate decision-making process																																	*				
Poor monitoring and control, e.g., due to incompetent and/or unreliable supervisors.									*										*	*	*									*		*			*		
Poor project management by contractor.	*																													*							
Project control meeting																		*																			
Poor schedule/cost control and management.									*																												
Time management																		*																			
Contractor's poor site management and supervision skills	*	*																*	*	*	*							*		*					*		
Poor financial management / control on site	*														*		*	*	*	*	*			*				*		*					*		
Quality of supervision																										*											
Improper management contracts, which are easy to cause the contract dispute																																*					
Conflicts, disputes, and lack of trust culture among the parties involved in the project									*			*																									
Litigation																			*																		
Adverse attitudes of the owner																	*																				
Contract document conflicts										*																	*										
Disputes on site																			*					*													
Contract dispute (unclear drawings or guidelines/regulations)																		*																			
Dispute on bill settlement.															*																						
Extra works not included in the contract																	*																				
Oral requests from the owner																	*																				
Additional request by client's representative					*																																

Cost associated with test of samples not provided in the contract																											*										
Shortening of contract period															*				*				*														
Change of schedule																											*										
Acceleration required by client		*																*									*										
Owner interference																														*							
Increased material costs	*	*			*									*	*			*	*	*	*		*	*					*	*	*	*			*	*	*
Price escalation of raw material															*																						
Material price fluctuations	*	*			*													*	*	*	*		*	*						*		*			*		
Unstable cost of manufactured materials																			*																		
Material price changes (inflation)	*																						*				*										
Shortage of materials	*	*																*	*	*	*									*					*		
manipulation of suppliers																								*											*		*
poor resource management																		*						*													
Inadequate production of raw material in the country																			*																*		
Difficulties in importing equipment and materials																																					*
Theft of materials																	*		*																		
Unreliable sources of materials on the local market.									*																												
inadequate production of raw materials by the country																								*													
Lack of project structure or material																*																					
Poor material quality																							*			*											
Increase in labour cost																													*								
Increased wages														*																							
High fluctuation in labour cost																		*																			
High cost of skilled labours																			*																		

High cost of labour	*																		*	*									*					*		
High transportation costs																		*																		
Labour, insurance, work security or workers' health problems																										*									
Inadequate manpower productivity								*									*	*																		
Relationship between site management and labour.														*				*					*						*							
Labour productivity																			*	*			*						*					*		
Morale/motivation of crew																									*											
Severe overtime																									*				*							
Shortage of labour																			*	*							*	*	*					*		
Shortages of skilled labour		*																	*	*			*		*			*	*					*		
Labour absenteeism																	*		*	*					*				*					*		
High staff turnover													*			*																				
Strikes (Strikes by site personnel)	*			*				*																												
Increased equipment costs													*																							
High cost of machinery.		*																*																		
High machineries maintenance costs																		*											*							
Inadequate or inefficient equipment, tools and plants.								*																			*		*							
Equipment availability and failure																			*	*							*		*					*		*
Lack of experience/ability/competence																	*		*	*							*		*					*		
Lack of competence						*																														
Lack of owner / owner representative / team experience/ability																																				
Competence/knowledge of owner																									*											
Inexperienced or newly qualified															*																					

construction supervisors																																					
Lack of experience of technical consultants																*														*							
lack of contractor / subcontractors / team experience/ability																								*			*										
Inexperience of the technical staff in the company																	*																				
Lack of subcontractors of experience/ability		*																		*	*									*					*		
Selection of subcontractor is not reasonable																																*					
Poor construction ability of sub-contractor																										*						*					
Lack of managerial capability of the company																	*																			*	
Inappropriate contractors																			*																		
Contractor's workload									*																												
Numerous construction projects / activities going on at the same time																			*					*		*				*					*		
Inappropriate contractor’s policies																			*																		
Firm’s policy					*																																
Poor ability of construction and management of contractor																																*					
Shortage in high-quality management personnel.												*						*																			
Rework and wastage on site									*	*													*	*						*							*
Inadequate construction techniques																		*																			
Errors in setting out basing on incorrect written data supplied by the engineer																											*										
Mistakes during construction																*	*			*	*									*					*		
Quality of work (by subcontractors)																										*											
Unsuitable construction method.		*																												*							

