Measuring the Construction Performance in Saudi Arabia and Proposing New Procurement Model Based on BV PIPS

(A University Case Study)

by

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ABSTRACT

Saudi Arabia has been facing issues with completing construction projects on time and on budget. It has been documented that 70% of public construction projects are delayed. Studies have identified the low-bid delivery method as an important factor in causing such delays. The procurement system (low-bid) ignores contractors' performance, and that is reflected in projects' performance. A case study was performed, at a University campus in northern Saudi Arabia, identifying the major causes of project delays and cost overruns. The University was experiencing delays from 50% to 150%. Also, the actual project costs for four projects were examined and found that all four projects' costs were higher than the original bid. The delay and cost overruns factors were gathered from the University engineers. A literature research identified one construction management method, best value performance information procurement system (BV PIPS), has documented multiple times its ability to improve project performance. In a comparison using the result of a case study and the results of (BV PIPS), Saudi Arabia's delivery system was identified as a potential cause of project performance issues. The current procurement system was analyzed and modified to adapt with the (BV PIPS). The proposed procurement system using BV PIPS, which can be implemented in Saudi Arabia, was created with owner side. A large survey was conducted of 761 classified contractors and 43 universities' representatives who rated causes of delay factors and cost overruns. The delay factors were then compared to delay factors experienced on Saudi construction projects, identified by performing a literature research. The comparison identified 14 important causes of delays. Moreover, the survey showed that classified contractors and universities' representatives unsatisfied with low-bid, and they agreed

with BV PIPS which selecting vendors based on performance with price. The proposed model required a submitted level of experience (LE), risk assessment (RA), and value added (VA). Besides, project managers of vendors should be interviewed during the clarification phase. In addition, venders should submit the project's scope, technical schedule, milestone schedule, and risk management plan. In the execution phase, vendors should submit a weekly risk report (WRR) and director's report (DR).

DEDICATION

I want to dedicate this to my parents, my wife and to all of my kids Razan, Yara, and Abdulrahman.

ACKNOWLEDGMENTS

I would like to acknowledge all of my Committee (Dr. Dean Kashiwagi, Dr. Jacob Kashiwagi, Dr. Abdulrahman Al-Tassan). Also, I would like to acknowledge Alfredo Rivera who has helped me during my Ph D.

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CHAPTER 1

INTRODUCTION

Saudi Arabia (SA) has been experiencing a construction boom for the past three decades. The construction industry is considered to be a big business, estimated to be worth more than $3.9 trillion yearly worldwide (Jackson, 2010). The estimated nearly investment budget for the Saudi construction industry from 1990 to 2000 was $234 billion (Cordesman, 2002). The Saudi construction industry has been identified as the largest in the gulf countries as Saudi spent $575 B on construction projects from 2008–2013 (Deloitte, 2013). For 2013 only, the Saudi Ministry of Finance allocated $48 billion for construction projects and $66 billion for 2014 (*Arab News*, 2014). In 2015, $32 billion was spent on governmental construction projects (Ministry of Finance, 2015). However, many researchers over the last three decades have classified the performance of the Saudi construction industry as low. Three studies have identified that 70% of public construction projects in Saudi Arabia experience delays (Al-Sultan, 1987; Assaf & Al-Hejji, 2006; Zain Al-Abedien, 1983). A study identified that the average delay percentages differed from the original contracts durations in Saudi Arabia by 10% to 30% (Assaf & Al-Hejji, 2006) and in another study by 39% (Elawi, Algahtany, & Kashiwagi, 2016). Furthermore, 80% of the public construction projects in Saudi Arabia faced cost overruns (Al Turkey, 2011). According to *Arab News* (2011), nonperformance in public construction projects in Saudi Arabia has more than $147 billion at stake. However, previous studies showed that one of the most important factors for the delays was the low-bid procurement system. In other words, contractors were selected based on price alone, ignoring contractor's performance side. In addition to the construction project

delays, there were also cost overrun problems. The university campus being used as a case study is considered to be one of these projects. This campus is located in Northern Saudi Arabia and was established in 2005. It has been under construction since 2006. In This study delay factors, cost overruns, and the low-bid system at a university campus was analyzed and modified to using BV PIPS.

Problem

Previous studies have proven that construction performance in Saudi Arabia is poor. The case study university campus should have been completed in 2012. However, only two buildings of the university campus are operational, despite the fact that, as of 2015, there are 22 buildings in the execution phase. Procurement system is considered a main factor that can increase the performance of projects. Government representatives usually base decisions on price when they procure construction projects. Previous studies have shown that low-bid is considered a major cause of construction project delay in Saudi Arabia (Albogamy, Scott, & Dawood, 2013; Al-Khalil & Al-Ghafly, 1999; Alzara, Kashiwagi, Kashiwagi, & Al-Tassan, 2016; Mahamid, 2013). When contractors are selected, the only focus is price. These low-bid projects are affected by substandard performance and delays, which often leads to increased costs. The government of Saudi Arabia has spent billions of dollars on construction projects, and they select contractors according to the lowest bid. However, these projects are often affected by cost overruns. This shows a contradiction in the way that contractors are selected because the system relies on cost criteria, but this leads to additional spending during the execution phase. Increasing project performance in Saudi Arabia requires reconsidering the procurement delivery system.

Research hypotheses

1. BV PIPS has the ability to deal with important delay factors in Saudi Arabia (SA)
2. The criterion of selecting contractors based on the lowest bid does not reflect the true price of projects. Also, the current project management methodology of the university's owner uses has led to cost overruns.
3. Classified contractors and universities' representatives need to accept and implement the best value performance information procurement system (BV PIPS) elements in Saudi Arabia.

Objectives of the Study

1. Identify important delay factors in public projects in Saudi Arabia (SA)
2. Identify causes for delays in projects on the university campus
3. Show how delay factors at the case study university are classified within the results from the literature review and survey
4. Show how BV PIPS can possibly deal with important delay factors to improve project performance in SA
5. Persuade stakeholders in Saudi Arabia that selecting contractors based on price criterion alone costs the government more due to substandard construction performance and cost overruns.
6. Identify current procurement process satisfaction of contractors and universities
7. Use BV PIPS model to identify how to increase construction industry performance in SA
8. Improve the current procurement system by a proposed model based on BV PIPS for SA

9. Determine if contractors and universities are interested in new procurement process improvements
10. Identify if the proposed improvements by the PhD candidate are sufficient for classified contractors and universities' representatives.

CHAPTER 2

METHODOLOGY

In this study a literature review was conducted on the performance of construction projects in Saudi Arabia and to explore essential factors that caused delays in public construction projects. Also, a relationship between low-price bidders and cost overruns were discovered. In addition, a literature review was conducted on the procurement delivery system issue and explained the best value performance information procurement system (BV PIPS), which has shown a higher level of construction performance than the low-bid system. Furthermore, case studies that used PIPS were discussed which approved a high level of performance with time, budget, and satisfaction. Next, the case study was conducted at the university in northern Saudi Arabia, which uses the low-bid system. A project director and 5 engineers at the university were interviewed to learn about the delay factors from an owner's perspective. Moreover, data were collected that included only projects that have complete information available with regard to bidders and cost overruns. Four construction projects were selected for which the complete data could be analyzed to examine cost overruns and show that the actual costs were higher than the original proposed prices. Interviews identified the causes of the cost overruns and showed the method for selecting contractors. The current procurement system was studied at the university with the client side, which consisted of procurement, project staff, and director. A modified version of BV PIPS that could be implemented in Saudi Arabia was proposed. Then a survey was created to identify the following:

1. Prioritizing causes of delay factors
2. Prioritizing causes of cost overruns

3. satisfied with current model (Low-Bid)
4. agreement with BV PIPS principles
5. agreement with proposed model

A survey was received from 761 classified contractors and 43 universities' representatives, and survey data were subjected to statistical analysis to show validity and reliability of the results.

Causes of Delay Factors

After prioritizing the delay factors via survey, they were compared with important delay factors around the country, which were collected from extant literature. The comparison showed the important factors that causes of delay projects at case study campus. The study then explained how BV PIPS can deal with identified important delay factors to improve project performance in SA.

Causes of Cost Overruns

After prioritizing causes of cost overruns via survey and data of cost overruns case studies were compared with BV PIPS performance.

Procurement System

The survey whether classified contractors and universities' representatives are in identify with current model, and agreement with BV PIPS principles and proposed model.

Based on the result of the survey and on BV PIPS, the proposed model was created, which can be applied in Saudi Arabia.

CHAPTER 3

LITERATURE REVIEW

Construction projects in Saudi Arabia have long-faced issues in regard to low performance. According to Al-sultan (1987), 70% of Saudi public projects faced time overages. Al-Barak (1993) reported that poor estimation practices and a shortage of skilled contractors cause project delays. Also, he believed that the national economy's stagnation was a factor that caused delays (Al-Barak, 1993). In 1999, Al-khalil and Al-Ghafly performed research to find the causes of delays in Saudi public utility projects. They investigated among owners, consultants, and contractors to determine who was responsible for project delays. They found that about 60% of projects begun between 1985 and 1994 were delayed. The owner and the consultant often blame the contractor for the project delays. Conversely, a contractor often accuses the owner and consultant of delaying the project (Al-khalil & Al-Ghafly, 1999). Likewise, delayed projects impact both the owner and contractor. The owner loses revenue because of the uncompleted project, which forces him or her to rent temporary premises. Contractors also incur overhead costs because delayed projects keep them from getting another project (Assaf & Al-Hejji, 2006). Other studies mentioned that government departments, as owners of public projects in Saudi Arabia, are affected by the disruption of public development plans, the financial execution plan, and community annoyance caused by the delay of particular projects. Whereas, a contractor is influenced through; increasing period of project, increasing overhead cost, and hindering contractor of finding another business opportunity (Al-Kharashi & Skitmore, 2009). All parties aim to complete construction projects on time. However, many previous studies found major factors that affected the

performance of organizations working on construction projects. Al-Karashi and Skitmore found about 112 factors responsible for project delays. They also obtained about 39 more factors from respondents in their study. The authors found 131 total factors, which are listed in the Appendix A (Al-Karashi & Skitmore, 2009). So, here in this study classified the related causes in four levels: owner-related causes, contractor-related causes, consultant-related causes, and other-related causes. An intensive review of significant, frequent factors that had appeared in previous studies about the Saudi Arabia construction industry was then made.

Important Delay Causes in Saudi Arabia

Owner-Related Causes

Owners play an active role in reducing project delays. Therefore, project period is considered to be a delay factor. Owners often cannot predict how long projects will take (Albogamy et al., 2013; Al-khalil & Al-Ghafly, 1999; Mahamid, 2013). Extension time is one of the owner-related delay factors. The owner approved extension time on 87% of projects (Al-khalil & Al-Ghafly, 1999). In addition, owners postpone making progress payments to other parties, which becomes another delay factor (Albogamy et al., 2013; Al-khalil & Al-Ghafly, 1999; Al-Kharashi & Skitmore, 2009; Al-Mudlej, 1984; Al-Sedairy, 2001; Al-Subaie, 1987; Hazmi, 1987; Mahamid, 2013). Another study found that project orders changed by the owner disrupted contractors' schedules, causing project delays (Albogamy et al., 2013; Assaf & Al-Hejji, 2006). Also, reviewing and approving project documents were mentioned as factors leading to the postponement of projects (Assaf & Al-Hejji, 2006). Also, suspension work in construction projects by the owner affects the project's performance (Al-Kharashi & Skitmore, 2009; Assaf & Al-Hejji,

2006). Also, a tendering system can be considered a significant factor that leads to the success of projects. Lowest bidding, which is the system applied in most Middle East countries, is also considered a reason for the prevalence of project delays in Saudi Arabia (Albogamy et al., 2013; Al-khalil & Al-Ghafly, 1999; Mahamid, 2013). Table 1 shows owner-related factors.

Table 1

Important Owner-Related Delay Factors in SA

No.	Owner-Related Causes of Delay
1	Unrealistic project Period
2	Extension of Time
3	Postponing Progress Payments
4	Changes in Project Orders
5	Failure to Review and Approve Project Documents
6	Suspension Work
7	Lowest Bidding Practices

Contractor-related causes

Al-Barak noted that the main causes of contractors' failures were skill shortages, poor estimation practices, and poor decision-making (Al-Barak, 1993). Project duration is also a contractor-related delay factor when the contractors have poor planning and scheduling skills (Albogamy et al., 2013; Al-khalil & Al-Ghafly, 1999; Mahamid, 2013). Qualified contractors may prevent project delays because of their experience, knowledge, and ability to field a trained workforce (Al-khalil & Al-Ghafly, 1999, Assa & Al-Hejji, 2006). Assaf and Al-Hejji (2006) found many factors related to contractors, such as conflicting views about subcontractors' schedules in project implementation and poor subsurface conditions. Some contractors do not expect the worst things that could happen on the worksite, for instance, a high water table. Other recent studies found that a lack of

experience and a shortage of manpower are major causes of project delays (Al-Kharashi & Skitmore, 2009; Assaf & Al-Hejji, 2006). Poor site management and supervision are also considered factors in the previously mentioned studies in addition to Mahamid's (2013) study, which has many other negative effects on the construction industry. Moreover, when a contractor has cash flow problems, it will naturally affect the project's completion (Albogamy et al., 2013; Al-khalil & Al-Ghafly, 1999; Al-Kharashi & Skitmore, 2009; Assaf & Al-Hejji 2006). Table 2 contains contractor-related factors.

Table 2

Important Contractor-Related Delay Factors in SA

No.	Contractor-Related Causes of Delay
1	Shortage of Skilled Workers
2	Poor Estimation Practices
3	Making Poor Decisions
4	Project's Duration
5	Contractors' Qualification
6	Conflicts with Subcontractors' Schedules
7	Poor Subsurface Conditions
8	Lack of Experience
9	Manpower Shortage
10	Poor Site Management and Supervision
11	Cash Flow Problem

Consultant-Related Causes

The previous studies revealed that some of the delay factors can be linked to a consultant. According to Assaf and Al-Hejji (2006), a consultant is responsible for project delays by producing design documents and reviewing and approving design documents (Albogamy et al., 2013; Assaf & Al-Hejji, 2006). Moreover, consultants are connected with diverse factors that cause project delays, such as failing to find mistakes and discrepancies in design documents and rigidity about deals (Assaf & Al-Hejji, 2006). In addition, consultants need to have high levels of experience in order to perform their

roles. Projects also often require hiring of a number of consultants (Albogamy et al., 2013; Al-Kharashi & Skitmore, 2009). Table 3 shows consultant-related factors.

Table 3

Important Consultant-Related Delay Factors in SA

No.	Consultant-Related Causes of Delay Factors
1	Failure to Produce (or Producing Faulty) Design Documents
2	Failure to Approve Design Documents
3	Mistakes and Discrepancies in Design Documents
4	Dealing Rigidly
5	Consultant Performance
6	Inadequate Number of Consultancy Employees

Other Causes

It is hard to classify some factors under the three main categories of owner, contractor, and consultant. For example, a delay in material delivery is considered a factor that has a degree of impact on project duration (Assaf & Al-Hejji, 2006). In construction projects, although it is difficult to coordinate among construction parties, communication and coordination increase the project's chances of success. Conversely, increasing rework—doing a job more than one time—reduces project schedule control (Mahamid, 2013). Table 4 contains other factors that delay projects.

Table 4

Other Important Delay Factors in SA

No.	Other Causes of Delay
1	Material Delivery Problems
2	Communication and Coordination Failures
3	Rework

The literature review showed that there are 27 significant, frequent factors that cause delays in construction projects in Saudi Arabia. There are six factors related to the project's owner, nine factors related to contractors, nine factors related to consultants, and four others that cause of delays in Saudi public projects.

