Ashmawi et al., *Cogent Engineering* (2018), 5: 1490148
https://doi.org/10.1080/23311916.2018.1490148

cogent engineering

CIVIL ENGINEERING | RESEARCH ARTICLE

Risk assessment and allocation in the contract for public works used in Saudi Arabia construction industry

Khaled Ashmawi[1], Laith A Hadidi[1]*, Sadi Assaf[1], Firas M Tuffaha[1] and Khalaf Al-Ofi[1]

Received: 10 February 2018
Accepted: 08 June 2018
First Published: 22 June 2018

*Corresponding author: Laith A Hadidi, Construction engineering and management department, King Fahd University of Petroleum and Minerals, Dhahran 31261, Saudi Arabia
E-mail: lhadidi@kfupm.edu.sa

Reviewing editor:
Mohammad Hamasha, Prince Sultan University, Saudi Arabia

Additional information is available at the end of the article

Abstract: This article aims to propose a new model to assess the Saudi public contract for risk sharing through the investigation of the perceptions and proposals of owners and contractors in Saudi Arabia on the statement of the clauses of the contract. The data collection tool used is a survey questionnaire comprising 70 items that refer to each clause of the Unified Contract for Public Works (UCPW) in Saudi Arabia. A sample size of 42 was determined using Kish's formula (20 contractors and 22 owners) and a total number of 46 responses had been received. The results revealed that, in general, respondents did not believe that risk sharing exist in the Saudi UCPW. Moreover, 11 new areas of disagreement emerged from the proposals of the respondents. Using the Chi-square test, the data was tested for dependency on respondent's type, and it was found that the number of risks allocated to each party is independent from the type of respondent.

Subjects: Engineering Management; Construction Management; Construction Business Management

Keywords: risk assessment; public contract; Saudi Arabia; construction contracts; risk sharing

1. Introduction

Risk sharing and allocation is, as the term implies, the distribution of risks among the different involved parties (owners and contractors). The laws that govern construction contracts, distribute risks by default among the involved parties. Whatever the accuracy or the percentage of risk that is allocated by the legal system, risk might be reallocated or shared upon agreements between the owner, the designer and the contractor, i.e. to reallocate risk in a better distribution (Fisk & Reynolds, 2010).

The fact that the construction industry is surrounded by risk and uncertainty is undeniable as the construction process itself is unique and is influenced by a large number of internal and external factors. As risk exists in every project and it cannot be escaped, it can be managed which includes

ABOUT THE AUTHOR

The authors are affiliated with the construction engineering and management department in King Fahd University of Petroleum and Minerals in Saudi Arabia. Their research approaches many topics related to construction and engineering management in Saudi Arabia including, but not limited to: Project management, quality management, energy and environment.

PUBLIC INTEREST STATEMENT

The article defines 70 risks related to construction projects extracted from the unified contracts public work (UCPW). The contract is studied to define the liability of each risk weather is it on the contractor, owner or shared by both. The feedback of construction practitioners is collected about risks liability and how it should be placed as a proposal for the UCPW. It is found that contractors should be wavered on some risks liability that should be either on owner or shared or undecided.

the agreement on risks sharing between owners and contractors (Kangari, 1995). Owners and contractors seek management of their risks through either risk acceptance, transference, mitigation or avoidance (no contract). Some risks can be transferred entirely or partially through insurance premiums. Some other risks can be mitigated by alleviating the frequency and the severity of that risk (Assaf, 1982). Alternatively, risks may also be shared or allocated as mentioned in the work of Charoenngam and Yeh (1999) and Fisk and Reynolds (2010). According to Charoenngam and Yeh (1999): "Risks should be allocated to the party best able to control them, and if they are beyond both parties control, they should be assigned to the owner". Charoenngam and Yeh (1999) stated that there might be risks that cannot be allocated to a single participant where risks should be carried by both involved parties. Successful risks allocation results in a better work and bidding environment which is reflected in prices of bids. Failing to share the risk will demonstrate adverse relationship between the employer (owner) and the contractor. In fact, improper allocation usually results in an increased bid pricing, conflicts and litigations. Proper inevitable risks sharing for the contract clauses/terms plays a key role in accepting/rejecting the contract. Any contract clause or term should be carefully analysed against risks and distributed reasonably over all parties (mainly the owner and the contractor). The issue of determining the best risk sharing in construction contracts has recently gained publicity among researchers. In a study in the United Arab of Emirates (UAE), El-Sayegh (2008) included a questionnaire that is answered by experts in the field of construction in the UAE. One of the questions asked in the questionnaire is related to the proper allocation of risks. It was found that most risks are allocated to the contractor and only two risks are directly allocated to the owner. It was found that owners in the UAE tend to transfer most of the risk to the contractors and do not have the incentive of risk sharing.