Obsolete or unsuitable construction methods																																					
Construction errors/defective works.		*			*										*																						
Technical challenges				*																																	
Lack of constructability																												*		*							
Improper / misuse of construction materials																																					*
Wastage on site.															*		*											*		*							
Project size																										*		*									*
Scale of construction																		*																			
Large and complex projects.									*										*																		
Project location									*															*		*									*		*
Remote location costs																							*														
Services relocation costs																							*														
Project complexity																*													*								
Complex local geological conditions																																*					
Engineering and construction complexities										*																											
Force majeure (strikes/weather/regu lation changes/accidents, etc.).												*			*				*																		
Bad weather	*			*					*							*										*		*		*							
Adverse weather.		*															*	*	*					*											*		*
Natural disaster					*													*																			
Protest																		*																			
Changes in governmental regulations														*																							
Procurement changes														*																							
Policy changes of land requisition compensation																																*					
risk and uncertainty																																				*	

uncertainty																																	*				
Bad luck						*																															
Uncertainties in economic and technical dimensions of project management							*																														
Unforeseen events										*																	*										
Cost of penalties																																					
Indemnities that the employer has contractually undertaken to assume																											*										
Penalties resulting from low quality																	*																				
Penalties resulting from delays																	*																				
Contractual claims, such as, extension of time with cost claims																				*	*									*					*		
Penalties resulting from safety accidents																	*																				
Site accidents.									*									*																			
Safety considerations																		*									*										
Environmental protection	*			*																																	
Fraudulent practices, kickbacks, corruption, Bribes.		*													*		*		*				*				*	*									
social and cultural impacts																								*				*							*		
Political pressures at the time of construction																											*										
Domination of construction industry by foreign firms and aids																			*																		
The types of clients																		*																			
Resumption/accommodation works																							*														
Change of partners in the project organization																*																					
Budget exceptions																		*																			

Regular budget update																	*																				
Contractors' bankruptcy																	*								*												
Complex investment process and administrative procedures																															*						
Fuel shortages									*																												
Others					*																																
High guarantee period of products																*																					*

Appendix B:

New Cause	Causes emerged
Inappropriate procurement route and procedure	*Insufficient time for bidders to study and prepare the tender*
	Inappropriate contractual procedure
	Long period between design and time of bidding/tendering.
	Bureaucracy in bidding/tendering method
Selection and assignment criteria	*Contract awarded to lowest bidder*
	Level and number of competitors
Discrepancies and/or deficiencies in contract documents	*Scope for the contractor not well defined*
	Unclear, ambiguous, and contradicting terms in the tender documents.
	Unbalanced distribution of risk between owner and contractor.
	The owner's disinterest in paying any compensations due to the decline in the economic and political conditions
	Severe contract conditions
	Mode of financing and payment for completed work
	Clearly define the scope of project in the contract
	Unclear division of responsibilities and lack of clear requirements for professional management.
	Project conditions
Inappropriate (Discrepancies and /or deficiencies) local /national data, regulation/policies, requirements, and political environment	*Laws and regulatory frameworks*
	Absence of construction cost data
	Lack of standard requirements from designers and poorly enforced professional liability of designers.
	Political insecurity and instability
	Obstacles from government
	Unforeseeable authority requirements or restrictions
	Local government
	Deficiencies in the infrastructure
	Local concerns and requirements
Difficult/Unstable/change in country's economic conditions	*Economic Instability*
	Gross domestic products (GDP)
	High interest rates charged by bankers on loans received by contractors
	High inflation, insurance and interest rates.
	Effects of inflation
	Inflationary pressure
	Market conditions
	Increase in tax/change in government fiscal/monetary policies
	Change in foreign exchange rate.
Inadequate planning, preparation, and pre-construction process and studies	*Inattention to risk inside government.*
	Lack of planning and coordination or less emphasis to planning
	Inadequate planning and scheduling
	Inadequate pre-construction study
	Lack of preliminary examination before design or tendering
	Inadequate preparation of the project concerning planning and execution.