Low-Bid and Cost Overruns

Previous researchers have identified that the use of a bid delivery method based on low prices is a main cause of time overruns in the public construction projects in Saudi Arabia (Albogamy et al., 2013; Al-Khalil & Al-Ghafly, 1999; Assaf & Al-Hejji, 2006; Mahamid, 2013). Selecting contractors based on the lowest bid is the most significant factor of delay projects in the field of construction (Banaitiene & Banaitis, 2006; Hatush & Skitmore, 1997a; Holt, Olomolaiye, & Harris, 1995; Huang, 2011; Merna & Smith, 1990; Moore, 1985; Ng & Skitmore, 2001; Plebankiewicz, 2008, 2010; Singh & Tiong, 2006; Waara & Brochner, 2006). According to Herbsman & Ellis (1992), project quality and time are not seen as being as important as low bids. Project performance is affected when vendors are selected based only on lowest price while ignoring time and quality (Holt, Olomolaiye, & Harris, 1994). In the United Kingdom, research encouraged the conversion to a performance-based norm from selecting vendors based on a low-bid delivery system, and results showed that the bids' prices were not significant (Wong, Holt, & Cooper, 2000). Furthermore, a study identified that, regardless of the lowest bid, the selection of qualified contractors among other bidders would have a positive impact on project performance and cost (Iyer & Jha, 2005). Conversely, when contractors' selection is based only on lowest price, unqualified contractors are encouraged to submit bids (Herbsman & Ellis, 1992). As a result, cost and time overruns in projects increase

due to the rewarding of projects to unqualified contractors (Banaitiene & Banaitis, 2006; Koushki, Al-Rashid, & Kartam, 2005). The appropriate awarding to qualified contractors of construction projects would increase the success rates of projects (Alhazmi & McCaffer, 2000; Plebankiewicz, 2009).

The selection of qualified vendors is, unfortunately, considered to be difficult (Sari & El-Sayegh, 2007), as project owners face complexity in the process of making decisions in selecting qualified contractors (Hatush & Skitmore, 1997b). Similarly, in Saudi Arabia, the selection of qualified contractors in the public sector is further affected by many obstacles such as the difficulty of decision-making because of a lack of experience, lack of capable consultants, and organizational stress of achieving the targeted projects' scheduled duration and budget (Al-Busaad, 1997). Another study identified that the selection of qualified contractors is considered to be a challenge for owners' procurement teams, which has a direct effect on the level of satisfaction and project accomplishment (Price & Al-Otaibi, 2010). Experts in the Saudi construction industry have found that the contractor-selection method usually fails to meet clients' expectations, which causes many issues such as cost overruns, contractor failure, increasing changes, claims, and poor quality (Abu Nemeh, 2012). According to Al-Hazmi (1987), order modifications, cost overruns, contractor insolvency, and substandard quality are caused when unqualified contractors are awarded projects by submitting the lowest price.

A study identified that bidders aim to win by submitting the lowest bid when the competition is based only on price (Cheng, 2008). However, the possibility that the actual costs of projects are not being represented increases if a cost-based selection of contractors is applied (Olaniran, 2015). Another study showed that a contractor who has the lowest bid usually submits an estimate that is lower than the project's actual estimated cost (Capen, Clapp, & Campbell, 1971). Consequently, selected contractors based on the lowest price model face profit and loss risks (Chao & Liou, 2007). Where other bidders would not accept that price, the lowest bidder will commit to the accomplishment of the project (Wolfsetter, 1996). To win bidding competitions in a low-bid procurement delivery method, several techniques have been used by bidders. Some bidders try to discover mistakes in the bidding documents to assist them in making change orders and claims for further work (Doyle & DeStephanis, 1990). The term *predatory bidding* refers to this approach, which is used to reduce contractors' losses (Crowley & Hancher, 1995). Therefore, the actual costs are not reflected in many low-bid projects because of the continuous order changes and claims that bidders use (Bedford, 2009). This method is used by contractors to offset the losses created by submitting a lower bid (Zack, 1993). Olaniran (2015) surveyed 54 construction experts to identify the causes of low project performance related to cost-based contractor selection. Out of 22 identified causes, the highest ranked cause was that the selected bidders reduced their profit margins. The second cause was the low level of project control and monitoring applied by many contractors. The third cause was the incompetence of selected contractors. Consequently, in the long term, project quality can be affected when contractors decrease their profit margins (Han, Park, Kim, Kim, & Kang, 2007).

Rather than using the low-bid price method, a new procurement method, BV PIPS, can be adapted in Saudi Arabia to improve performance of projects. BV PIPS has proven to increase performance in construction projects. In this system, expert vendors are selected based on their performance while providing the lowest verified price. The vendors provide in a clarification phase a detailed proposal that includes the delivery information through a specific technique (Kashiwagi & Kashiwagi, 2011). Alzara et al. (2016) identified the major time overrun risk factors that cause poor performance in Saudi Arabia and recognized BV PIPS as a solution for overcoming these time-overrun risk factors.

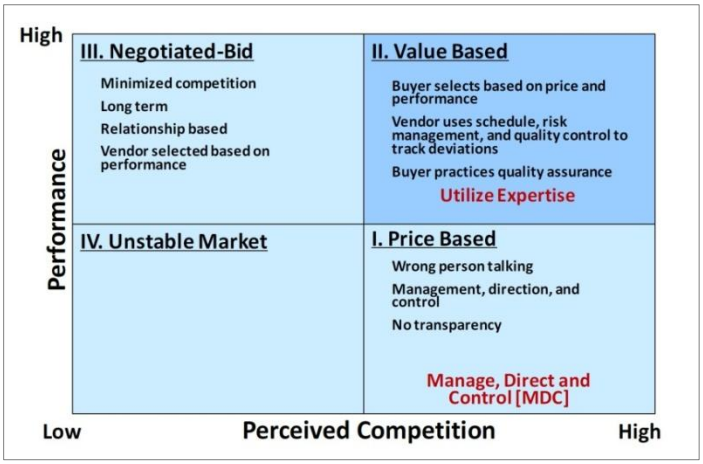
Best Value and Performance Information Procurement System (BV/PIPS)

Dr. Kashiwagi created BV PIPS at Arizona State University (ASU) in 1991. BV PIPS has proven to minimize risks in projects and increase contractors' performance through the use of experts (Kashiwagi, Sullivan, & Kashiwagi, 2009; Kashiwagi, Kashiwagi, Sullivan, & Kashiwagi , 2015). BV PIPS applies a special delivery environment that minimizes decision-making, direction, management, and control (Kashiwagi, 1991, 2010). In 2008, the International Council for Building (CIB) Working Commission W117 sanctioned a group (TG61) to perform a study using worldwide literature research to detect innovative approaches in construction documented an increase in performance of projects (Egbu, Carey, Sullivan, & Kashiwagi, 2008). The study filtered through more than 15 million articles, reviewed more than 4,500 papers, and identified the PIPS/PIRMS as the system that had published the most documentation showing an increase in construction performance on multiple tests. Performance of

projects is affected when they are based on value or on price. The industry structure model in Figure 1 shows the difference between methods based on value or on price. When the method is value based, projects show high levels of performance, and when it is based on price, they show substandard performance.

Figure 1

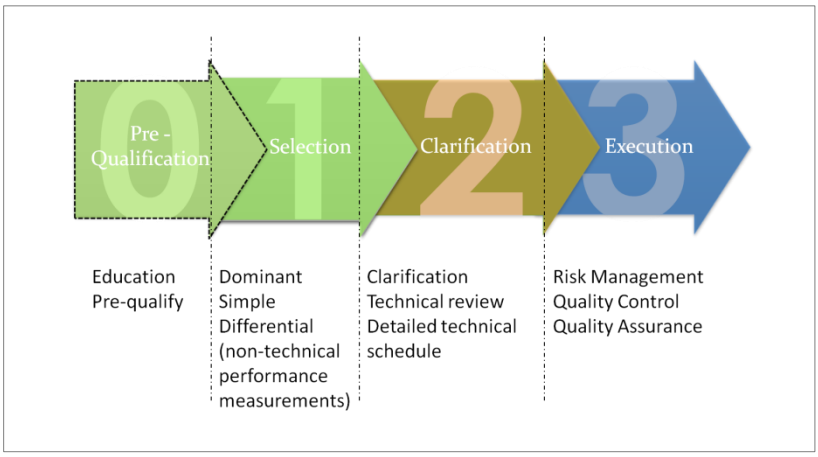
Industry Structure Model (Kashiwagi, 2014)



BV PIPS focuses on finding and using expert vendors to increase the performance of projects. Performance metrics of PIPS projects were completed on budget, on time, and with a high level of quality. PIPS has been tested with over 1,800+ projects with $6.3 billion project value ($4 billion in construction projects and $2.3 billion in non-construction service projects). These projects' metrics show a 98% rate of success in 6 different countries and 31 states (Kashiwagi, 2014). PIPS increases project performance and efficiency while reducing project risks in comparison with the low-price bid method. The PIPS process shown in Figure 2 consists of four phases: pre-qualification (optional), selection, clarification, and execution.

Figure 2

The Four Phases of BV PIPS (Kashiwagi, 2014)

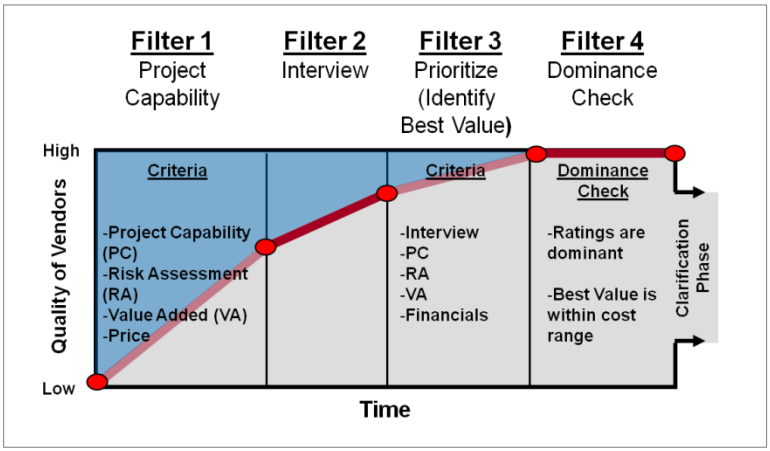


- Pre-qualification phase: This optional phase educates contractors about BV PIPS and how to submit dominant metrics to prove performance.
- Selection phase: This phase has four filters to find the best value contractor for a project (see Figure 3). In filter one, contractors should submit project capability and their price, which contains three documents: level of expertise (LE), value added (VA), and risk assessment (RA). Each of the three documents should be two pages maximum. The second filter is an interview determining the contractors' expertise. The interview is for the key people who will do the work such as project managers (PMs) to see if they are experts with a clear vision for the project as it progresses forward. The third filter is the committee-prioritized criteria, which weighs the previous steps. Weighting could use numbers from 1–10 or percentages. The fourth filter is a dominance check for the most appropriate contractor who provides information to minimize risk with the lowest cost.

- Clarification phase: This most important phase has the contractors clarify the plan and their offer. The contractor in this phase should explain what is outside the scope of the project while simplifying the proposal for the owner. Contractor and owner should clarify all aspects related to the project by providing a plan from the beginning of the project to the end, including the project scope, a milestone schedule, detailed technical specifications, and a risk management plan.
- Execution phase: This final has the contractor submit a weekly risk report (WRR) and director's report (DR) to the owner. The WRR is provided as an Excel document that explains the project activities and any deviations from the initial plan in terms of time, cost, and quality. The WRR also provides a milestone schedule, performance measurements, and a risk management plan. The DR contains a summary of all WRRs and provides each contractor's performance and any risk that should be focused on.

Figure 3

Shown Selection Phase Filters (Kashiwagi, 2014).



The PIPS process has proven to be successful when applied. Table 5 demonstrates four case studies that used PIPS. These case studies indicate that 100% of the projects that applied PIPS were finished on budget, and most of the projects were accomplished on time. The table shows that there was no change in orders in all the projects, and the overall satisfaction received a high rating from project owners. PIPS considers both performance and cost in the selection of contractors, not just price (CFMA, 2006; Chan & Chan, 2004; Egan, 1998; PBSRG, 2010; Kashiwagi, 2010, 2011).

Table 5

Examples of PIPS Case Studies

Case studies / Criteria	United Airlines	Utah	The University of Hawaii	Minnesota
Duration of execution	1996–1998	1999–2011	2000–2005	2005–present
Number of projects	32	4	11	247
Cost	$ 13 Million	$ 64,405,100	$ 1,658,192	$97.2 Million
Overall satisfaction	100%	N/A	92%	95%
On time	98%	100%	100%	100%
On budget	100%	100%	100%	100%
Change orders	0%	0%	N/A	0%

(Adapted from Kashiwagi, 2014).

CHAPTER 4

A UNIVERSITY CASE STUDY

The university campus selected for this case study is located in northern Saudi Arabia. This campus consists of 21 colleges in addition to other facilities and serves approximately 26,000 students. The university campus required a number of construction stages to be completed.

Causes of Delay Factors

In an interview with the director of department of projects and five engineers at the university campus was conducted on 14-15 March, 2015 via Skype. It was discovered that of a total of 22 projects at the university, 17 were delayed. There were also 15 projects under construction on the university campus. There are another eight projects that are currently in the design stage. However, the planned operation of the university campus should have begun in 2012. Conversely, two buildings were operational until 2015. Hence, the percentages of delay in overrun time at the university were between 50% and 150%. It was also found that 99% of the university projects overran projected costs. So, the delay of construction projects at the university was caused by many factors that have links to the owner, contractors, consultants, and other factors.

Owner-Related Causes at the Case Study

It is obvious that there is no clear vision for projects. Also, there were only incomplete ideas when the university planned its construction projects. As a result, most of the university's projects do not reflect reality. There are huge projects with unrealistic requirements. Because of this, after a contractor delivers a building, it is found that its design is not appropriate for use, which happens because the designers had been

controlled by the owner during the design stage. In addition, 88% of the university's projects are not well thought out, and these projects' budgets do not correspond with their design requirements. Consequently, when selecting a contractor, the owner often makes the decision to remove some work from the project in order to get the contractor price closer to the budget. The owner will find someone to complete these works later. This action delayed projects at the university because the removed works were based on work being done by the first contractor. For example, the first contractor may need the air duct system to be completed, which is removed from first contractor's works to another bid, to install a false ceiling. Consequently, the tendering system takes a long time to sing with a contractor and adds to the difficulty of governmental proceedings. Other factors are also related to the owner.

Contractors who want to obtain university projects must have classifications from the Ministry of Municipal and Rural Affairs. There are five classes, and each class shows the highest financial limit within the contractors' abilities. Owners may also make the decision to prevent low-class contractors from partaking in the competition by merging similar projects into one tender. However, that method increases the projects' sizes, which limits the university's ability to monitor them. Additionally, it is clear that there are poor organization within the project management department. Although there is no ability to manage many projects simultaneously, it is clear that there are many too many projects to progress through the implementation process. In addition, some delayed projects were found to need approval in order to use a particular system. However, the holder of authority was not a specialist, which led to slow approval. Also, the owner's employees

were responsible for delaying projects at the university because they delayed progressive payments to the contractors. Table 6 shows owner-related delay factors at the case study.

Table 6

Owner-Related Delay Factors in the Case Study

No.	Owner-Related Causes of Delay at the case study
1	Lack of Vision
2	Design Requirements Do Not Reflect Reality
3	Designer is Controlled by Owner
4	Lack of Project Budget
5	Wrong Decision-Making by Owner
6	Not Following the Conditions Solidarity Among Contractors
7	Inadequate Project Management Department
8	Late Review and Approval of Design Documents by Owner
9	Changing Consultant During Implementation
10	Delay in Progress Payments to Contractors

Contractor-Related Causes at the Case Study

The literature review found that one common delay on university projects was poor contractor performance. One project is separating itself from its contractor because of poor performance, the contractor's lack of qualifications, and a conflict among company partners. Withdrawing from a construction project sometimes requires procedures that can take up to ten years to complete. In addition, another contractor-related factor is a lack of experience. Although contractors must review the proposal and inform the owner about items that are not mentioned in the proposal, contractors and consultants discovered many items that were not mentioned in the project proposals but were uncovered during implementation. Besides, despite contractors have about two months after selecting a contractors and before signing contracts, the contractor do not utilize that time for reviewing proposals to find any luck of works. Moreover, most contractors on the university's projects lacked project-management skills. For example,

risks that could cause damage to projects were not clear to some project managers. The size of these projects often exceeded the contractors' ability. In addition, some contractors had too many projects, and that affected their ability to finish projects on time. Also, contractors suffered from a shortage of manpower. Additionally, contractors delayed the payment of salaries to their laborers, which delayed projects when the laborers stopped working. Table 7 shows contractor-related factors at the case study.