The allocation of risks usually takes place in the general conditions of the contract. Contract conditions represent the provisions that regulate the relationship between the contracting parties and allocates responsibilities among them. Thus, the principle in risk allocation is to transfer each risk to the party that can handle it best, and that has the best means to deal with this risk. In all parts in the world, there are different forms of construction contracts such as the International Federation of Consulting Engineers contracts (FIDIC), the Engineers Joint Contracts Document Committee (EJCDC, 2015) contracts, the American Institute of Architects contract (AIA) and the Royal Institute of Charted Surveyors (RICS) contracts in the UK. Saudi Arabia is no exception to have a general governmental contract template named as the Unified Contract for Public Works (UCPW). The Saudi construction sector is one of the largest economy sectors after oil and petrochemicals. The Saudi construction industry has been growing rapidly over the last few decades and regardless of the recent downturn in the oil prices, there is still an evident need for construction. "The Saudi government has always been actively concerned with growing the Saudi infrastructure. Indications show that this concern will remain at the forefront of Saudi decision making" (Husein, 2014). A total amount of USD 7.44 billion worth of contracts has been awarded in the first quarter of 2016, followed by a USD 5.41 billion in the second quarter (NCB, 2016a, 2016b). Most of which are governmental projects awarded to big local contractors.

In this article, we investigate the Saudi UCPW clauses to assess the level of risk sharing among all involved parties. Managing risk usually goes through a systematic process including risk assessment and decision making tree. However, for the scope of this research, the emphasis is on risk sharing through contract clauses and its dimensions. Therefore, discussion here is limited to the concept of risk sharing and contract conditions. The research hypothesis addresses the following question: Does the Saudi UCPW allocate risks properly.

1.1. Risk sharing in construction

According to Kalin, Weygant, Rosen, and Regener (2010), contract conditions come in two types, namely: General, or supplementary contract conditions. The general conditions mainly state the rights and define the relationships of the contracting parties as the owner and the contractor. However, the general conditions are not limited to the owner and the contractor. They may also

include parties such as subcontractors and consultants, but any other parties are only mentioned as needed (Kalin et al., 2010). The general conditions are of importance because they define relationships between contracting parties, their responsibilities and rights (Bubshait & Almohawis, 1994). The supplementary conditions on the other hand, as the name implies, supplement the general conditions with items that apply exclusively for the project. The supplementary conditions may contain very similar items that are already included in the general conditions or even duplicate the titles of these items, but they may include different implementation or add specific requirements that apply for this unique project (Fisk & Reynolds, 2010). Chui and Bai (2010) analysed the general conditions of construction contracts commonly used in the United States (AIA-A201) and China (GF-1999-0201) have been analysed and compared. The findings of this research reveal that the content of subclauses in AIA-A201 and GF-1999-0201 is different in several ways which will affect the risk sharing liability between the owner and contractor. El-Sayegh and Mansour (2015) analysed risk sharing in highway construction projects through identifying 33 risk factors and found that the most significant risks include inefficient planning, unexpected ground utilities, quality and integrity of design, delays in approvals and delays in expropriations. Cargo material handling may impose certain risks and should be taking care at the contract provision (Hadidi & Alkhaldi, 2016; Pratap, Kumar, Cheikhrouhou, & Tiwari, 2015). Liu, Zhao, and Yan (2016) explored the risk paths in the international construction projects performed by Chinese contractors, and examined the risk effects on the objectives of these projects. Liu et al. (2016) identified a total of 60 risks from literature review and conducted industry survey with 104 professionals from Chinese international contractors.