	Wrong / inappropriate choice of project site
	Failure of land expropriation
	Land acquisition costs
	Late start of the planning process, and with too low a budget
	Insufficient, unstandardized owner's brief
	Lack of end user's involvement
	Inadequate project objectives
	The gap between the construction plan and the reality is too great.
	No practical use of the earned value management system
	Poor feasibility and project analysis
Deficiencies in cost and time estimates prepared by public agencies	*Inaccurate estimates by consultant*
	Inadequate planning for the project costs and the lack of following-up costs during the project execution.
	Unreasonable estimation and adjustment of project costs
	incompleteness of estimations
	unreasonable project time frame
	Inadequate duration of contract period
	Cost underestimation
Strategic misrepresentation	*Deliberate cost underestimation*
	Manipulation of forecasts
	consciously manipulated
	Political focus on reduced project costs or time
	Political interference
Optimism bias	*Cognitive bias of people*
	unconsciously manipulated
	Optimistic expectation regarding time, cost, and quality
Inadequate Inappropriate (Discrepancies and/or deficiencies) design process and documents	*Too small design budget*
	Mistakes and errors in design
	Unconstructable design.
	Poor design
	Difficulties and feasibility that design does not consider construction
	Noncompliance of design with client's requirements
	Noncompliance of design with government regulations
	Design problems
	Delay of drawings and site instructions
	late design work
	Impractical and complicated design
	Discrepancies between design and technical standards
Inadequate site and ground investigations	*Insufficient information about ground conditions*
	Differing site conditions
	Unforeseen conditions
	Geological conditions of actual construction are inconsistent with geological conditions of survey and design.
	Unforeseen site conditions
	Fossils or things of geological interest
Premature tender documents (drawings,	*Errors or inconsistencies in project documents*
	Insufficient/incomplete drawings

bill of quantities, specifications, contracts and legal documents)	*Inaccurately estimated quantities*
	Omissions and errors in the bills of quantities
	Inaccurate material estimates
	Unclear drawings and specifications
	Unclear technical specifications
	Unclear project scope
Difference between selected bid and the consultants' estimate	*Contract tender price higher than original estimate*
	Tender-winning prices are unrealistically low (suicide tendering)
Inaccurate cost and schedule estimates by contractor	*Forecasting errors including price rises*
	Poor estimating
	Missed item in estimate
	Inaccurate tender offer
	Inefficient scheduling process
	Failure to identify risks and institute necessary and timely remedy and control program
	Wrong method of cost estimation
	Mistakes in cost estimates
	Failure to price in certain risks
	Inconsistent application of contingencies
Inadequate planning and preparation by contractors	*Inaccurate review for drawings and contract documents*
	The contractor doesn't carry out a field visit to the site during the bidding process.
	Contractor's ignores of conducting a technical study before introducing the tender.
Financial difficulty by client during construction phase	The client's financial capability
	Unreasonable use and allocation of fund
	Financing problems
	Owners' financial difficulties
Delay in payment of completed works	*Delayed payment to contractors, subcontractors and/or suppliers*
	Monthly payment difficulties from agencies (e.g., contractor, owner)
Contractors' financial difficulties	*Cash flow and financial difficulties faced by contractors*
Changes in the project's scope, design, specifications	*Variations*
	Additional work.
	Addition or enhancement required by client or end users
	Supplementary/additional agreement
	Change orders by client leading to variations.
	Project scope creep.
	scope changes, whether mandated by circumstances or requested by client.
	Too many changes in owners' requirements or definitions.
	Frequent change orders
	Design changes during the construction phase
	Technology change
	Quantity increased measure
	Design scope change—design error.
	Design/project scope change —environmental issues.
	Design scope change—safety audit requirement.
	Late user changes affecting the project or function