Table 7

Contractor-Related Delay Factors in the Case Study

No.	Contractor-Related Causes of Delay at case study
1	Poor Contractor Performance
2	Conflict Among Company Partners
3	Contractor's Inadequate Qualifications
4	Lack of Contractor Experience
5	The Proposal Was Not Studied by the Contractor
6	Contactor Lacked Project Management Skills
7	Ability of Contractors
8	Concurrent Projects
9	Shortage of Manpower
10	Delayed Payment to Laborers

Consultant-Related Causes at the Case Study

Poor consultant performance was also one of the causes of delay at the case study. Some consultants would like to extend their contract with the owner and, therefore, delay projects. Hence, some works were suspended by the consultant without a convincing reason. In addition, another delay factor is that many mistakes are often discovered in the blueprints during the implementation stage. Also, it is found that there is lack of consultancy employees and that causes delay construction at the university. However, when the consultants' contracts have been finished and the projects have been delayed, the university's owner has resorted to contracting with an international consultant for all

of the university's projects, which will save about $8 million, as opposed to contracting with more than one local consultant. In addition, when the owner contracts with one consultant for all campus projects, it reduces the extension of contracts for each project on campus if one of these projects is delayed. However, when a new consultant begins work, he or she is faced with some difficulties, such as the fact that most construction is already underway and that he or she needs time to understand what is going. Table 8 shows consultant-related factors at the case study.

Table 8

Consultant-Related Delay Factors at the Case Study

No.	Consultant-Related Causes of Delay Factors at case study
1	Sub-par Consultants
2	Delay Projects to Extend His/Her Contract with Owner
3	Lack of Consultancy Employees

Others Causes Of Delay at the Case Study

Others causes of delay are some factors that are not related to the three construction parties. Bidder procedure was one of the factors delaying university projects. Also, some parts of the procurement system are not clear, which makes employees spilt projects into multiple stages, which causes delays. Additionally, there are a large numbers of projects around Saudi Arabia that lack the necessary materials. For example, one contractor could not supply granite because there was high demand for it from contractors. Moreover, new regulations from the Ministry of Labor caused a shortage of manpower, as opposed to older regulations that helped contractors find manpower easily. Table 9 contains other delay factors at the case study.

Table 9

Other Delay Factors at the Case Study

No.	Other Causes of Delay at the case study
1	Material Delivery Problems
2	The Bidder System
3	Unclear Procurement System
4	New Worker Regulations

The results showed that there were 27 factors that delayed projects at the university. These factors were shown from the owner's perspective. Of the 27 delay factors, nine were owner-related, 10 were contractor-related, four were consultant-related, and four others were also found at the university.

Cost Overruns

In April 2015, data were collected from the university to identify cost overruns when the criteria for selecting contractors were based on price alone. The delivery system at the university is based on the low-bid method. The study concentrated on obtaining complete data in regard to projects from the beginning of the project to the current time period. It was found that only four projects contained complete project information. That difficulty in collecting data existed because the university's construction projects had transitioned through many stages and various responsible authorities since their execution in 2006. The four case studies showed all bidder costs for each project and which contractors had been selected. Moreover, the data contained the actual costs obtained during the execution phase. All personal information in regard to the contractors, including their names, was coded for this study.

In case study one, there were five bidders. The lowest bid came from Cont AAAFS at $31,605,544, and the highest was provided by Cont AAMASC at $59,333,506. The budget of project one was $34,538,933. In this example, the lowest bid won the project. When the final data were collected, the actual project only reached 24% completion and the actual price was $38,666,667, as shown in Table 10.

Table 10

Data Regarding Case Study One

Project 1					
Bidders	**Cost**	**Result**	**Budget of project**	**Actual value at 24% completion**	**Percent of cost deviation**
Cont AAAFS	$31,605,544	Selected	$ 34,538,933	$38,666,667	22.3%
Cont ATCCSA	$42,185,088				
Cont FTCC	$44,368,791				
Cont WIAC	$47,940,058				
Cont AAMASC	$59,333,506				

In case study two, five bidders applied. The lowest bid, provided by Cont AMG, was $24,645,130, whereas the highest bid, provided by Cont AAU, was $40,678,645. However, the lowest and second-lowest bidders left the competition with bids of $40,678,645 and $35,422,798, respectively. Then, from the three remaining contractors, the project owner selected the lowest bid, which was provided by Cont SACC at $37,317,248. However, the budget for project two was $35,733,333. After negotiations between the project owner and contractor, they signed the contract with a price of $34,666,667. The actual value, at 60% project completion, was $43,466,667. Table 11 shows the details for case study two.

Table 11

Data Regarding Case Study 2

Project 2					
Bidders	**Cost**	**Result**	**Budget of project**	**Actual value at 60% completion**	**Percent of cost deviation**
Cont AMG	$24,645,130	Withdrawn	$ 35,733,333	$ 43,466,667	25.4%
Cont ATCCSA	$35,422,798	Withdrawn			
Cont SACC	$37,317,248	Selected			
Cont BCL	$39,474,272				
Cont AAU	$40,678,645				

Five vendors bid on case study three. The lowest bid, provided by Cont DMC, was $38,501,294, whereas the highest bid, provided by Cont ACCL, was $45,530,146. The budget for project three was $40,000,000. The project owner selected the contractor with the lowest price, which was Cont DMC at $38,501,294. However, the actual value, at 80% completion, was $41,866,667. The bidding information is shown in Table 12.

Table 12

Data Regarding Case Study 3

Project 3					
Bidders	**Cost**	**Result**	**Budget of project**	**Actual value at 80% completion**	**Percent of cost deviation**
Cont DMC	$38,501,294	Selected	$ 40,000,000	$ 41,866,667	8.7%
Cont AAF	$40,397,923				
Cont BCL	$40,883,645				
Cont ACC	$41,919,152				
Cont ACCL	$45,530,146				

The fourth case study focused on project four in which five contractors applied for the project. The lowest price, provided by Cont AMG, was $27,070,573, whereas the highest price, provided by Cont BCL, was $40,965,773. The budget for the project was $28,000,000. Therefore, Cont AMG won the competition with the lowest price,

$27,070,573. However, the actual value of the project at 62% completion totaled $39,200,000. The bidding information is shown in Table 13.

Table 13

Data Regarding Case Study 4

Project 4					
Bidders	**Cost**	**Result**	**Budget of project**	**Actual value at 62% completion**	**Percent of cost deviation**
Cont AMG	$ 27,070,573	Selected	$ 28,000,000	$ 39,200,000	44.8%
Cont ATCCSA	$ 33,554,292				
Cont SACC	$ 36,304,503				
Cont AAU	$ 40,434,665				
Cont BCL	$ 40,965,773				

A University Case Study Analysis

All of the four university case studies analyzed experienced cost overruns. As mentioned above, all of these projects used the low-bid delivery system. In case study one, a contractor, AAAFS, was selected based on its low bid; however, cost overruns of 24% at completion totaled approximately $7,061,123. In case study two, there was approximately $6,149,419 in cost overruns in comparison to the bid price, and $8,800,000 in cost overruns at 60% completion in comparison to the signed contract. In case study three, a contractor, DMC, was selected due to the low bid price; however, this project experienced $3,365,373 in cost overruns. Moreover, the completion rate for that project was 80%. In case study four, a contractor, AMG, was selected due to its low bid price, and cost overruns reached $12,129,427. The percentage of completion in case study four was 62%. Figures 4, 5, 6, and 7 show the selected contractors in comparison to other bidders and cost overruns. The total of cost overruns for these case studies is

$31,355,923. This wasted amount is equivalent to the cost of one university building. The low-bid system has been proven to offer substandard performance and cost overruns at the university campus. Table 14 shows the details in regard to cost overruns for the case studies. Although the instruction of the procurement system does not allow of cost overruns to exceeding 10% of the total value of the contract, however, dividing bids into several parts breaks this rule.

Figure 4

Selected Contractor and Cost Overruns in Case Study One

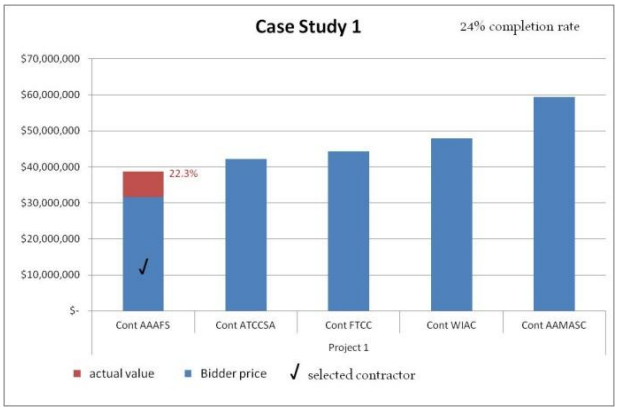


Figure 5

Selected Contractor and Cost Overruns in Case Study Two

Figure 6

Selected Contractor and Cost Overruns in Case Study Three

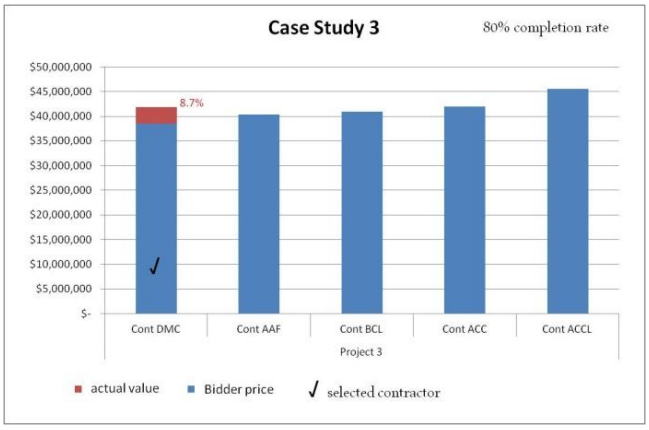


Figure 7

Selected Contractor and Cost Overruns in Case Study Four

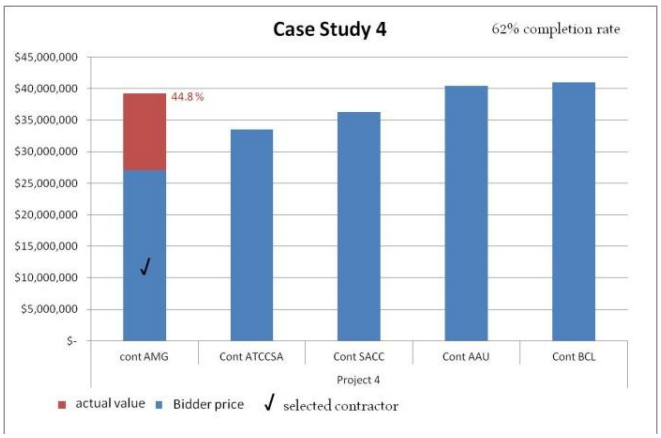


Table 14

Details of Case Study Cost Overruns

	Case study 1	Case study 2	Case study 3	Case study 4	Average
Contract Value	$31.6 Million	$34.6 Million	$38.5 Million	$ 27 Million	$ 32.9 Million
Total Cost of Contracts	131.7 Million				
Percent overrun	22.3%	25.4%	8.7%	44.8%	23.3%
Cost overrun	$ 7.1 Million	$8.8 Million	$3.4 Million	$12.1 Million	$7.8 Million
Total overrun	$31.4 Million				

Interviews identified seven risk factors that could cause cost overruns in Saudi Arabia. These seven risk factors were Change Orders, Bid Proposal Errors, Contractor's Errors, Consultant's Errors, Client's Change of Scope, Dividing Bids into Several Parts, and Unforeseen Risks.

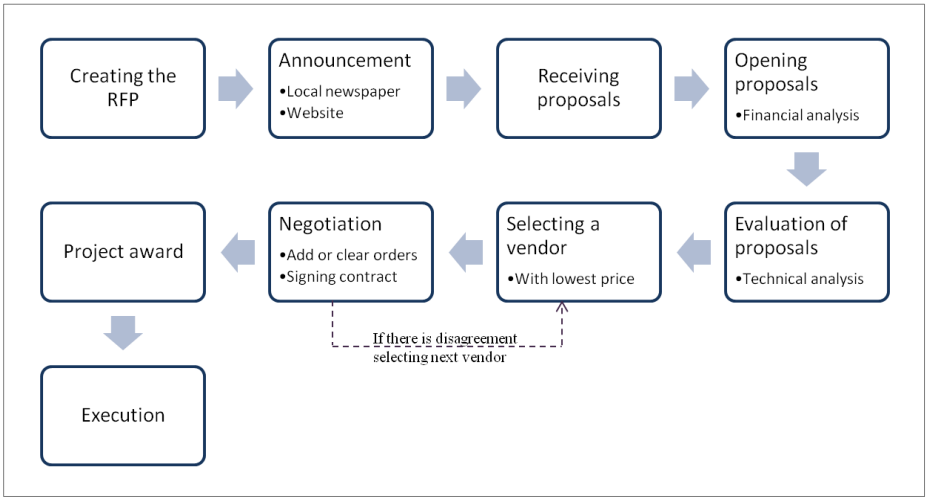
Current Procurement System (Low-Bid)

In July 2015, the university campus was visited by and met with the director and the procurement and project staff to understand the current procurement system and define BV PIPS for the university. The current procurement system in Saudi Arabia is subject to royal decree number M/58, enacted on September 27, 2006. This system selects bidders based on lowest price. Tenders and procurement laws include many basic principles and general provisions that consist of 81 articles. To improve the current procurement system, the fundamentals of the system must be understood. Public projects in Saudi Arabia are subjected to nine phases. The first phase involves the request for proposal (RFP). In the second phase, bids are announced in local newspapers and on Web sites. The next phase is that owners receive the proposals and check them to match instructions. Then when the committee and time are identified for opening of sealed-bids, the fourth phase is ready for financial analysis and prioritized by lowest price. In the fifth phase, all proposals should be evaluated by a technical analysis committee. Usually the lowest bidder is selected in the next phase. Then the lowest bidder moves to the negotiation phase with the owner. In this phase, the committee negotiates the price with the vendor before they sign a contract to add or remove some orders to reach a compromise value. If the vendor and negotiating committee are not able to compromise, the committee should then negotiate with the next bidder. After they sign the contract

with the vendor, they move to the next phase, which is the project awarding procedure. Then the vendor moves to the last phase, the execution phase, in which the owner hires consultants to inspect the implementation works. The current procurement system is shown in Figure 8.

Figure 8

This Shows the Current Procurement System in Saudi Arabia



After BV PIPS is discussed with the client, it is possible to improve the current procurement system through modifications based on BV PIPS. The owner has the ability to ask bidders for any requirements that it wants to add to the bid. So, based on BV PIPS, it is possible to ask bidders to submit some documents in the evaluation proposals phase. These documents are level of experience (LE), risk assessment (RA), and value added (VA), which help to assess the bidders' probable performance. Then the owner can select a bidder with the lowest price and high performance. When the selected bidder moves to the negotiation or clarification phase, then the PM should interview the vendor. Also, the owner can ask the vendor to submit the project's scope, technical schedule, milestone schedule, and risk management plan. In case the vendor is not qualified for these

requirements, the committee should then negotiate with the next bidder. The owner then awards the project and moves to the execution phase. The vendor then submits a WRR and DR during implementation to the client, the Contractors' Classification Agency, and the National Information Center. The documented data help the owner to anticipate the vendors' performance in the future.

CHAPTER 5

SURVEY

A project director and five engineers at the university were interviewed, and they identified 27 delay causes and seven cost overrun causes in Saudi Arabia. Moreover, When BV PIPS was discussed with the client, the principles, phases, and filters of BV PIPS that could be added to the current procurement system were considered. Then surveys were created which consisted of three parts; delay causes, cost overrun causes, and the proposed model (see Appendix B). Surveys were sent to more than 1,500 classified contractors and 14 project departments of universities in Saudi Arabia for rating delay causes , cost overrun causes, and the current procurement system and for BV PIPS to be accepted and applied in Saudi Arabia. A total of 761 classified contractors and 43 representatives of universities responded to the survey. Survey data were subjected to statistical analysis to show validity and reliability of the results.