Kalin et al. (2010) pointed out that modifying the general conditions of a contract to solely suit a specific project, forming the set of supplementary conditions, is necessary for the owner. General guidelines for risk sharing have also been addressed by the work of Fisk and Reynolds (2010). First, the party that carries and manages a certain risk properly should be rewarded (compensated). Second, risk must be allocated to the party with the best means to handle it. Third, risk is allocated to the party with the most efficient system is favourable. Fourth, risk is allocated to the party with the ability to undertake it financially. Lastly, risk allocation must be done through steps that assures that risk is allocated as intended. In another study, Al Sabah (2014) investigated the relationship between construction risks and project success in the Arabian Gulf region. The objective of the study was to identify, assess and classify the influence of pure risks on project performance. The work of Al Sabah (2014) was focused on 122 multinational firms working in the Arabian Gulf region and a total of 74 risks were under consideration. The results found that 30 risks, 18 internal risks and 12 external risks, were found to have significance on project performance.

1.2. Unified contract for public works (UCPW) in Saudi Arabia

Public construction projects in Saudi Arabia are governed by the Unified Contract for Public Works (UCPW) issued by the Ministry of Finance (MOF). The formulation of the UCPW is derived from the FIDIC contract, and the latest revision of the Saudi contract was in 2013. Nevertheless, the contract in its current format is still preliminary and needs a major review as per the words of the authors (UCPW, 2011). Stemming from this fact and given the status of the industry and the immaturity of the Saudi public contract, there is an evident need to conduct a research to investigate the Saudi contract for possible areas of improvement. The issue of risk sharing and allocation in Saudi Arabia has also been the subject of many researchers in the last two decades. However, these studies were not focused on the UCPW and rather looked at the subject of risk sharing and allocation in the industry in general. For example, Al-Barghouthi (1994) studied liability sharing in both, design and construction contracts, and he found that there were many disagreed upon clauses. Al-Barghouthi (1994) also found that owners in Saudi Arabia use exculpatory language to escape responsibility or shift it to the other party; additionally, clauses that grants the contractor important rights were missing, such as: Compensation for loss of opportunity and progress payment guaranteed bonds.

Al Salman (2004) looked at risk sharing in the Saudi construction industry and took the opinions of contractors and owners on 25 risk categories. He found that the perceived allocation of risk differs from what is really practiced, where contractors bear most of the risks. The most important risk was found to be the quality of work and the least important was adverse weather conditions. Al Salman (2004) also found that contractors favour risk sharing because some risks are beyond their control and to compensate for the high competition when the market is slow. Khaliluddin (2010) took the same approach of Al Salman but considered 36 risks. Khaliluddin (2010) findings matched Al Salman (2004), except for the least significant risk, which turned out to be bribes and corruption.

2. Research methods

The first step of this research was to conduct a comprehensive literature about potential risks in contract handling. Then, a semi-structured interviews and workshops were conducted with construction experts in Saudi Arabia to revise the gathered risks and to compare them with the articles of the Unified Contract for Public Works (UCPW). The research team extracted the necessary clauses out of the UCPW. This helped the team to build the research instrument which is a questionnaire composing two parts. First part aims to collect data about the respondents and their firms. The second part listed 70 types of risks related to the UCPW articles. To fill the second part, the respondent will evaluate each risk type twice. At first, respondent will evaluate (from his perception) who currently holds the risk liability (owner (O), contractor (C) or shared (S)). Second, respondent will evaluate (propose) the same risk who should carry this risk liability (owner, contractor or consultant). This type of data collection enables to perform the gap analysis between how is each risk shared and how should it be.

The respondent has to allocate each risk to the most suitable bearer/bearers twice. The first time allocates the risks based on perception. The second time the respondent proposes a better allocation of these risks to their most efficient bearer. The data required to complete this research was collected through the survey questionnaire.