Schedule delay caused by contractors	*Delay in project implementation*
	Delays in site mobilization
	Delays in material procurement
	Delays in material delivery
	Delay in planned activity
Schedule delay caused by client	*Delay in decision making by client.*
	Delay preparation and approval of drawings
	Delay in inspection and approval of completed works
	Delay in preliminary handing over of the project by the owner
	Failure on the part of the employer to give possession of the site to contractor as agreed in the contract
Schedule delay caused by external factor	*Stagnant project*
	Site constraints
	Slow permits by government agencies
	Difficulty in obtaining work permits from governmental institutions
	Obstacles from other contractors
	Bureaucracy in government agencies
	Work suspension owing to conflicts
Poor communication and coordination between a project's parties	*Lack of communication between parties.*
	Slow information flow between parties
	the high-level management decentralizes the power
	Lack of coordination between construction parties.
	Difficult relationship with local government
	How well crew works together
Poor project/site controlling, monitoring, and management	*Poor contract management by consultant.*
	Inadequate decision-making process
	Poor monitoring and control, e.g., due to incompetent and/or unreliable supervisors.
	Poor project management by contractor.
	Project control meeting
	Poor schedule/cost control and management.
	Time management
	Contractor's poor site management and supervision skills
	Poor financial management / control on site
	Quality of supervision
	Improper management contracts, which are easy to cause the contract dispute
Conflicts, disputes, and lack of trust culture among the parties involved in the project	*Litigation*
	Adverse attitudes of the owner
	Contract document conflicts
	Disputes on site
	Contract dispute (unclear drawings or guidelines/regulations)
	Dispute on bill settlement.
Extra works not included in the contract	*Oral requests from the owner*
	Additional request by client's representative
	Cost associated with test of samples not provided in the contract
	Shortening of contract period
	Change of schedule
	Acceleration required by client

	Owner interference
Increased material costs	*Price escalation of raw material*
	Material price fluctuations
	Unstable cost of manufactured materials
	Material price changes (inflation)
Shortage of materials	*manipulation of suppliers*
	poor resource management
	Inadequate production of raw material in the country
	Difficulties in importing equipment and materials
	Theft of materials
	Unreliable sources of materials on the local market.
	inadequate production of raw materials by the country
	Lack of project structure or material
Increase in labour cost	*Increased wages*
	High fluctuation in labour cost
	High cost of skilled labours
	High cost of labour
	High transportation costs
	Labour, insurance, work security or workers' health problems
Inadequate manpower productivity	*Relationship between site management and labour.*
	Labour productivity
	Morale/motivation of crew
	Severe overtime
Shortage of labour	*Shortages of skilled labour*
	Labour absenteeism
	High staff turnover
	Strikes (Strikes by site personnel)
Increased equipment costs	*High cost of machinery.*
	High machineries maintenance costs
Lack of experience /ability /competence	Lack of competence
Lack of owner / owner representative / team experience/ability	*Competence/knowledge of owner*
	Inexperienced or newly qualified construction supervisors
	Lack of experience of technical consultants
lack of contractor / subcontractors / team experience/ability	*Inexperience of the technical staff in the company*
	Lack of subcontractors of experience/ability
	Selection of subcontractor is not reasonable
	Poor construction ability of sub-contractor
	Lack of managerial capability of the company
	Inappropriate contractors
	Contractor's workload
	Numerous construction projects / activities going on at the same time
	Inappropriate contractor's policies
	Firm's policy
	Poor ability of construction and management of contractor
	Shortage in high-quality management personnel.

Rework and wastage on site	*Inadequate construction techniques*
	Errors in setting out basing on incorrect written data supplied by the engineer
	Mistakes during construction
	Quality of work (by subcontractors)
	Unsuitable construction method.
	Obsolete or unsuitable construction methods
	Construction errors/defective works.
	Technical challenges
	Lack of constructability
	Improper / misuse of construction materials
	Wastage on site.
Project size	*Scale of construction*
	Large and complex projects.
Project location	*Remote location costs*
	Services relocation costs
Project complexity	*Complex local geological conditions*
	Engineering and construction complexities
Force majeure (strikes/weather/regulat ion changes/accidents, etc.).	*Bad weather*
	Adverse weather.
	Natural disaster
	Protest
Changes in governmental regulations	Procurement changes
	Policy changes of land requisition compensation
	risk and uncertainty
	Uncertainty
	Bad luck
	Uncertainties in economic and technical dimensions of project management
	Unforeseen events
Cost of penalties	*Indemnities that the employer has contractually undertaken to assume*
Penalties resulting from delays	*Contractual claims, such as, extension of time with cost claims*
Penalties resulting from safety accidents	*Site accidents.*
	Safety considerations
	Environmental protection