Causes of Delay Factors

Validity

The construct validity was used to assess causes for project delays in Saudi Arabian universities. The Pearson's correlation was used to evaluate the relationship between each delay cause (item) and the total representing all the items. Generally, a correlation value of 0.70 or higher reflects a strong (high) relationship, demonstrating that the item is consistent with the total of the items. Table 15 includes the results.

Table 15

Construct Validity for Project Delay Causes (Overall Sample; N = 804)

Item No.	Delay Cause	Owner-Related	Contractor-Related	Consultant-Related	Other Cause	Overall Cause
1	Lack of Vision	0.895				0.827
2	Design Requirements Do Not Reflect Reality	0.602				0.912
3	Owner Controlled Designer	0.933				0.902
4	Lack of Project Budget	0.909				0.919
5	Owner's Wrong Decision Making	0.937				0.910
6	Owner Did Not Follow Solidarity Conditions	0.878				0.909
7	Inadequate Project Management Department	0.923				0.901
8	Owner's Late Design Document Review and Approval	0.877				0.696
9	Changing Consultant During Implementation	0.931				0.898
10	Delay in Progress Payments to Contractors	0.917				0.916
11	Poor Contractor Performance		0.922			0.895
12	Conflict among Company Partners		0.918			0.925
13	Inadequate Contractor Qualifications		0.940			0.878
14	Lack of Contractor Experience		0.915			0.933
15	Contractor Did Not Study Proposal		0.706			0.686
16	Contactor Lacked Project Management Skills		0.873			0.927
17	Contractor Ability		0.941			0.909
18	Concurrent Projects		0.942			0.705
19	Manpower Shortage		0.907			0.847
20	Delayed Payment to Laborers		0.901			0.920
21	Poor consultant performance			0.893		0.931
22	Consultant Delayed Projects to Extend His or Her Contract with Owner			0.943		0.895
23	Lack of Consultancy Employees			0.954		0.878
24	Material Delivery Problems				0.824	0.917
25	Bidder System				0.918	0.919
26	Unclear Procurement System				0.929	0.915
27	New Worker Regulations				0.888	0.889

The correlation values in Table 15 reflect a very strong relationship between each item of the delay cause and the cause related it belongs to, suggesting very satisfactory construct validity. All the values are statistically significant at the 0.01 level. Most of the values are close to the integer 1, which represents the maximum value a relationship may reach. The minimum correlation values were observed between item 2 and the owner-related causes (0.602) and observed minimum values between items 8 and 15 and the total items (0.696) and (0.686) respectively. These values express a moderate relationship.

Reliability

The internal consistency approach for Cronbach's alpha was used to describe how much the items pertaining to each dimension of the project delay causes (owners, contractors, consultants, and others) are reliable for measuring them. This method is based on calculating the ratio of the sum of an item's variance to the variance representing the total items, and adjusting the answer to the number of items. The formula for calculating α is:

$$\alpha = \frac{n}{n-1}\left(1 - \frac{\sum_i V_i}{V_t}\right)$$ (Cronbach, 1951, p. 299)

Where: *n* is the number of items

V_i is the item variance

V_t is the total item variance

The internal consistency value in Table 16 suggests a strong reliability. Generally, a value of 0.60 or greater expresses a good reliability. These provided values express a high degree of consistency, implying good reliability (the maximum possible value that can be obtained here is 1).

Table 16

Reliability Analysis Using Cronbach's Alpha for Project Delay Causes (Overall Sample; N = 804)

Dimensions	**No. of Items**	**Value**
Owner-related Causes	10	0.969
Contractor-related Causes	10	0.972
Consultant-related Causes	3	0.916
Other Causes	4	0.908
Overall Causes	27	0.989

Prioritizing Causes of Cost Overruns

The following formulas were used to calculate the included statistical indices:

1. The mean:

$$\text{Mean (m)} = \Sigma\ [a.\ (n/N)]$$

Where: *a* is the statistical weight

n is the weight frequency

N is the sample size

2. The standard deviation:

$$SD = \sqrt{\frac{\sum (x - \bar{x})^2}{N - 1}}$$

Where: *x* is the response value

x bar is the mean

n is the sample size

3. The frequency index (F.I.) is the percentage of the mean being assessed out of the highest response weight.

$$(\text{F.I.}) = \Sigma\ [a.\ (n/N)] \times 100/10$$

Where: *a* is a constant of weighting given to each despondence (1 = not common, 5 = don't know, 10 = common)

n is the weight frequency

N is the total number of responses for this research

The results are presented in three levels: contractors, universities' representatives, and the overall results of contractors and universities' representatives.

The contractors' sample. Table 17 reflects the descriptive statistics for the owner-related project delay causes in Saudi Arabian universities from the contractor's perspective. The results show that item a8 (Delay in Progress Payments to Contractors) ranks first because it recorded the greatest FI (95.70), and item a15 (Owner Did Not Follow Solidarity Conditions) ranks last because it recorded the smallest FI (57.0).

Table 17

Descriptive Statistics for Owner-Related Project Delay Causes Arranged in Descending Order (Contractor Sample; N = 761)

Cause Code	Delay Cause	Frequency %			Mean	SD	FI*	Order
		Not Common (1)	Don't Know (5)	Common (10)				
a8	Delay in Progress Payments to Contractors	2.8	3.7	93.6	9.57	1.72	95.7	1
a13	Lack of Project Budget	7.4	13.9	78.7	8.64	2.76	86.4	2
a7	Owner's Late Design Document Review and Approval	8.3	15.5	76.2	8.48	2.88	84.8	3
a14	Owner's Wrong Decision Making	11.2	21.3	67.5	7.93	3.18	79.3	4
a16	Inadequate Project Management Department	12.1	25.0	62.9	7.66	3.25	76.6	5
a10	Lack of Vision	12.1	36.9	51.0	7.07	3.23	70.7	6
a12	Owner Controlled Designer	14.8	33.2	51.9	7.00	3.37	70.0	7
a17	Changing Consultant During Implementation	17.6	40.7	41.7	6.38	3.37	63.8	8
a11	Design Requirements Do Not Reflect Reality	16.7	43.5	39.8	6.32	3.30	63.2	9
a15	Owner Did Not Follow Solidarity Conditions	23.4	43.9	32.7	5.70	3.38	57.0	10

(*) mean percentage out of the maximum weight (10).

Table 18 reflects the descriptive statistics for the contractor-related project delay causes in Saudi Arabian universities from the contractor's perspective. The results show that item b23 (Delayed Payment to Laborers) ranks first because it recorded the greatest FI (85.4), and item b18 (Conflict among Company Partners) ranks last because it recorded the lowest FI (37.90).

Table 18

Descriptive Statistics for Contractor-Related Project Delay Causes arranged in descending order (Contractor Sample; N = 761)

Cause Code	Delay Cause	Frequency %			Mean	SD	FI*	Order
		Not Common (1)	Don't Know (5)	Common (10)				
b23	Delayed Payment to Laborers	9.5	12.2	78.3	8.54	2.93	85.4	1
b22	Concurrent Projects	7.5	15.9	76.6	8.53	2.81	85.3	2
b4	Manpower Shortage	11.2	15.6	73.2	8.21	3.13	82.1	3
b20	Contactor Lacked Project Management Skills	12.1	14.7	73.2	8.18	3.19	81.8	4
b2	Poor Contractor Performance	8.1	22.7	69.1	8.13	2.97	81.3	5
b21	Contractor Ability	11.2	17.5	71.4	8.12	3.15	81.2	6
b5	Inadequate Contractor Qualifications	12.0	38.5	49.5	7.00	3.21	70.0	7
b3	Lack of Experienced Contractors	12.9	38.5	48.6	6.92	3.25	69.2	8
b19	Contractor Did Not Study Proposal	17.0	45.2	37.8	6.21	3.27	62.1	9
b18	Conflict among Company Partners	51.4	31.8	16.8	3.79	3.31	37.9	10

(*) mean percentage out of the maximum weight (10).

Table 19 reflects the descriptive statistics for consultant-related project delay causes in Saudi Arabian universities from the contractor's perspective. The results show that item c24 (Poor Consultant Performance) ranks first because it recorded the greatest FI (83.7), and item c9 (Lack of Consultancy Employees) ranks last because it recorded the lowest FI (63.70).

Table 19

Descriptive Statistics for Consultant-Related Project Delay Causes Arranged in Descending Order (Contractor Sample; N = 761)

Cause Code	Delay Cause	Frequency %			Mean	SD	FI*	Order
		Not Common (1)	Don't Know (5)	Common (10)				
c24	Poor Consultant Performance	5.7	22.3	72.0	8.37	2.74	83.7	1
c25	Consultant Delayed Project to Extend His or Her Contract with Owner	7.5	22.7	69.8	8.19	2.91	81.9	2
c9	Lack of Consultancy Employees	16.7	42.6	40.7	6.37	3.32	63.7	3

(*) mean percentage out of the maximum weight (10)

Table 20 reflects the descriptive statistics for the other project delay causes in Saudi Arabian universities from the contractor's perspective. The results show that item d1 (Bidding System [Low Price]) ranks first because it recorded the greatest FI (89.1), and item d6 (Material Delivery) ranks last because it recorded the lowest FI (59.9).

Table 20

Descriptive Statistics for Other Project Delay Causes Arranged in Descending Order (Contractor Sample; N = 761)

Cause Code	Delay Cause	Frequency %			Mean	SD	FI*	Order
		Not Common (1)	Don't Know (5)	Common (10)				
d1	Bidding System (Low Price)	4.9	13.1	82.0	8.91	2.46	89.1	1
d27	New Worker Regulations	3.8	26.7	69.5	8.32	2.64	83.2	2
d26	Unclear Procurement System	14.1	34.6	51.4	7.01	3.33	70.1	3
d6	Material Delivery	25.8	33.9	40.3	5.99	3.64	59.9	4

(*) mean percentage out of the maximum weight (10)

Table 21 reflects the descriptive statistics for overall project delay causes in Saudi Arabian universities from the contractor's perspective. The results show that item a8 (Delay in Progress Payments to Contractors) ranks first because it recorded the greatest FI (95.7), and item b18 (Conflict among Company Partners) ranks last because it recorded the lowest FI (37.9).

The top 10 delay causes were colored in red. The last delay cause (item) was almost 82.0% (81.9%). So the study can focus on the top 10 delay causes as major causes.

Table 21

Descriptive Statistics for Overall Project Delay Causes Arranged in Descending Order (Contractor Sample; N = 761)

Cause Code	Delay Cause	Frequency %			Mean	SD	FI*	Order
		Not Common (1)	Don't Know (5)	Common (10)				
a8	Delay in Progress Payments to Contractors	2.8	3.7	93.6	9.57	1.72	95.7	1
d1	Bidding System (Low Price)	4.9	13.1	82.0	8.91	2.46	89.1	2
a13	Lack of Project Budget	7.4	13.9	78.7	8.64	2.76	86.4	3
b23	Delayed Payment to Laborers	9.5	12.2	78.3	8.54	2.93	85.4	4
b22	Concurrent Projects	7.5	15.9	76.6	8.53	2.81	85.3	5
a7	Owner's Late Design Document Review and Approval	8.3	15.5	76.2	8.48	2.88	84.8	6
c24	Poor Consultant Performance	5.7	22.3	72.0	8.37	2.74	83.7	7
d27	New Worker Regulations	3.8	26.7	69.5	8.32	2.64	83.2	8
b4	Manpower Shortage	11.2	15.6	73.2	8.21	3.13	82.1	9
c25	Consultant Delayed Project to Extend His or Her Contract with Owner	7.5	22.7	69.8	8.19	2.91	81.9	10
b20	Contactor Lacked Project Management Skills	12.1	14.7	73.2	8.18	3.19	81.8	11
b2	Poor Contractor Performance	8.1	22.7	69.1	8.13	2.97	81.3	12
b21	Contractor Ability	11.2	17.5	71.4	8.12	3.15	81.2	13
a14	Owner's Wrong Decision Making	11.2	21.3	67.5	7.93	3.18	79.3	14
a16	Inadequate Project Management Department	12.1	25.0	62.9	7.66	3.25	76.6	15
a10	Lack of Vision	12.1	36.9	51.0	7.07	3.23	70.7	16
d26	Unclear Procurement System	14.1	34.6	51.4	7.01	3.33	70.1	17
b5	Inadequate Contractor Qualifications	12.0	38.5	49.5	7.00	3.21	70.0	18
a12	Owner Controlled Designer	14.8	33.2	51.9	7.00	3.37	70.0	18
b3	Lack of Experienced Contractors	12.9	38.5	48.6	6.92	3.25	69.2	20
a17	Changing Consultant During Implementation	17.6	40.7	41.7	6.38	3.37	63.8	21
c9	Lack of Consultancy Employees	16.7	42.6	40.7	6.37	3.32	63.7	22
a11	Design Requirements Do Not Reflect Reality	16.7	43.5	39.8	6.32	3.30	63.2	23
b19	Contractor Did Not Study Proposal	17.0	45.2	37.8	6.21	3.27	62.1	24
d6	Material Delivery	25.8	33.9	40.3	5.99	3.64	59.9	25
a15	Owner Did Not Follow Solidarity Conditions	23.4	43.9	32.7	5.70	3.38	57.0	26
b18	Conflict among Company Partners	51.4	31.8	16.8	3.79	3.31	37.9	27

(*) mean percentage out of the maximum weight (10).

The universities representatives' sample. Table 22 reflects the descriptive statistics for owner-related project delay causes in Saudi Arabian universities from the university representative's perspective. The results show that item a8 (Delay in Progress Payments to Contractors) ranks first because it recorded the greatest FI (86.7), and item

a15 (Owner Did Not Follow Solidarity Conditions) ranks last because it recorded the lowest FI (48.4).

Table 22

Descriptive Statistics for Owner-Related Project Delay Causes Arranged in Descending Order (University Representatives Sample; N = 43)

Cause Code	Delay Cause	Frequency %			Mean	SD	FI*	Order
		Not Common (1)	Don't Know (5)	Common (10)				
a8	Delay in Progress Payments to Contractors	7.0	14.0	79.1	8.67	2.75	86.7	1
a13	Lack of Project Budget	14.0	11.6	74.4	8.16	3.33	81.6	2
a7	Owner's Late Design Document Review and Approval	16.3	14.0	69.8	7.84	3.50	78.4	3
a11	Design Requirements Do Not Reflect Reality	14.0	25.6	60.5	7.47	3.40	74.7	4
a10	Lack of Vision	14.0	30.2	55.8	7.23	3.39	72.3	5
a14	Owner's Wrong Decision Making	14.0	30.2	55.8	7.23	3.39	72.3	5
a16	Inadequate Project Management Department	14.0	30.2	55.8	7.23	3.39	72.3	5
a12	Owner Controlled Designer	25.6	34.9	39.5	5.95	3.66	59.5	8
a17	Changing Consultant During Implementation	30.2	44.2	25.6	5.07	3.39	50.7	9
a15	Owner Did Not Follow Solidarity Conditions	30.2	48.8	20.9	4.84	3.21	48.4	10

(*) mean percentage out of the maximum weight (10)

Table 23 reflects the descriptive statistics for contractor-related project delay causes in Saudi Arabian universities from the university representative's perspective. The results show that item b2 (Poor Contractor Performance) ranks first because it recorded the greatest FI (91.2), and item b18 (Conflict among Company Partners) ranks last because it recorded the lowest FI (42.8).

Table 23

Descriptive Statistics for Contractor-Related Project Delay Causes Arranged in Descending Order (University Representatives Sample; N = 43)

Cause Code	Delay Cause	Frequency %			Mean	SD	FI*	Order
		Not Common (1)	Don't Know (5)	Common (10)				
b2	Poor Contractor Performance	4.7	9.3	86.0	9.12	2.33	91.2	1
b23	Delayed Payment to Laborers	4.7	16.3	79.1	8.77	2.54	87.7	2
b20	Contactor Lacked Project Management Skills	4.7	20.9	74.4	8.53	2.65	85.3	3
b4	Manpower Shortage	0.0	30.2	69.8	8.49	2.32	84.9	4
b22	Concurrent Projects	9.3	16.3	74.4	8.35	3.01	83.5	5
b3	Lack of Experienced Contractors	4.7	25.6	69.8	8.30	2.73	83.0	6
b19	Contractor Did Not Study Proposal	9.3	20.9	69.8	8.12	3.07	81.2	7
b21	Contractor Ability	9.3	25.6	65.1	7.88	3.11	78.8	8
b5	Inadequate Contractor Qualifications	9.3	39.5	51.2	7.19	3.12	71.9	9
b18	Conflict among Company Partners	44.2	34.9	20.9	4.28	3.47	42.8	10

(*) mean percentage out of the maximum weight (10)

Table 24 reflects the descriptive statistics for consultant-related project delay causes in Saudi Arabian universities from the university representative's perspective. The results show that item c24 (Poor Consultant Performance) ranks first because it recorded the greatest FI (70.5), and item c9 (Lack of Consultancy Employees) ranks last because it recorded the lowest FI (43.3).