The respondents are construction experts in the Saudi Markets which carefully selected based on their job titles and the number of years of construction practice. In the conducted survey, respondents had various job titles based on the organisation they work in. However, most of the surveyed respondents had job titles referring to Tendering Manager, Contracts Administrator or Procurement Manager. Table 1 shows job title frequencies for each group. Most of the respondents had more than 20 years of experience or more. Few respondents had less than 10 years of experience as shown in Tables 1 and 2.

The research team carefully reviewed the respondents' feedback who were asked to cover all questions thoroughly. A total of 48 responses were collected comprising 24 owner representatives and 24 contractors. The next step is to verify the sufficiency of the sample size. This was verified using the Kish formula. The independence between two categories is tested based on the Chi-square test. Section 3 shows the details of the population and sample size. It also shows the

Table 1. Job titles by type of respondent

Job Title	Owner	Contractor	Total
Tendering Manager	9%	11%	20%
Contracts Administrator	22%	15%	37%
Procurement Manager	4%	9%	13%
Project/Construction Manager	0%	4%	4%
Other	13%	13%	26%
Total	48%	52%	100%

Table 2. Years of experience

Years	Owner	Contractor	Total
20 or more	17%	26%	43%
15 to 20	9%	9%	17%
10 to 15	13%	15%	28%
5 to 10	7%	2%	9%
5 or less	2%	0%	2%
Total	48%	52%	100%

independence between the two categories (owners and contractors). The last step in this research is to find the risk allocation for the 70 types of risks. The recommended allocation is for the party that gets more than 50% of the votes for each risk. If a risk did not have a party with more than 50% of the votes, it is labelled "undecided". Each risk is studied how it is currently perceived by the respondents as the current format of the UCPW. Then compare it how it should be allocated. Figure 1 summarise the research methodology.

3. Data statistical analysis

The study targeted public projects owners (or their representatives) and contractors working under the UCPW contract. The population of contractors was determined using the Saudi Ministry of

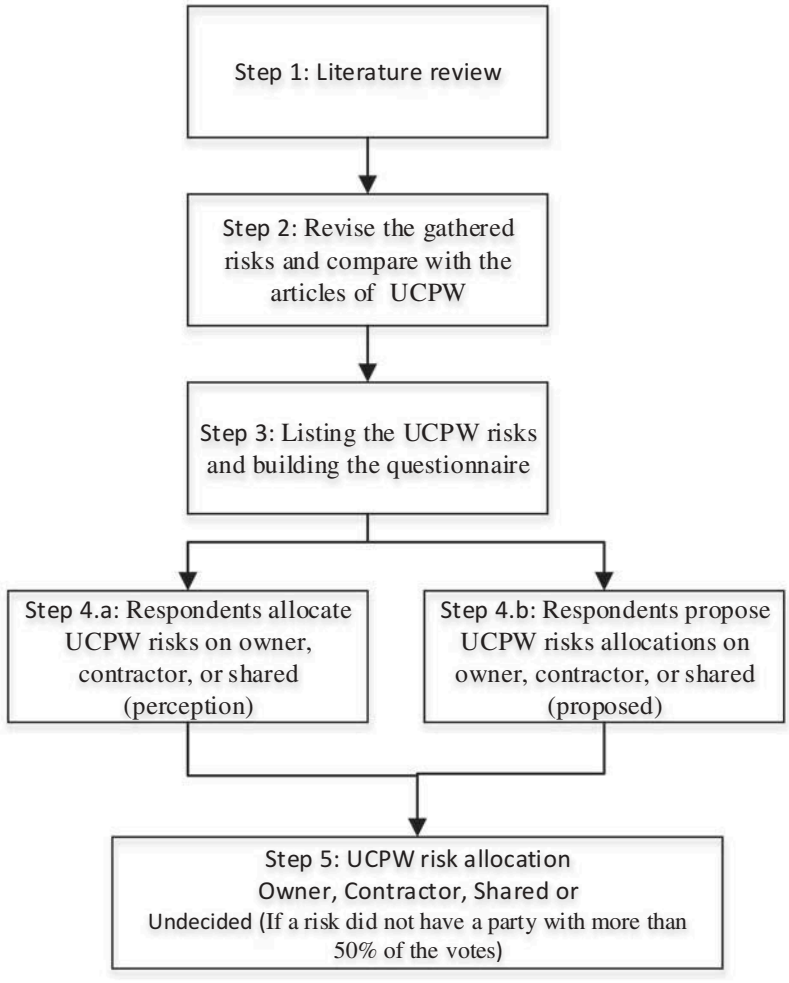

Figure 1. Research methodology.