Appendix C: Correction:

Comments	The changes made
1. Whilst there is a problem statement section in the thesis it does not actually clearly provide a view for the reader on what specific problem the research is trying to address/solve. There needs to be a clear problem explicated within the first chapter.	Section 1.2, which is the problem statement, has been reviewed and amended accordingly to be clearer so as to present a specific problem explicitly identified in the section.
2. Based on the above being made clear and also supported by the narrative in the research the work also needs to more clearly set out research aims and objectives. These are not necessarily the same as what is provided in the thesis at the moment. Indeed, research objectives provide a window into the objectives of the research - in doing so, we get a better idea at the start of the research what to expect from the mobilised research activities such as, what is the point of the SLR's and the output from various phases of the research. To be clear they are more concerned with the story of the research process/design. The objectives need to provide something of value to the research.	Sections 1.3 and 1.4 have been reviewed where the research questions, aim, and objectives have been amended accordingly under the same sections. The wording of the aim and objectives have been changed to be clearer and strengthen the links between the aim and objectives, as well as with the research questions. Moreover, the process captured within the research design graph has been developed and further clarified through material added to section 1.7.
3. There is a need to explain the role of the individual parts of the research and how they interrelate and connect to deliver objectives and fundamentally help to address the problem - essentially a broad research design.	The discussion of the research components has been developed further in section 1.7, where the different sections and subsection of the research process have been shown, along with how they are linked to each other. Moreover, the research design graph in the section has also been added to enhance the clarity of how each of the sections are linked.
4. There is a need to perhaps consider the theoretical perspective or lens that the research adopts to reinforce the argument	A new section (1.1.4) in Chapter One was added to provide the theoretical perspective (lens) for exploring the context, and the process for this has been explained and linked to

that the research is underpinned by a sensitivity to context.	theories. Four profiles (lenses) have been identified for context exploration.
5. The objective of chapter 2 needs to be made more explicit at the outset. It is also necessary to be absolutely clear regarding what role in the research the findings from the analysis of the literature provide.	The introduction of Chapter Two has been amended to introduce a clear objective of the chapter as well as provide clarity around its role in the research. Moreover, the research provides a summary at the end of Chapter Two for the literature review.
6. Chapter 3 needs to much more clearly explain the choices and the rationale for the choices made at every layer of the onion! Consider reviewing the methods adopted in previous research and how they inform your choices.	*Chapter Three has been totally restructured and reformed. New sections were added, and other sections were removed to achieve the optimum research methodology explanation.* Each layer of the research onion has been restructured to illustrate the rational choice for each of the layers. The rational choice was based on the optimum approach to reaching the research aim and objectives. Moreover, reviewing of the previous research methods was contributed to the rational choice to ensure that the research avoids the limitations of reusing the same methods. This can be seen in sections (3.2, 3.3, 3.4, and 3.5).
7. The case study needs much more depth and arguments concerning what is considered the ''phenomena of interest', the 'case', the basis of generalisation and the way that the instruments used to collect data were designed - I would also include an idea of the sampling strategy and criteria.	The research has added a new heading section (3.6 Research Design) and new subheads (3.6.2.1 The study's question(s), 3.6.2.2 The qualitative study's proposition, 3.6.2.3 Unit of analysis, 3.6.2.4 The logic linking the data to the proposition/theory, 3.6.2.5 The criteria for interpreting the findings) where the phenomena of interest, the case, the basis of generalisation and the way that the instruments used to collect data were designed. Moreover, section (3.7) illustrates the sampling strategy and criteria. Under section (3.6), the research illustrates examples of previous research in choosing the research process and illustrates how that