Table 24

Descriptive Statistics for Consultant-Related Project Delay Causes Arranged in Descending Order (University Representatives Sample; N = 43)

Cause Code	Delay Cause	Frequency %			Mean	SD	FI*	Order
		Not Common (1)	Don't Know (5)	Common (10)				
c24	Poor Consultant Performance	18.6	25.6	55.8	7.05	3.61	70.5	1
c25	Consultants Delayed Project to Extend His or Her Contract with Owner	20.9	48.8	30.2	5.67	3.27	56.7	2
c9	Lack of Consultancy Employees	48.8	25.6	25.6	4.33	3.75	43.3	3

(*) mean percentage out of the maximum weight (10)

Table 25 reflects the descriptive statistics for other project delay causes in Saudi Arabian universities from the university representative's perspective. The results show that item d1 (Bidding System [Low Price]) ranks first because it recorded the greatest FI (93.5), and item d27 (New Worker Regulations) ranks last because it recorded the minimum FI (53.0).

Table 25

Descriptive Statistics for Other Project Delay Causes Arranged in Descending Order (University Representatives Sample; N = 43)

Cause Code	Delay Cause	Frequency %			Mean	SD	FI*	Order
		Not Common (1)	Don't Know (5)	Common (10)				
d1	Bidding System (Low Price)	4.7	4.7	90.7	9.35	2.15	93.5	1
d26	Unclear Procurement System	4.7	30.2	65.1	8.07	2.79	80.7	2
d6	Material Delivery	25.6	39.5	34.9	5.72	3.55	57.2	3
d27	New Worker Regulations	18.6	60.5	20.9	5.30	2.88	53.0	4

(*) mean percentage out of the maximum weight (10)

Table 26 reflects the descriptive statistics for overall project delay causes in Saudi Arabian universities from the university representative's perspective. The results show that item d1 (Bidding System [Low Price]) ranks first because it recorded the greatest FI (93.5), and item b18 (Conflict among Company Partners) ranks last because it recorded the lowest FI (42.8).

The top 10 delay causes are indicated in red. The last delay cause (item b19: Contractor Did Not Study the Proposal) was 81.2%, so the study can focus on the top 10 delay causes as major causes.

Table 26

Descriptive Statistics for Overall Project Delay Causes Arranged in Descending Order (University Representatives Sample; N = 43)

Cause Code	Delay Cause	Frequency %			Mean	SD	FI*	Order
		Not Common (1)	Don't Know (5)	Common (10)				
d1	Bidding System (Low Price)	4.7	4.7	90.7	9.35	2.15	93.5	1
b2	Poor Contractor Performance	4.7	9.3	86.0	9.12	2.33	91.2	2
b23	Delayed Payment to Laborers	4.7	16.3	79.1	8.77	2.54	87.7	3
a8	Delay in Progress Payments to Contractors	7.0	14.0	79.1	8.67	2.75	86.7	4
b20	Contactor Lacked Project Management Skills	4.7	20.9	74.4	8.53	2.65	85.3	5
b4	Manpower Shortage	0.0	30.2	69.8	8.49	2.32	84.9	6
b22	Concurrent Projects	9.3	16.3	74.4	8.35	3.01	83.5	7
b3	Lack of Experienced Contractors	4.7	25.6	69.8	8.30	2.73	83.0	8
a13	Lack of Project Budget	14.0	11.6	74.4	8.16	3.33	81.6	9
b19	Contractor Did Not Study Proposal	9.3	20.9	69.8	8.12	3.07	81.2	10
d26	Unclear Procurement System	4.7	30.2	65.1	8.07	2.79	80.7	11
b21	Contractor Ability	9.3	25.6	65.1	7.88	3.11	78.8	12
a7	Owner's Late Design Document Review and Approval	16.3	14.0	69.8	7.84	3.50	78.4	13
a11	Design Requirements Do Not Reflect Reality	14.0	25.6	60.5	7.47	3.40	74.7	14
a10	Lack of Vision	14.0	30.2	55.8	7.23	3.39	72.3	15
a14	Owner's Wrong Decision Making	14.0	30.2	55.8	7.23	3.39	72.3	15
a16	Inadequate Project Management Department	14.0	30.2	55.8	7.23	3.39	72.3	15
b5	Inadequate Contractor Qualifications	9.3	39.5	51.2	7.19	3.12	71.9	18
c24	Poor Consultant Performance	18.6	25.6	55.8	7.05	3.61	70.5	19
a12	Owner Controlled Designer	25.6	34.9	39.5	5.95	3.66	59.5	20
d6	Material Delivery	25.6	39.5	34.9	5.72	3.55	57.2	21
c25	Consultants Delayed Project to Extend His or Her Contract with Owner	20.9	48.8	30.2	5.67	3.27	56.7	22
d27	New Worker Regulations	18.6	60.5	20.9	5.30	2.88	53.0	23
a17	Changing Consultant During Implementation	30.2	44.2	25.6	5.07	3.39	50.7	24
a15	Owner Did Not Follow Solidarity Conditions	30.2	48.8	20.9	4.84	3.21	48.4	25
c9	Lack of Consultancy Employees	48.8	25.6	25.6	4.33	3.75	43.3	26
b18	Conflict among Company Partners	44.2	34.9	20.9	4.28	3.47	42.8	27

(*) mean percentage out of the maximum weight (10)

The contractors and universities representatives' sample. Table 27 reflects the descriptive statistics for owner-related project delay causes in Saudi Arabian universities from both the contractor's and university representative's perspectives. The results show that item a8 (Delay in Progress Payments to Contractors) ranks first because it recorded

the greatest FI (95.2), and item a15 (Owner Did Not Follow Solidarity Conditions) ranks last because it recorded the lowest FI (56.5).

Table 27

Descriptive Statistics for Owner-Related Project Delay Causes Arranged in Descending Order (Combined Sample; N = 804)

Cause Code	Delay Cause	Frequency %			Mean	SD	FI*	Order
		Not Common (1)	Don't Know (5)	Common (10)				
a8	Delay in Progress Payments to Contractors	3.0	4.2	92.8	9.52	1.80	95.2	1
a13	Lack of Project Budget	7.7	13.8	78.5	8.62	2.79	86.2	2
a7	Owner's Late Design Document Review and Approval	8.7	15.4	75.9	8.45	2.92	84.5	3
a14	Owner's Wrong Decision Making	11.	21.8	66.9	7.89	3.19	78.9	4
a16	Inadequate Project Management Department	12.2	25.2	62.6	7.64	3.26	76.4	5
a10	Lack of Vision	12.2	36.6	51.2	7.07	3.24	70.7	6
a12	Owner Controlled Designer	15.4	33.3	51.2	6.95	3.39	69.5	7
a17	Changing Consultant During Implementation	18.3	40.9	40.8	6.31	3.38	63.1	8
a11	Design Requirements Do Not Reflect Reality	16.5	42.5	40.9	6.38	3.31	63.8	9
a15	Owner Did Not Follow Solidarity Conditions	23.8	44.2	32.1	5.65	3.38	56.5	10

(*) mean percentage out of the maximum weight (10)

Table 28 reflects the descriptive statistics for contractor-related project delay causes in Saudi Arabian universities from both the contractor's and university representative's perspectives. The results show that item b23 (Delayed Payment to Laborers) ranks first because it recorded the greatest FI (85.5), and item b18 (Conflict among Company Partners) ranks last because it recorded the lowest FI (38.1).

Table 28

Descriptive Statistics for Contractor-Related Project Delay Causes Arranged in Descending Order (Combined Sample; N = 804)

Cause Code	Delay Cause	Frequency %			Mean	SD	FI*	Order
		Not Common (1)	Don't Know (5)	Common (10)				
b23	Delayed Payment to Laborers	9.2	12.4	78.4	8.55	2.91	85.5	1
b22	Concurrent Projects	7.6	15.9	76.5	8.52	2.82	85.2	2
b4	Manpower Shortage	10.6	16.4	73.0	8.23	3.09	82.3	3
b20	Contactor Lacked Project Management Skills	11.7	15.0	73.3	8.20	3.16	82.0	4
b2	Poor Contractor Performance	8.0	22.2	70.0	8.18	2.94	81.8	5
b21	Contractors Ability	11.1	17.9	71.0	8.11	3.14	81.1	6
b5	Inadequate Contractor Qualifications	11.8	38.6	49.6	7.01	3.21	70.1	7
b3	Lack of Experienced Contractors	12.4	37.8	49.8	6.99	3.24	69.9	8
b19	Contractor Did Not Study Proposal	16.5	43.9	39.6	6.32	3.29	63.2	9
b18	Conflict among Company Partners	51.0	32.0	17.0	3.81	3.32	38.1	10

(*) mean percentage out of the maximum weight (10)

Table 29 reflects the descriptive statistics for consultant-related project delay causes in Saudi Arabian universities from both the contractor's and university representative's perspectives. The results show that item c24 (Poor Consultant Performance) ranks first because it recorded the greatest FI (83.0), and item c9 (Lack of Consultancy Employees) ranks last because it recorded the lowest FI (62.6).

Table 29

Descriptive Statistics for Consultant-Related Project Delay Causes Arranged in Descending Order (Combined Sample; N = 804)

Cause code	Delay Cause	Frequency %			Mean	SD	FI*	Order
		Not common (1)	Don't know (5)	Common (10)				
c24	Poor Consultant Performance	6.3	22.5	71.1	8.30	2.81	83.0	1
c25	Consultants Delayed Project to Extend His or Her Contract with Owner	8.2	24.1	67.7	8.05	2.98	80.5	2
c9	Lack of Consultancy Employees	18.4	41.7	39.9	6.26	3.37	62.6	3

(*) mean percentage out of the maximum weight (10)

Table 30 reflects the descriptive statistics for other project delay in Saudi Arabian universities from both the contractor's and university representative's perspectives. The results show that item d1 (Bidding System [Low Price]) ranks first because it recorded the greatest FI (89.3), and item d6 (Lack of Consultancy Employees) ranks last because it recorded the lowest FI (59.7).

Table 30

Descriptive Statistics for Other Project Delay Causes Arranged in Descending Order (Combined Sample; N = 804)

Cause Code	Delay Cause	Frequency %			Mean	SD	FI*	Order
		Not Common (1)	Don't Know (5)	Common (10)				
d1	Bidding System (Low Price)	4.9	12.7	82.5	8.93	2.44	89.3	1
d27	New Worker Regulations	4.6	28.5	66.9	8.16	2.73	81.6	2
d26	Unclear Procurement System	13.6	34.3	52.1	7.06	3.31	70.6	3
d6	Material Delivery	25.7	34.2	40.0	5.97	3.63	59.7	4

(*) mean percentage out of the maximum weight (10)

Table 31 reflects the descriptive statistics for overall project delay causes in Saudi Arabian universities from both the contractor's and university representative's perspectives. The results show that item a8 (Delay in Progress Payments to Contractors) ranks first because it recorded the greatest FI (95.2), and item b18 (Conflict among Company Partners) ranks last because it recorded the lowest FI (38.1).

The top 10 delay causes are indicated in red. The last project delay cause (item b2; Poor Contractor Performance) was (81.8%), so the study can focus on the top 10 project delay causes as major causes.

Table 31

Descriptive Statistics for Overall Project Delay Causes Arranged in Descending Order (Combined Sample; N = 804)

Cause Code	Delay Cause	Frequency %			Mean	SD	FI*	Order
		Not Common (1)	Don't Know (5)	Common (10)				
a8	Delay in Progress Payments to Contractors	3.0	4.2	92.8	9.52	1.80	95.2	1
d1	Bidding System (Low Price)	4.9	12.7	82.5	8.93	2.44	89.3	2
a13	Lack of Project Budget	7.7	13.8	78.5	8.62	2.79	86.2	3
b23	Delayed Payment to Laborers	9.2	12.4	78.4	8.55	2.91	85.5	4
b22	Concurrent Projects	7.6	15.9	76.5	8.52	2.82	85.2	5
a7	Owner's Late Design Document Review and Approval	8.7	15.4	75.9	8.45	2.92	84.5	6
c24	Poor Consultant Performance	6.3	22.5	71.1	8.30	2.81	83.0	7
b4	Manpower Shortage	10.6	16.4	73.0	8.23	3.09	82.3	8
b20	Contactor Lacked Project Management Skills	11.7	15.0	73.3	8.20	3.16	82.0	9
b2	Poor Contractor Performance	8.0	22.2	70.0	8.18	2.94	81.8	10
d27	New Worker Regulations	4.6	28.5	66.9	8.16	2.73	81.6	11
b21	Contractor Ability	11.1	17.9	71.0	8.11	3.14	81.1	12
c25	Consultants Delayed Project to Extend His or Her Contract with Owner	8.2	24.1	67.7	8.05	2.98	80.5	13
a14	Owner's Wrong Decision Making	11.	21.8	66.9	7.89	3.19	78.9	14
a16	Inadequate Project Management Department	12.2	25.2	62.6	7.64	3.26	76.4	15
a10	Lack of Vision	12.2	36.6	51.2	7.07	3.24	70.7	16
d26	Unclear Procurement System	13.6	34.3	52.1	7.06	3.31	70.6	17
b5	Inadequate Contractor Qualifications	11.8	38.6	49.6	7.01	3.21	70.1	18
b3	Lack of Experienced Contractors	12.4	37.8	49.8	6.99	3.24	69.9	19
a12	Owner Controlled Designer	15.4	33.3	51.2	6.95	3.39	69.5	20
a11	Design Requirements Do Not Reflect Reality	16.5	42.5	40.9	6.38	3.31	63.8	21
b19	Contractor Did Not Study Proposal	16.5	43.9	39.6	6.32	3.29	63.2	22
a17	Changing Consultant During Implementation	18.3	40.9	40.8	6.31	3.38	63.1	23
c9	Lack of Consultancy Employees	18.4	41.7	39.9	6.26	3.37	62.6	24
d6	Material Delivery	25.7	34.2	40.0	5.97	3.63	59.7	25
a15	Owner Did Not Follow Solidarity Conditions	23.8	44.2	32.1	5.65	3.38	56.5	26
b18	Conflict among Company Partners	51.0	32.0	17.0	3.81	3.32	38.1	27

(*) mean percentage out of the maximum weight (10)

Causes of Cost Overrun

Validity

The construct validity was used to assess the validity of the items of the cost overrun causes the project in Saudi Arabian universities. The correlation values shown in table 32 reflect a very strong relationship between each item of the cost overrun and the

total of the items, suggesting very satisfactory construct validity. All the values were statistically significant at 0.05 and 0.01 levels. Note that most of the values provided in the table were close to the integer 1, which represents the maximum possible value a relationship may reach. The minimum correlation (but considered to express high correlation) value was observed between item no. 1 (Change Orders) and the cost overrun (0.841). A value of 0.70 or higher is considered to express a strong relationship.

Table 32

The Construct Validity for the Cost Overrun Causes (All Sample N=804)

Item no.	Cost overrun causes	Over all causes
1	Change Orders	0.841
2	Bid Proposal Errors	0.888
3	Contractor's Errors	0.884
4	Consultant's Errors	0.911
5	Client's Change of Scope	0.890
6	Dividing Bids into Several Parts	0.949
7	Unforeseen Risks	0.948

Reliability

The approach of internal consistency for Cronbach's alpha was used to describe how much the items of the cost overrun are reliable to measure these causes. The value of the internal consistency provided in table 33 suggests strong reliability. A value of 0.60 or greater expresses good reliability, so the provided values express a high degree of consistency.