Municipal and Rural Affairs (MOMRA) classification to be class 1, class 2 and class 3 contractors based in the Eastern Province of Saudi Arabia and their total was 93 contractors. The population of owners was determined to be all public owners or their representatives (consultants or engineers) in the Eastern Province of Saudi Arabia. Based on the Saudi Council of Engineers (SCE) classification the total number of public owners is 155. The minimum effective sample size for each population is calculated using Kish's formula shown in Equations 1 and 2. Substituting 0.5 for p, q becomes 0.5. And substituting 0.1 for SEM gives a value of 25 as the first estimate of the sample size (n_0). We found the sample size to be 22 owners and 20 contractors.

Equation 1: Initial Estimate of the Sample Size

$$n_0 = \frac{pq}{SEM^2} \tag{1}$$

Equation 2: Final Estimate of the Sample

$$n = \frac{n_0}{1 + \frac{n_0}{N}} \tag{2}$$

Where:

n_0 = *the first estimate of the sample size*

P = *the proportion of the characteristics being measured*

$q = 1 - p$

n = *the final estimate of the sample size*

N = *the target population size*

SEM = *the maximum percentage of the standards error allowed for the sample mean.*

Substituting 0.5 for p, q becomes 0.5. And substituting 0.1 for SEM gives a value of 25 as the first estimate of the sample size (n_0). Plugging this number into the second equation and substituting the population (N) of the owners, contractors and consultants, we find the sample size for contractors to be 20 and for consultants to be 22.

The Chi-square test is used to determine if the responses (allocation of risks) is dependent on the type of the respondent or not. The Chi-square test of independence assumes two hypotheses as follows:

- H_o: The two categorical variables are independent
- H_a: The two categorical variables are related.

Using contingency tables, another table of observed and expected values is generated and used to calculate a value called "Chi-Square". The formulas that govern the calculations of the expected values and the Chi-square are shown in Equations 5 and 6, respectively. Then, using the degrees of freedom (Equation 7) and the significance level, the obtained Chi-square value is compared to the respective value in the Chi-square distribution table. If the obtained value from the data is larger than the tabulated value, the null hypothesis is rejected and the alternative hypothesis is assumed to be true.

Equation 5: Expected Value

$$E_{i,j} = \frac{\sum_{k-1} O_{i,j} \sum_{k-1} O_{k,j}}{N} \tag{5}$$

Where:

$E_{i,j} = Expected\ Value$

$\sum_{k-1} O_{i,j} == Sum\ of\ the\ ith\ column$

$\sum_{k-1} O_{k,j} = Sum\ of\ the\ kth\ column$

$N = Total\ Number$

Equation 6: Chi-Square

$$x^2 = \sum_{i-1}\sum_{j-1} \frac{(O_{i,j-}E_{i,j})^2}{E_{i,j}} \quad (6)$$

Where:

$x^2 = Chai\ square\ test\ if\ independence$

$O_{i,j} = Obsereved\ value\ of\ the\ two\ nominal\ variables$

$E_{i,j} = Expected\ value\ of\ the\ two\ nominal\ variables$

Equation 7: Degrees of Freedom Formula

$$DF = (r-1)(c-1) \quad (7)$$

Where:

$DF = Degrees\ of\ Freedom$

r = number of rows

c = number of columns

Using the resulting data from the survey, contingency tables for the number of risks allocated to each party has been obtained and used to generate the expected value tables as illustrated through Tables 3-6. The expected value tables have been used then to calculate the Chi-square value and was found to be 2.862 for the perceived allocation and 3.161 for the proposed allocation.

Entering the Chi-square probability table with 3 degrees of freedom and 0.05 significance level, the calculated Chi-square value for both perceived and proposed allocations was found to be less than the table value of 7.815.