<table>
<tr><td></td><td>affected the choosing of case study and SLR as the main research strategies.</td></tr>
<tr><td>8. The way the data has been treated, reduced and analysed using rigorous analytical techniques such as thematic analysis must be made transparent to the reader. Especially the qualitative data.</td><td>Section (3.11 Data analysis) was restructured and reformed to show the methods by which the collected data have been used, treated, reduced and analysed.</td></tr>
<tr><td>9. The function of the case study must also be made clearer - is it used to test propositions and if so, where do these propositions come from. There needs to be transparency on how the analysis of the data has produced findings and exactly what those findings were.</td><td>In section (3.6 Research Design) and subheads (3.6.2.1 The study’s question(s), 3.6.2.2 The qualitative study’s proposition), the research illustrate the function of the case study as well as the research proposition. Moreover, Section (3.11 Data analysis) and subheads (3.6.2.4 The logic linking the data to the proposition/theory, 3.6.2.5 The criteria for interpreting the findings) shows how the data analysis proceeded. Chapter Four, under sections (4.2, 4.3, 4.4, 4.5, and 4.6) illustrates the production of the findings of the analysis.</td></tr>
<tr><td>10. How the findings of the case study relate to the research objectives and their relevance to other parts of the research must be made clear - the logic of its role.</td><td>Under section (3.6 Research Design), a research design diagram (Figure 22) was developed which shows the findings of the research approaches and the research objectives.</td></tr>
<tr><td>11. The survey needs also to have more transparent detail regarding its role or function - what is it attempting to do and what informs the survey.</td><td rowspan="2">Due to misjudgement by the researcher, the research in his previous submission considered the second Interviews as being a separate research approach (Survey). After a new assessment, it was clearer for the researcher that the second-round interviews should be under the main research approach (case study). Based on that the Survey research approach was eliminated. Thus, no further action was taken for comments 11, 12, and 13.</td></tr>
<tr><td>12. Like the case study there is a need to fully explain the sampling strategy/criteria, the way the survey data is collected, how the instrument was designed, how the data has been treated, reduced and analysed using rigorous analytical techniques - again the logic of how you get from questions of how will I collect data' and "what data is</td></tr>
</table>

necessary' to explaining how data is analysed to provide a clear set of findings'. The reader needs to see this logic.	
13. How the findings from the survey relate to the research objectives and their relevance to other parts of the research such as the model development also needs to be made quite transparent and clear - the logic of its role.	
14. The end of the research methodology section needs to provide quite a comprehensive research design (a diagram would help here) of all the research activities such as the SLR's, chapter 2, the case study (interviews and project docs), the survey interviews, the development steps of the model and the articulation of the model and how this essentially addresses the research problem.	A new section (3.6 Research Design) was introduced, and the research design for the case study and the systematic literature review illustrate how each of the research approaches contribute to achieving the research objectives and aim. Moreover, a research design diagram (Figure 22) was developed which shows all the research activities and how the activities engaged with each other to achieve the research aim and objectives.
15. You need to clarify within the methodology your philosophical choices more clearly and how the research is inductive (if inductive is the dominant route chosen) by referring the process of induction to the research design and choices. Be clear about whether you are building or testing theory and how you achieve this.	Sections (3.2 research philosophy, and 3.3 research approach) were reformed and restructured to illustrate the rationale behind the choices made. Moreover, examples of the previous studies limitations were also explained and shown to contribute to the rational decision.
16. In an analysis chapter, we need to then see the results of the various pieces of analysis (empirical) and how these are then used to build the model. The theoretical and analytical techniques used to develop the model must also be explicated here or perhaps in a previous chapter.	Based on the improvement on the 15 points above and restructuring and reforming of Chapter Three, the analysis and discussion chapter (Chapter Four) shows clearly the various stages of analysis and how these are then used to build the model. Moreover, a new section (4.3.5) was added where a matrix has developed and added to show the links between the four profiles (context prospective), process weaknesses and the possible causes of cost

	overrun. This is also considered beneficial for the path development and used to build the model. Also, sections (3.11.1) and (4.6.1) illustrate the theoretical tool that used to develop the model and how the matrix in section (4.3.5), and causes in section (4.5.7), contributed to the building of causality paths that are used eventually to build the final model.