Table 33

Reliability Analysis Using Cronbach's Alpha the Cost Overrun Causes (Overall Sample N=804)

	No. of items	**value**
Cost overrun causes	7	0.960

Prioritizing Causes of Cost Overruns

The mean, standard deviation, and frequency index formulas were used to calculate the included statistical indices. The results are presented in three levels; contractors, universities' representatives, and the overall results of contractors and universities' representatives.

The contractors' sample. Table 34 reflects the descriptive statistics for the cost overrun causes for Saudi Arabian university projects from the contractor's perspective. The results show that item no. 1 (Change Orders) is ranked first as it recorded the greatest FI (88.6), while item no. 3 (Contractor's Errors) is ranked last as it recorded the lowest FI (58.6). All other values ranged between these two values. It is noted that the top three cost overrun causes had a score above 80.0 FI.

Table 34

Descriptive Statistics for the Causes of Cost Overruns According to Contractors Arranged in Descending Order (Contractor's Sample N=761)

Cause code	Item	Frequency %			mean	SD	FI*	order
		Not common (1)	Don't know (5)	Common (10)				
1	Change Orders	5.5	12.9	81.6	8.86	2.53	88.6	1
2	Bid Proposal Errors	8.3	12.9	78.8	8.61	2.83	86.1	2
5	Client's Change of Scope	6.6	15.9	77.5	8.61	2.72	86.1	2
4	Consultant's Errors	10.1	41.8	48.1	7.00	3.11	70.0	4
7	Unforeseen Risks	14.7	34.8	50.5	6.93	3.35	69.3	5
6	Dividing Bids into Several Parts	14.7	35.7	49.5	6.89	3.34	68.9	6
3	Contractor's Errors	24.4	38.9	36.7	5.86	3.52	58.6	7

(*) mean percentage out of the maximum weight (10)

The universities representatives' sample. Table 35 reflects the descriptive statistics for the cost overrun causes for Saudi Arabian university projects from the perspective of university representatives. The results show that item no. 1 (Change Orders) is ranked first as it recorded the greatest FI (97.7), while item no. 4 (Consultant's Errors) is ranked last as it recorded the lowest FI (54.0). All other values ranged between these two values. It is noted that the top three cost overrun causes had a score above 80.0FI.

Table 35

Descriptive Statistics for the Causes of Cost Overruns According to Representatives of Universities Arranged in Descending Order (University Representatives N=43)

Cause code	Item	Frequency %			mean	SD	FI*	order
		Not common (1)	Don't know (5)	Common (10)				
1	Change Orders	0.0	4.7	95.3	9.77	1.07	97.7	1
5	Client's Change of Scope	4.7	18.6	76.7	8.65	2.60	86.5	2
2	Bid Proposal Errors	14.0	9.3	76.7	8.28	3.30	82.8	3
3	Contractor's Errors	14.0	34.9	51.2	7.00	3.36	70.0	4
6	Dividing Bids into Several Parts	18.6	30.2	51.2	6.81	3.57	68.1	5
7	Unforeseen Risks	18.6	30.2	51.2	6.81	3.57	68.1	5
4	Consultant's Errors	27.9	41.9	30.2	5.40	3.49	54.0	7

(*) mean percentage out of the maximum weight (10)

The contractors and universities representatives' sample. Table 36 reflects the descriptive statistics for the cost overrun causes for Saudi Arabian university projects from both the perspectives of the contractors and university representatives. The results show that item no. 1 (Change Orders) is ranked first as it recorded the greatest FI (89.1) while item no. 3 (Contractor's Errors) is ranked last as it recorded the lowest FI (59.2). All other values ranged between these two values.

Table 36

Descriptive Statistics for the Causes of Cost Overruns According to Contractors and Representatives of Universities Arranged in Descending Order (Contractors And University Representatives N=804)

Cause code	Item	Frequency %			mean	SD	FI*	order
		Not common (1)	Don't know (5)	Common (10)				
1	Change Orders	5.2	12.4	82.3	8.91	2.48	89.1	1
5	Client's Change of Scope	6.5	16.0	77.5	8.62	2.71	86.2	2
2	Bid Proposal Errors	8.6	12.7	78.7	8.59	2.86	85.9	3
7	Unforeseen Risks	14.9	34.6	50.5	6.93	3.36	69.3	4
4	Consultant's Errors	11.1	41.8	47.1	6.91	3.15	69.1	5
6	Dividing Bids into Several Parts	14.9	35.4	49.6	6.88	3.36	68.8	6
3	Contractor's Errors	23.9	38.7	37.4	5.92	3.52	59.2	7

(*) mean percentage out of the maximum weight (10)

Current Procurement System and Proposed Model Using BV PIPS

Validity

Construct validity was used to assess the validity of the items of the current procurement system, best value principles, and the new (proposed) procurement systems in Saudi Arabia. The Pearson's correlation was used to evaluate the relationship between each item and the total representing all the items. The correlation values mentioned in

Table 37 reflect a strong relationship between each item and the dimension to which it belongs, suggesting a highly satisfactory construct validity. All the values were statistically significant at 0.05, 0.01 levels. Note that most of the values provided in the table were close to the integer 1, which represents the maximum possible value a relationship may reach. The minimum correlation values were observed between item 12 and the proposed procurement system (0.860) and between item 1 and the total of items in part 1 (0.559). This value expresses a moderate relationship. Generally a value of 0.70 or higher is considered to express a strong relationship.

Table 37

The Construct Validity for the Current Procurement System, Best Value Principles, and New (Proposed) Procurement Systems (N = 804)

Item no.	Current Procurement System	Best Value Principles	New Proposed Procurement System	Overall
1	0.950			0.559
2	0.898			0.860
3		0.980		0.917
4		0.973		0.928
5		0.960		0.887
6			0.983	0.947
7			0.977	0.939
8			0.962	0.945
9			0.979	0.949
10			0.980	0.945
11			0.971	0.929
12			0.860	0.851
13			0.962	0.931

Reliability

The internal consistency approach for Cronbach's alpha was used to describe how much the items pertaining to each dimension of the current and new (proposed) procurement systems are reliable in measuring these procurement systems. The values of the internal consistency provided in Table 38 suggest a very meaningful reliability.

Generally a value of 0.60 or greater expresses a strong reliability so the provided values express a high degree of consistency and, consequently, good reliability. (Here also the maximum possible value that may be obtained is 1.)

Table 38

Reliability Analysis Using Cronbach's Alpha for the Current Procurement Systems, BV, and the New (Proposed) Procurement Systems (N = 804)

Dimensions	No. of items	Value
Current Procurement System	2	0.806
Best Value Principles	3	0.960
New Proposed Procurement System	8	0.987
Overall	13	0.967

Rating Procurement System

The mean, standard deviation, and frequency index formulas were used to calculate the included statistical indices. The results are presented in three levels; contractors, universities' representatives, and the overall results of contractors and universities' representatives.

The contractors' sample. Table 39 reflects the descriptive statistics for the current procurement system in projects in Saudi Arabia. The results show that item A1 (I have high satisfaction with the current procurement system) was ranked first in order because it received the greatest FI (38.0), whereas item A2 (Do you think selecting contractors solely based on price is the optimal practice for procuring services?) was ranked last in order because it recorded the minimum FI (18.80). All these results suggest

that the classified contractors have a weak opinion of the current procurement system (Low-bid).

Table 39

Descriptive Statistics for the Current Procurement System in Projects in Saudi Arabia Arranged in Descending Order (Contractors Sample N = 761)

Item code	Current Procurement System	Frequency %			Mean	SD	FI*	Order
		Disagree (1)	Don't know (5)	Agree (10)				
A1	I have high satisfaction with the current procurement system	45.9	41.4	12.7	3.80	3.02	38.00	1
A2	Do you think selecting contractors solely based on price is the optimal practice for procuring services?	83.7	11.8	4.5	1.88	2.18	18.80	2

(*) mean percentage out of the maximum weight (10)

Table 40 shows the descriptive statistics for the best value principles to be used in Saudi Arabia. The results show that item B3 (I would you be interested in learning more about a new procurement model that may improve the current procurement system by identifying and utilizing expertise) was ranked first in order because it recorded the greatest FI (94.30), whereas item B2 (Would you support improvements to the current procurement system that selects contractors based on performance with price?) was ranked last in order because it recorded the minimum FI (90.70). All other values ranged between these two values. These values suggest that the classified contractors ranked best value as an important outcome.

Table 40

Descriptive Statistics for the Best Value Principles to Be Used in Saudi Arabia Arranged in Descending Order (Contractors Sample N = 761)

Item code	Best Value Principles	Frequency %			Mean	SD	FI*	Order
		Disagree (1)	Don't know (5)	Agree (10)				
B3	I would you be interested in learning more about a new procurement model that may improve the current procurement system by identifying and utilizing expertise.	1.8	8.0	90.1	9.43	1.78	94.30	1
B1	Do you think selecting contractors based on performance with price would be more optimal?	5.1	5.8	89.1	9.25	2.25	92.50	2
B2	Would you support improvements to the current procurement system that selects contractors based on performance with price?	7.2	5.5	87.3	9.07	2.53	90.70	3

(*) mean percentage out of the maximum weight (10)

Table 41 outlines the descriptive statistics for the new (proposed) procurement system in Saudi Arabia. The results show that item C7 (Would it be beneficial if the government documented all performance on projects and posted the performance for all contractors to compare?) was ranked first in order because it recorded the greatest FI (94.30), whereas item C4 (During the clarification period, would interviewing the selected contractor's project manager performing the work improve the procurement process?) was ranked last in order because it recorded the minimum FI (88.30). All other values ranged between these two values and suggest the classified contractors have a high opinion of the proposed procurement system

Table 41

Descriptive Statistics for the New (Proposed) Procurement System for Saudi Arabia Arranged in Descending Order (Contractors Sample N = 761)

Item code	New Proposed Procurement System	Frequency %			mean	SD	FI*	Order
		Disagree (1)	Don't know (5)	Agree (10)				
C7	Would it be beneficial if the government documented all performance on projects and posted the performance for all contractors to compare?	2.8	6.4	90.8	9.43	1.88	94.30	1
C8	Would these new procurement process improvements help to identify expertise and utilize it to improve the overall performance on projects?	3.5	10.9	85.5	9.14	2.20	91.40	2
C6	During the execution of a project, would project performance increase if contractors measured their performance (time, cost, quality) weekly and submitted it to the client?	3.5	12.6	83.8	9.05	2.27	90.50	3
C3	In addition to only evaluating price, would asking contractors to propose ways they can add value to a project in their proposal improve the procurement process?	7.2	6.4	86.3	9.03	2.55	90.30	4
C5	During the clarification period, would requiring the selected contractor to provide a project plan from beginning to end, including scope of work, technical and milestone schedule, major risks that fall outside of that scope before they receive a contract, and how they will measure their performance, improve the procurement process?	5.5	10.6	83.8	8.97	2.47	89.70	5
C2	In addition to only evaluating price, would requiring contractors to submit potential risks they foresee on the project and state how they will mitigate and manage them improve the procurement process?	5.4	11.4	83.2	8.94	2.47	89.40	6
C1	In addition to only evaluating price, would requiring contractors to submit verifiable performance information improve the procurement process?	6.3	10.0	83.7	8.93	2.54	89.30	7
C4	During the clarification period, would interviewing the selected contractor's project manager performing the work improve the procurement process?	9.1	7.1	83.8	8.83	2.79	88.30	8

(*) mean percentage out of the maximum weight (10)

The universities representatives' sample. Table 42 outlines the descriptive statistics for the current procurement system in Saudi Arabia. The results show that item A1 (I have high satisfaction with the current procurement system) was ranked the first order because it recorded the greatest FI (28.10), whereas item A2 (Do you think selecting contractors solely based on price is the optimal practice for procuring services?)

was ranked the last in order because it recorded the minimum FI (11.90). These values suggest the universities' representatives have a low opinion of the current procurement system.

Table 42

Descriptive Statistics for the Current Procurement System in Saudi Arabia Arranged in Descending Order (Universities' Representatives Sample N = 43)

Item code	Current Procurement System	Frequency %			mean	SD	FI*	Order
		Disagree (1)	Don't know (5)	Agree (10)				
A1	I have high satisfaction with the current procurement system	60.5	34.9	4.7	2.81	2.49	28.10	1
A2	Do you think selecting contractors solely based on price is the optimal practice for procuring services?	95.3	4.7	0.0	1.19	0.85	11.90	2

(*) mean percentage out of the maximum weight (10)

Table 43 reflects the descriptive statistics for the best value principles to be used in Saudi Arabia. The results show that item B2 (Would you support improvements to the current procurement system that selects contractors based on performance with price?) was ranked first in order because it recorded the greatest FI (100.0), whereas item B1 (Do you think selecting contractors based on performance with price would be more optimal?) was ranked last in order because it recorded the minimum FI (95.30). These values suggest the universities' representatives have a positive opinion of BV PIPS.

Table 43

Descriptive Statistics for the Best Value Principles to Be Used in Saudi Arabia Arranged in Descending Order (Universities' Representatives Sample N = 43)

Item code	Best Value Principles	Frequency %			mean	SD	FI*	Order
		Disagree (1)	Don't know (5)	Agree (10)				
B2	Would you support improvements to the current procurement system that selects contractors based on performance with price?	0.0	0.0	100.0	10.00	0.00	100.00	1
B3	I would you be interested in learning more about a new procurement model that may improve the current procurement system by identifying and utilizing expertise.	0.0	4.7	95.3	9.77	1.07	97.70	2
B1	Do you think selecting contractors based on performance with price would be more optimal?	0.0	9.3	90.7	9.53	1.47	95.30	3

(*) mean percentage out of the maximum weight (10)

Table 44 sketches the descriptive statistics for the new (proposed) procurement system for Saudi Arabia. The results show that item C5 (During the clarification period, would requiring the selected contractor to provide a project plan from beginning to end, including scope of work, technical and milestone schedule, major risks that fall outside of that scope before they receive a contract, and how they will measure their performance, improve the procurement process?) was ranked first in order because it recorded the greatest FI (97.70), whereas item C7 (Would it be beneficial if the government documented all performances on projects and posted a performance for all contractors to compare?) was ranked last in order because it recorded the minimum FI (87.40). All other values range between these two values and suggest the universities' representatives have a high opinion of the proposed procurement system.

Table 44

Descriptive Statistics for the New (Proposed) Procurement System for Saudi Arabia Arranged in Descending Order (Universities' Representatives Sample N = 43)

Item code	New Proposed Procurement System	Frequency %			mean	SD	FI*	Order
		Disagree (1)	Don't know (5)	Agree (10)				
C5	During the clarification period, would requiring the selected contractor to provide a project plan from beginning to end, including scope of work, technical and milestone schedule, major risks that fall outside of that scope before they receive a contract, and how they will measure their performance, improve the procurement process?	0.0	4.7	95.3	9.77	1.07	97.70	1
C6	During the execution of a project, would project performance increase if contractors measured their performance (time, cost, quality) weekly and submitted this to the client?	4.7	0.0	95.3	9.58	1.92	95.80	2
C8	Would these new procurement process improvements help to identify expertise and utilize it to improve the overall performance on projects?	4.7	0.0	95.3	9.58	1.92	95.80	2
C3	In addition to only evaluating price, would asking contractors to propose ways they can add value to a project in their proposal improve the procurement process?	4.7	4.7	90.7	9.40	1.97	94.00	4
C1	In addition to only evaluating price, would requiring contractors to submit verifiable performance information improve the procurement process?	0.0	16.3	83.7	9.19	1.87	91.90	5
C4	During the clarification period, would interviewing the selected contractor's project manager performing the work improve the procurement process?	0.0	16.3	83.7	9.19	1.87	91.90	5
C2	In addition to only evaluating price, would requiring contractors to submit potential risks they foresee on the project and state how they would mitigate and manage them improve the procurement process?	4.7	11.6	83.7	9.00	2.41	90.00	7
C7	Would it be beneficial if the government documented all performance on projects and posted the performance for all contractors to compare?	14.0	0.0	86.0	8.74	3.16	87.40	8

(*) mean percentage out of the maximum weight (10)

The contractors and universities representatives' sample. Table 45 outlines the descriptive statistics for the current procurement system in Saudi Arabia. The results show that item A1 (I have high satisfaction with the current procurement system) was ranked first in order because it recorded the greatest FI (37.5), whereas item A2 (Do you

think selecting contractors solely based on price is the optimal practice for procuring services?) was ranked last in order because it recorded the minimum FI (18.40). These values suggest both the classified contractors and universities' representatives have a low opinion concerning the current procurement system.