The null hypothesis could not be rejected and the amount of risk allocation is said to be statistically independent from the nature of the respondent i.e. owner or contractor.

Table 3. Contingency table for perceived allocation

	Owner	Contractor	Shared	Undecided	Total
Owner	9	50	1	10	70
Contractor	10	55	1	4	70
Total	19	105	2	14	140

Table 4. Contingency table for perceived expected data

Observed	Expected	|O-E|	(O-E)^2	Chi-square/E
9	9.5	0.5	0.25	0.026
50	52.5	2.5	6.25	0.119
1	1	0	0	0.000
10	7	3	9	1.286
10	9.5	0.5	0.25	0.026
55	52.5	2.5	6.25	0.119
1	1	0	0	0.000
4	7	3	9	1.286
Chi-square				2.862

Table 5. Contingency table for proposed allocation

	Owner	Contractor	Shared	Undecided	Total
Owner	10	42	11	7	70
Contractor	13	47	7	3	70
Total	23	89	18	10	140

Table 6. Contingency table for proposed expected allocation

Observed	Expected	|O-E|	(O-E)^2	Chi-square/E
10	11.5	1.5	2.25	0.196
42	44.5	2.5	6.25	0.140
11	9	2	4	0.444
7	5	2	4	0.800
13	11.5	1.5	2.25	0.196
47	44.5	2.5	6.25	0.140
7	9	2	4	0.444
3	5	2	4	0.800
Chi-square				3.161

4. Risk allocation

The approach taken to determine a risk bearer is by taking the opinion of population majority on each risk. Tables 7 and 8 presents the mean, the standard deviation and the variance for the two groups of data, the perceived and the proposed allocations. The mean, and the standard deviation are generated on the basis of number of times a risk has been allocated to each party, using the different responses from each party. The recommended allocation is for the party that gets more than 50% of the votes for each risk. If a risk did not have a party with more than 50% of the votes, it is labelled "undecided". Table 7 shows that the current format of the UCPW is placing more risks

Table 7. Descriptive statistics for perceived allocation

Variable	Mean	Standard Deviation
Owner	19%	25%
Contractor	63%	26%
Shared	18%	11%

Table 8. Descriptive statistics for proposed allocation

Variable	Mean	Standard Deviation
Owner	21%	26%
Contractor	53%	27%
Shared	26%	14%

liability on the contractor (63%) then the owner (19%), and only 18% risk sharing between both parties. However, respondents think that the burden on contractors should be less. Respondents propose as shown in Table 8 the contractors to bear (53%), owners (21%) and sharing only (26%).

The results of risk distribution for the composite perceived and proposed allocations (owners' and contractors' responses together) are presented in Tables 9 and 10. In Table 9, respondents feel that only 9 risks are carried by the owner, and 52 risks are carried by the contractor. Surprisingly, respondents do not see risk sharing in the current format of the UCPW. Nine types of risk are seen undecided (risks with almost equal percentages, i.e. risks with close percentages to 50% but are not exactly 50% are considered undecided upon)

Table11 and Table 12 show the distribution of clauses for owners, contractors and shared.

As mentioned earlier, UCPW clauses were run by both groups of respondents. Each respondent, is given the chance to identify the risk of UCPW clause twice, i.e. current risk bearer, and who should be the bearer (proposed risk allocation). Previous studies, which are reviewed carefully in this research, studied risks in general. That is, the considered risks in these studies were not unique to the UCPW and very little similarity between the two exists. In despite of that, in the following, a comparison is made whenever found possible between the findings of this research and previous researches (Al-Barghouthi, 1994; Al Sabah, 2014; Al Salman, 2004; Khaliluddin, 2010). The behaviour of the owners and the contractors towards these risks is described as well.