Table 45

Descriptive Statistics for the Current Procurement System in Saudi Arabia Arranged in Descending Order (Sample N = 804)

Item code	Current Procurement System	Frequency %			Mean	SD	FI*	Order
		Disagree (1)	Don't know (5)	Agree (10)				
A1	I have high satisfaction with the current procurement system	46.6	41.0	12.3	3.75	3.00	37.50	1
A2	Do you think selecting contractors solely based on price is the optimal practice for procuring services?	84.3	11.4	4.2	1.84	2.14	18.40	2

(*) mean percentage out of the maximum weight (10)

Table 46 outlines the descriptive statistics for the best value principles to be used in Saudi Arabia. The results show that item B3 (I would you be interested in learning more about a new procurement model that may improve the current procurement system by identifying and utilizing expertise) was ranked first in order because it recorded the greatest FI (94.50), whereas item B2 (Would you support improvements to the current procurement system that selects contractors based on performance with price?) was ranked last in order because it recorded the minimum FI (91.20). These results suggest that both classified contractors and universities' representatives have a high opinion regarding BV PIPS.

Table 46

Descriptive Statistics for the Best Value Principles to Be Used in Saudi Arabia Arranged in Descending Order (Sample N = 804)

Item code	Best Value Principles	Frequency %			Mean	SD	FI*	Order
		Disagree (1)	Don't know (5)	Agree (10)				
B3	I would you be interested in learning more about a new procurement model that may improve the current procurement system by identifying and utilizing expertise.	1.7	7.8	90.4	9.45	1.75	94.50	1
B1	Do you think selecting contractors based on performance with price would be more optimal?	4.9	6.0	89.2	9.26	2.21	92.60	2
B2	Would you support improvements to the current procurement system that select contractors based on performance with price?	6.8	5.2	87.9	9.12	2.47	91.20	3

(*) mean percentage out of the maximum weight (10)

Table 47 summarizes the descriptive statistics for the new (proposed) procurement system for Saudi Arabia. The results show that item C7 (Would it be beneficial if the government documented all performance on projects and posted the performance for all contractors to compare?) was ranked first in order because it recorded the greatest FI (93.90), whereas item C4 (During the clarification period, would interviewing the selected contractor's project manager performing the work improve the procurement process?) was ranked last in order because it recorded the minimum FI (88.50). All other values ranged between these two values, which suggest that both classified contractors and universities' representatives have a high opinion of the proposed procurement system.

Table 47

Descriptive Statistics for the New (Proposed) Procurement System for Saudi Arabia

Arranged in Descending Order (Sample N = 804)

Item code	New Proposed Procurement System	Frequency %			Mean	SD	FI*	Order
		Disagree (1)	Don't know (5)	Agree (10)				
C7	Would it be beneficial if the government documented all performance on projects and posted the performance for all contractors to compare?	3.4	6.1	90.5	9.39	1.97	93.90	1
C8	Would these new procurement process improvements help to identify expertise and utilize it to improve the overall performance on projects?	3.6	10.3	86.1	9.16	2.19	91.60	2
C6	During the execution of a project, would project performance increase if contractors measured their performance (time, cost, quality) weekly and submitted to the client?	3.6	11.9	84.5	9.08	2.25	90.80	3
C3	In addition to only evaluating price, would asking contractors to propose ways they can add value to a project in their proposal improve the procurement process?	7.1	6.3	86.6	9.05	2.53	90.50	4
C5	During the clarification period, would requiring the selected contractor to provide a project plan from beginning to end, including scope of work, technical and milestone schedule, major risks that fall outside of that scope before they receive a contract, and how they will measure their performance, improve the procurement process?	5.2	10.3	84.5	9.01	2.42	90.10	5
C1	In addition to only evaluating price, would requiring contractors to submit verifiable performance information improve the procurement process?	6.0	10.3	83.7	8.95	2.51	89.50	6
C2	In addition to only evaluating price, would requiring contractors to submit potential risks they foresee on the project and state how they will mitigate and manage them improve the procurement process?	5.3	11.4	83.2	8.95	2.47	89.50	6
C4	During the clarification period, would interviewing the selected contractor's project manager performing the work improve the procurement process?	8.6	7.6	83.8	8.85	2.74	88.50	8

(*) mean percentage out of the maximum weight (10)

CHAPTER 6

ANALYSIS & RESULTS

Causes of Delay Factors

The previous study found 27 important factors that delayed public projects in Saudi Arabia. An interview was conducted with owners of the university, and that interview revealed 27 delay factors that delayed projects at the university. Thses 27 delay factors rated via survey which included 761 classified contractors and 43 universities' representatives. When the university delay factors were compared with important delay factors in Saudi Arabia and top 10 rated by survey, it was found that 14 most common delay factors, as shown in Figure 9. The 14 delay factors can be solved via BV PIPS. This analysis shows that BV PIPS can deal with these delay factors, as shown in Table 48.

Figure 9

Comparison of The University's Delay Factors with Most Important Delay Factors in Literature Review and The Survey

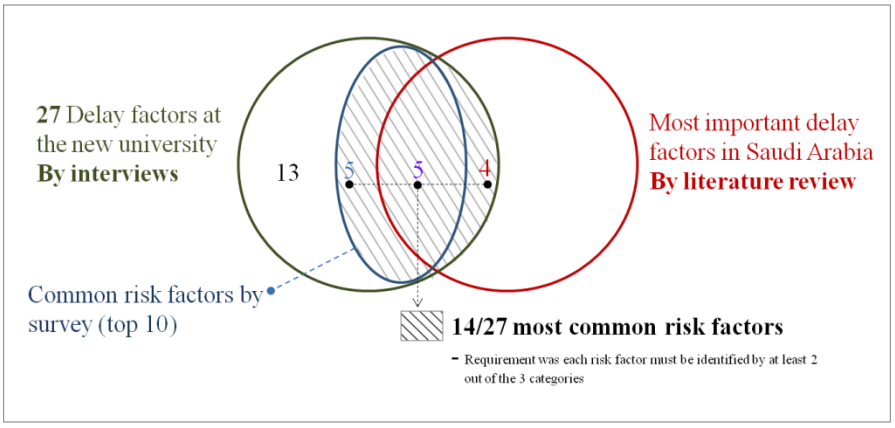


Table 48

How BV PIPS Can Solve Important Delay Factors in Saudi Arabia

Important Risk Factor	**Rating Average by survey sample n = 804**	**Important in previous studies**	**(PIPS) Where Risk is Addressed**	**Justification**
1- Delay in Progress Payments to Contractors	9.52	√	BV ,S, C, and E	Creating BV environment, risk assessment
2- Bidding System (Low Price)	8.93	√	BV , P-Q, S, C, and E	PIPS based on performance
3- Lack of Project Budget	8.62		BV and C	Creating BV environment
4- Delayed Payment to Laborers	8.55		C	risk assessment
5- Concurrent Projects	8.52		S, C, and E	Level of experience, interview, risk assessment
6-Owner's Late Design Document Review and Approval	8.45	√	BV ,and C	Creating best value (BV) environment.
7- Poor Consultant Performance	8.30		BV ,S, and C	Experience of vender mitigate that factor
8- Manpower Shortage	8.23	√	BV , P-Q, C, and E	Risk assessment,
9- Contactor Lacked Project Management Skills	8.20		S, C, and E	Level of experience, interview, risk assessment.
10- Poor Contractor Performance	8.18	√	P-Q, S, C, and E	Level of experience, interview, risk assessment.
11- Lack experience of contractors	6.99	√	BV , P-Q, S, C, and E	Level of experience, interview, risk assessment.
12- Inadequate Contractor Qualifications	7.01	√	BV , P-Q, S, and C	Qualification vender, level of experience.
13- Material delivery	5.97	√	S, C, and E	Risk assessment, show plan B
14- Lack of consultancy employees	6.26	√	BV ,S, and C	Experience of vender mitigate that factor
Key : BV: Best Value environment **P-Q:** Pre-qualification. **S**: selection. **C**: clarification. **E**: execution.				

Best Value depends on penalty principles related to common sense. Best Value decreases management, decision-making, and control by utilizing expertise and increasing transparency. These principles assist owners in utilizing expert opinion to increase the approval rate of design documents. When an organization increases transparency and decreases control, the organization's progress increases, which solves many factors related to owner. Bidding system in Saudi Arabia based on lowest price.

This can be solved by changing the bidding system to BV PIPS, which uses many phases to select the highest-performing vendor who is the best value. BV PIPS is a procurement system that relies on performance to find the best value vendor, contrary to the current bid system in Saudi Arabia that relies on lowest price. The pre-qualification phase that informs vendors about Best Value and shows them that BV PIPS relies on performance and how they must check their level of performance through numbers and matrices. The selection phase has many filters that determine the level of vendor experience. Also in this filter, vendors should submit risk-assessment documents which include delay factors that show the vendors' capability to see risks that could affect projects and how the vendor can mitigate risks. Expert vendors can see this problem and provide a plan B if necessary. Moreover, the interview with the people who will do the work—or the project manager—will show if vendors have poor performance or lack experience. The interview assists owner to recognize if contractors have clear vision of projects. The clarification phase is considered as important phase. A vendor who has already been selected clarifies their offerings and planning process. The vendor should identify the scope of the work and submit a detailed technical schedule and a milestone schedule. That will show if the vendor can complete the work. BV PIPS helps the owner to find an expert vendor who has a high performance level and can complete works that already prove his or her abilities during the selection phase. So, expert vendors do the work well, which reduces the need for consultancy employees.

Causes of Cost Overrun

According to the survey, it is found that Change Orders, Client's Change of Scope, and Bid Proposal Errors are the most important causes of cost overruns in Saudi Arabia. Conversely, BVA and PIPS display a high level of construction performance with 100% of such projects staying within budget and being completed on time with 0% change orders. PIPS has demonstrated ability to locate expert contractors with the high performance and the lowest price. During the clarification phase, an expert contractor will clarify and consider all risks and change orders that could happen during the execution phase and lead to cost deviation.

Current Procurement System and Proposed Model Using BV PIPS

The survey showed that classified contractors and universities' representatives are unsatisfied with the current (low-bid) procurement system. In addition, it showed contractors and universities' representatives had a high level of agreement over accepting best value principles and selecting contactors based on performance with price. In addition, contractors and universities' representatives agreed about the benefits of submitting LE, RA, and VA documents in the elevation phase. Moreover, in the clarification phase, they agreed on interviewing the PM and submitting the project's scope, technical schedule, milestone schedule, and risk management plan. They also agreed on submitting a WRR and DR during the execution phase and to document them. Figures 10, 11, 12, 13, 14, 15, 16, 17, 18, and 19 outline the survey results of classified contractors and universities' representatives' opinions regarding improving the current procurement system.

Figure 10

The Bar Chart Shows Satisfaction with the Low-Bid System

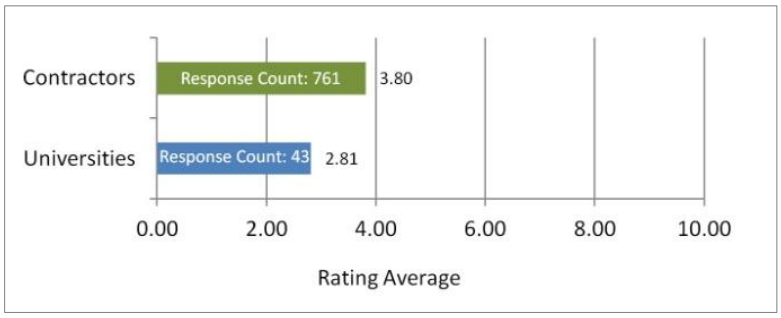


Figure 11

The Bar Chart Shows Agreement over Selecting Contactors Based on Performance with Price

Figure 12

The Bar Chart Shows Agreement over Submitting Level of Experience (LE) Reports

Figure 13

The Bar Chart Shows Agreement over Submitting Risk Assessments (RA) During the Proposal Evaluation Phase

Figure 14

The Bar Chart Shows Agreement over Submitting Value Added (VA) Reports During Proposal Evaluations.

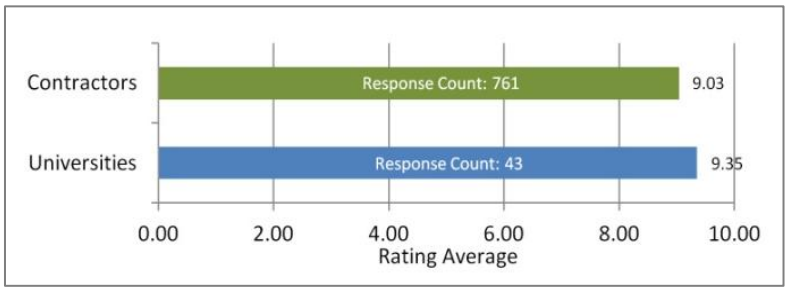


Figure 15

The Bar Chart Shows Agreement over Whether a Project Manager Should Be Interviewed During the Clarification Phase

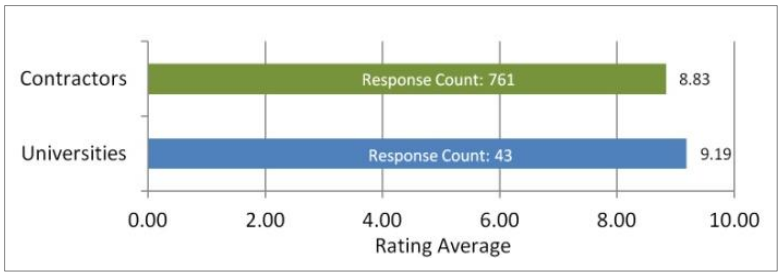


Figure 16

The Bar Chart Shows Agreement over Submitting the Project's Scope, Technical Schedule, Milestone Schedule, and Risk Management Plan During the Clarification Phase

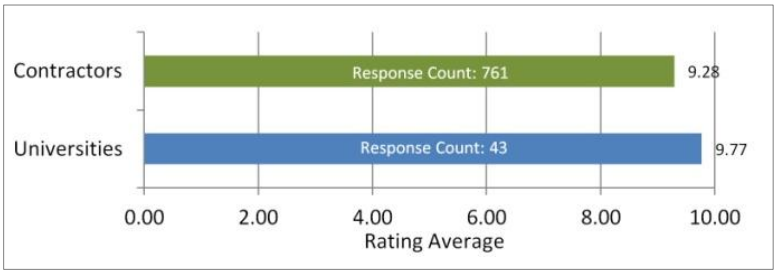


Figure 17

The Bar Chart Shows Agreement over Submitting a Weekly Risk Report (WRR) and Director's Report (DR) During the Execution Phase

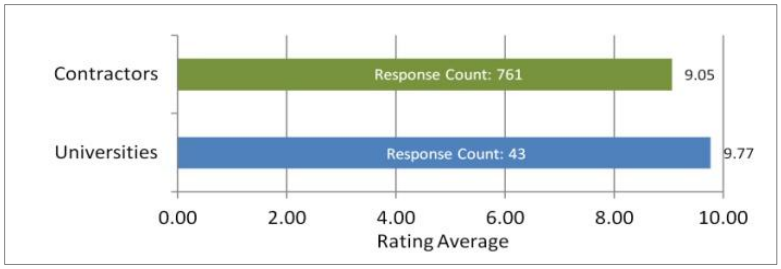


Figure 18

The Bar Chart Shows Agreement over Documenting the Contractor's Performance

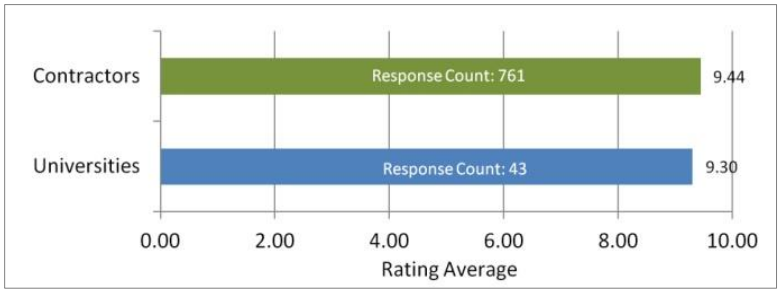
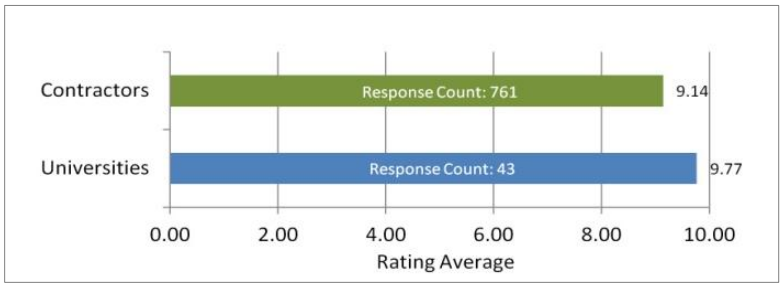


Figure 19

The Bar Chart Shows Agreement over Whether the New Procurement Processes Improve Overall Performance on Projects



The proposed procurement system using BV PIPS in Saudi Arabia utilizes the following process:

- The first phase involves the request for proposal (RFP).
- In the second phase, bids are announced in local newspapers and on Web sites.
- In the third phase, owners receive the proposals and check them to match instructions.
- When the committee and time frame are identified for the opening of sealed bids, the fourth phase is ready for financial analysis and is prioritized by lowest price.
- In the fifth and sixth phase, the committee evaluates the level of experience (LE), risk assessment (RA), and value added (VA) documents—each of the three documents should be two pages, maximum. Bidders with low performance should be eliminated, and the committee should select the lowest bidder price among those contractors who have acceptable performance. Committees should use the numbers 1–10 or percentages to weight the three documents and then review all documents of the selected bidder. If the committee finds anything that conflicts

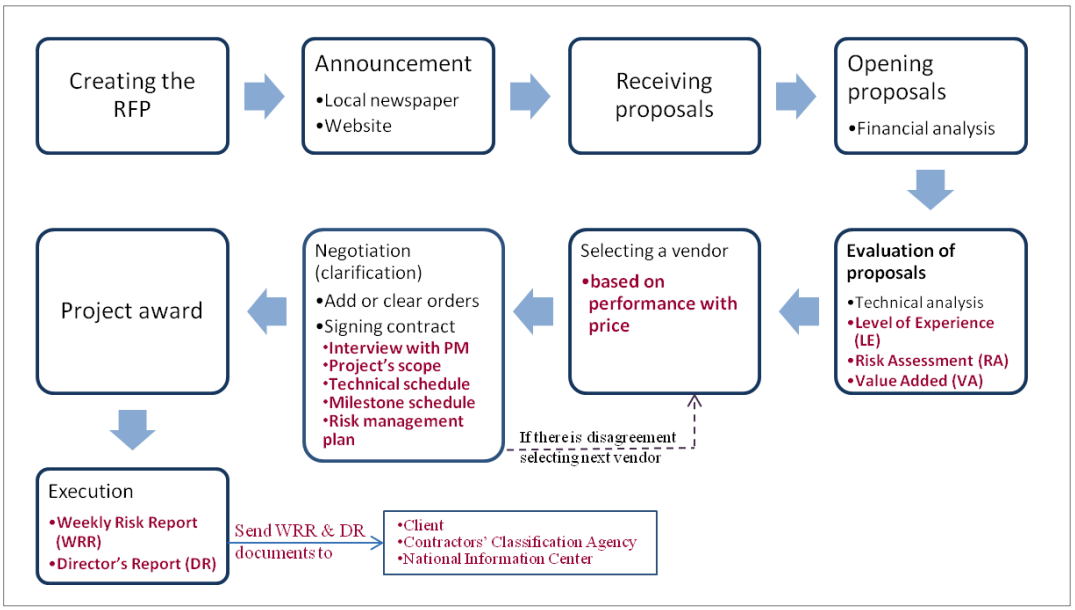
with the LE, RS, or VA documents, the committee should eliminate the bidder and select the next one.

- If accepted, the lowest bidder moves to the negotiation phase with the committee. In the seventh phase, the committee should interview the project manager for 15 minutes about the project to see if the project manager is an expert. Also, the bidder should submit the project's scope, technical schedule, milestone schedule, and risk management plan. Based on these requirements, the committee should be able to see if the bidder is an expert. If the bidder and committee are not able to find common ground, the committee should then select another bidder.
- After signing the contract with the vendor, bidder move to the eighth phase, which is the project awarding procedure.
- In the ninth phase, the vendor moves to the execution phase. Here, the vendor should submit a weekly risk report (WRR) and director's report (DR) to document the contractor's performance to the client, the Contractors' Classification Agency, and the National Information Center. These documents assist in increasing transparency among project parties, which will increase the success of the project.

The summary of the proposed procurement system using VB PIPS is shown in Figure 20.

Figure 20

Proposed Procurement System Using BV PIPS



CHAPTER 7

CONCLUSION

The most common delay factors, which caused delays to projects in Saudi Arabia, can be solved via the application of BV PIPS. Most importantly, delay factors are solved through phases. These phases have many filters that help owners find good vendors based on their performance. These filters prevent delays in the construction of public projects in Saudi Arabia by using only select, high-quality contractors. 14 important delay factors were found by comparing important delay factors that found in a literature review with the identified causes of delay in the the university and survey. The important delay factors are “delay in progress payments to contractors,” “bidding system (low price),” “lack of project budget,” “delayed payment to laborers,” “concurrent projects,” “owner’s late design document review and approval,” “poor consultant performance,” “manpower shortage,” “contactor lacked project management skills,” “poor contractor performance,” “lack experience of contractors,” “inadequate contractor qualifications,” “material delivery,” and “lack of consultancy employees”. One of these significant factors is the low bid system, which was ranked second with a recorded FI of (89.3).

The low-bid method and results lead to significant costs for the Saudi Arabian government because lowest bids do not reflect the actual price of projects. In cases involving a university, total cost overruns totaled $31,355,923 in just four projects, showing what occurs when contracts are awarded on price alone. Paradoxically, when the government wishes to save money by awarding projects to the lowest bidders, these projects end up costing a significant amount of money and experience numerous delays.

Change Orders, Client's Change of Scope, and Bid Proposal Errors are the most important causes of cost overruns in Saudi Arabia. These risk factors were rated via 761 classified contactors and 43 universities representatives. Conversely, BVA and PIPS display a high level of construction performance with 100% of such projects staying within budget and being completed on time with 0% change orders.

Saudi Arabian project performance is negatively affected by the low-bid procurement system. Satisfaction of the current (low-bid) procurement system is poor, as shown by 761 surveyed classified contractors and 43 universities' representatives. Price should not be the only evaluation factor. Contractors and universities' representatives both supported using BV PIPS elements for the procurement process. Level of experience (LE), risk assessment (RA), and value added (VA) documents help owners to assess contractors' performances using dominant metrics. When a contractor moves to the clarification phase, owners should interview the project manager, and contractors should submit the project's scope, technical schedule, milestone schedule, and risk management plan. In this phase, the owner should know if the contractors are experts or not. After the contractor passes the clarification phase, the next phase is execution. Here, contractors should submit a weekly risk report (WRR) and director's report (DR) to document the contractor's performance to evaluate contractors in the future. All these requirements received a high rating on the frequency index, about 89 and above, when 804 classified contractors and universities' representatives were surveyed. This study recommends clients run projects in Saudi Arabia using this proposed BV PIPS procurement system.

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APPENDIX A

CAUSES OF DELAY FACTORS

Client-related causes of delay

1. Owner's interference
2. Owner's personality
3. Negotiation by knowledgeable people
4. Delay in progress payments by owner
5. Late in revising and approving design documents by owner
6. Poor coordination by owner with the various parties during construction
7. Excessive bureaucracy by owner's administration
8. Clarity of scope of change
9. Delay in the settlement of contractor claims by owner
10. Poor coordination by owner and other parties
11. Conflicts between joint-ownership of the project
12. Delay to furnish and deliver the site to contractor by owner
13. Difficulties in obtaining work permits
14. Variations in quantities
15. Suspension of work by owner
16. Delay in approving sample materials by owner
17. Delay in approving shop drawings by owner
18. Uncooperative owner with contractor complicating contract administration
19. Delay in issuance of change orders by owner
20. Owner's failure to coordinate with Government authorities during planning
21. Non-payment of contractor claim
22. Interference by owner in the construction operations
23. Poor communication by owner and other parties
24. Lack of finance to complete the work by client
25. Slow decision making by owner
26. Owner's poor communication with construction parties and government authorities
27. Key personal replaced

Contractor-related causes of delay

28. Rework due to errors during construction
29. Delay in site mobilization
30. Internal company problems
31. Company organization
32. Other work on hold
33. Loose safety rules and regulations within the contractor's organization
34. Ineffective scheduling of project by contractor
35. Cash flow management
36. Improper construction methods implemented by contractor
37. Inefficient quality control by contractor
38. Increased number of projects
39. Increase in contractor's overheads

40. Poor site management and supervision by contractor
41. Delays in sub-contractors' work
42. Delay in the preparation of contractor submissions
43. Improper technical study by contractor during the bidding stage
44. Ineffective planning by contractor
45. Ineffective contractor head office involvement in the project
46. Replacement of key personal
47. Delay of field survey by contractor
48. Conflicts between contractor and other parties (consultant and owner)
49. Conflicts in sub-contractors' schedules in execution of project
50. Contractor's poor coordination with the parties involved in the project
51. Inadequate contractor's work
52. Poor communication by contractor with the parties involved in the project
53. Poor communication by contractor with other parties
54. Poor coordination by contractor with other parties
55. Difficulties in financing project by contractor
56. Ineffective control of the project progress by the contractor
57. Frequent change of sub-contractors because of their inefficient work
58. Frauds
59. Inefficient Work-break down structure
60. Poor qualification of the contractor's technical staff
61. Contractor experience

Consultant-related causes of delay

62. Delay in performing inspection and testing by consultant
63. Delay in approving major changes in the scope of work by consultant
64. Poor coordination between consultant and other parties
65. Poor communication between consultant and other parties
66. Late in reviewing and approving design documents by consultant
67. Inflexibility (rigidity) of consultant
68. Company organization
69. Replacement of key personnel
70. Conflicts between consultant and design engineer
71. Frauds
72. Internal company problems
73. Inadequate experience of consultant

Materials-related causes of delay

74. Delay in materials delivery
75. Late procurement of materials
76. Damage of sorted material while they are needed urgently
77. Changes in materials prices

78. Changes in materials specifications
79. Shortage of materials required
80. Late in selection of finishing materials due to availability of many types in market
81. Shortage of construction materials in market
82. Delay in manufacturing special building materials

Labor-related causes of delay

83. Low productivity level of labor
84. Shortage of contractor's administrative personnel
85. Personal conflicts among labor
86. Nationality of labor
87. Inadequate equipment used for the works
88. Shortage of technical professionals in the contractor's organization
89. Shortage of equipment required
90. Failure of equipment
91. Shortage of supporting and shoring installations for excavations
92. Low productivity and efficiency of equipment
93. Low level of equipment-operator's skill
94. Lack of high-technology mechanical equipment
95. Shortage of manpower (skilled, semi-skilled, unskilled labor)
96. Poor qualification of the contractor's technical staff assigned to the project
97. The required labor skills are not available
98. The required equipment and tools are not available
99. Low skill of manpower

Contract/relationships-related causes of delay

100. Ineffective delay penalties
101. Unavailability of incentives for contractor for finishing ahead of schedule
102. The objective of the project is not well defined
103. Legal disputes between various parties
104. The scope of work is not well defined
105. Type of construction contract
106. Conflict between contract documents
107. Type of project bidding and award (negotiation, lowest bidder)
108. Inadequate definition of substantial completion
109. Lack of communications between the parties
110. Original contract duration is too short
111. Inappropriate overall organization structure linking all parties to the project
112. Major disputes and negotiations

Others

113. Quality management system and assurance control
114. The consultant attempting to hide their mistake when the quantity amount changes
115. Insufficient allowance for employees' holidays in the schedule
116. Inadequate original contract duration
117. Lack of clarity of drawings and specifications
118. Client need to analyze the causes of change
119. The lack of experienced engineers engaged by consultants for high-tech work
120. Insufficient numbers of contractors to build the increasing number of construction projects in Saudi Arabia
121. Insufficient consideration of the behavior of people
122. Lack of regular meetings
123. Unclear scope of work to be done by staff contractors
124. High turn-over of personnel in Saudi Arabia
125. Insufficient study of all the details and capacity of the contractor before selection by client
126. Overdependence on the lowest tender amount in contractor selection
127. Discrepancies between bill of quantities, specifications and drawings
128. Level of salary of consultant staff
129. Lack of ethics
130. Delayed salary payments to staff
131. Designer engineer selection of special building materials not available in the local market.

APPENDIX B

SURVEY

Part 1 Instructions: Please rate project delay causes in Saudi Arabian universities, with 1 meaning "not common," 5 meaning "don't know," and 10 meaning "common." Please only use one of these three choices for each question.

Criteria	**Rating (1, 5, or 10)**
Bidding System (Low Price)	
Poor Contractor Performance	
Lack of Experienced Contractors	
Manpower Shortage	
Inadequate Contractor Qualifications	
Material Delivery	
Owner's Late Design Document Review and Approval	
Delay in Progress Payments to Contractors	
Lack of Consultancy Employees	
Lack of Vision	
Design Requirements Do Not Reflect Reality	
Owner Controlled Designer	
Lack of Project Budget	
Owner's Wrong Decision Making	
Owner Did Not Follow Solidarity Conditions	
Inadequate Project Management Department	
Changing Consultant During Implementation	
Conflict among Company Partners	
Contractor Did Not Study Proposal	
Contactor Lacked Project Management Skills	
Contractor Ability	
Concurrent Projects	
Delayed Payment to Laborers	
Poor Consultant Performance	
Consultant Delayed Project to Extend His or Her Contract with Owner	
Unclear Procurement System	
New Worker Regulations	

Part 2 Instructions: please rate the causes of cost overruns to projects in Saudi Arabian universities, with 1 meaning "not common," 5 meaning "don't know," and 10 meaning "common." Please only use one of these three choices for each question.

Criteria	**Rating (1-5 or 10)**
Client's Change of Scope	
Unforeseen risks	
Change Orders	
Bid Proposal Errors	
Contractor's Errors	
Consultant's Errors	
Dividing Bids into Several Parts	

Part 3 Instructions: please fill in the survey below by providing a rating per question. 1 means you "disagree," 5 means you "don't know," and 10 means you "agree." Please only use one of these three choices for each question.

No	Questions	Rating (1-5 or 10)
	Current Procurement System	
1	I have high satisfaction with the current procurement system	
2	Do you think selecting contractors solely based on price is the optimal practice for procuring services?	
	Best Value Principles	
1	Do you think selecting contractors based on performance with price would be better?	
2	Would you support improvements to the current procurement system that selects contractors based on performance with price?	
3	I would you be interested in learning more about a new procurement model that may improve the current procurement system by identifying and utilizing expertise.	
	New Proposed Procurement System Improvements	
1	In addition to evaluating price, would requiring contractors to submit verifiable performance information improve the procurement process?	
2	In addition to evaluating price, would requiring contractors to submit potential risks they foresee on the project and how they will mitigate and manage them improve the procurement process?	
3	In addition to evaluating price, would requiring contractors to propose ways they can add value to a project in their proposal improve the procurement process?	
4	During the clarification period, would interviewing the selected contractor's project manager performing the work improve the procurement process?	
5	During the clarification period, would requiring the selected contractor to provide a project plan from beginning to end, including scope of work, technical and milestone schedule, major risks that fall outside of that scope before they receive a contract, and how they will measure their performance, improve the procurement process?	
6	During the execution of a project, would project performance increase if contractors measured their performance (time, cost, quality) weekly and submitted to clients?	
7	Would it be beneficial if the government documented all performance on projects and posted the performance for all contractors to compare?	
8	Would these new procurement processes improvements help to identify expertise and use it to improve overall performance on projects?	