Looking at the perception and proposal of owners and contractor, one can easily notice that variations exist between the views of the two parties. For example, owners have the perception that confidentiality of bid details is the only shared risk, and contractors have the perception that quality assurance and control is the only shared risk. Furthermore, compared to owners, contractors have proposed to shift more risks away from them towards the owner or to be shared. Contractors are also less indecisive on the allocation of risks than owners, and owners proposed the sharing of more risks compared to contractors. Finding the total number of risks borne by each party and testing the data for dependence on the type of respondent (owner or contractor), we find that the amount of risks allocated to each party does not vary greatly with the type of respondent. That is, the percentages of risks carried by each party in perception and proposal is independent from the party allocating these risks. Having this in mind, and comparing to the different views of each party, it can be detected that there is a relative agreement between the parties on the number of risks allocated to each party, but the disagreement is on which risks allocated to which party. Areas of disagreement are then found by compiling the responses of both parties and categorising them based on frequency of agreement. This approach is considered to be applicable since the number of owner respondents and contractor respondents is almost the same giving both samples an equal weight.

4.1. Owner categorised risks

Looking at the risks allocated to the owner, not surprisingly, it can be seen that most of clauses risks are entirely under his control. Examples are: Stand-by time controlled by owner and cost of contractor's search for defects controlled by owner. This result conforms the literature findings, except for the "issue and document change" risk, where 72% of the respondents have proposed that it should be allocated to the owner only. The remaining 28% have proposed that it should be shared. Such allocation is logical since the UCPW obligates the contractor to inform the owner or

Table 9. Perceived allocation (percentages)

Risk Description	Owner	Contractor	Shared
Answer clarifications during bidding period	96%	0%	4%
Stipulate payment method	96%	0%	4%
Stipulate definitions and contractual responsibilities	96%	0%	4%
Stipulate methods for claims and dispute settlement	89%	0%	11%
Confidentiality of bid details	43%	17%	39%
Bid mistakes	39%	37%	24%
Obtain necessary guarantees, insurances and bonds	4%	83%	13%
Obtain necessary licenses and permits	26%	59%	15%
Third party and liability	13%	78%	9%
Pay Zakat, taxes and duties	9%	83%	9%
Sufficient quantity and skill of labour	0%	85%	15%
Labour housing transportation and medical treatment	0%	91%	9%
Maintaining labour roaster at work	0%	93%	7%
Availability of resources to execute work	0%	100%	0%
Adequacy and suitability of equipment	0%	85%	15%
Provide and maintain temporary structures	0%	80%	20%
Provide site superintendence during execution	22%	63%	15%
Site housekeeping and sanitary conditions	0%	89%	11%
Site first aid trained personnel and supplies	0%	96%	4%
Site security (including material yard)	4%	91%	4%
Site safety	4%	72%	24%
Pollution control caused by work	0%	85%	15%
Noise control and undue disturbance of public	0%	96%	4%
Unnecessary or improper interference with public convenience	0%	78%	22%
Mobilisation and demobilisation	4%	91%	4%
Dumping debris in an approved location	5%	84%	11%
Prepare schedules (bar charts, CPM, . . .) for owner's approval	9%	76%	15%
Maintain progress and overcome schedule slippage	0%	76%	24%
Notify owner of actual or anticipated delay	13%	61%	26%
Promotion of local manufacturers and suppliers	26%	43%	30%
Utilise Saudi airline and maritime carriers	28%	50%	22%
Maintaining procurement records	0%	82%	18%
Preservation of existing structures, facilities and utilities	9%	76%	15%
Preserve vegetarian (other than marked for removal) on or near site	9%	76%	15%
Subcontractors' and suppliers' acts and omissions	4%	78%	17%
Obtain approval before subcontracting	9%	78%	13%
Guarantee no further subcontracting	26%	74%	0%
Obtaining SASO approval on imported material and equipment	4%	74%	22%
Adherence to laws and customs of Saudi Arabia	13%	52%	35%
Adherence to import and customs laws	13%	57%	30%
Perform government relations activities	22%	63%	15%
Giving notices and paying fines to public authorities applicable to work	26%	39%	35%

(*Continued*)

Risk Description	Owner	Contractor	Shared
Prepare as-built drawings	9%	70%	22%
Prepare shop and work drawings	9%	65%	26%
Documenting by photographs	13%	59%	28%
Delayed progress payments	54%	26%	20%
Infringement of patents, copyrights and trade secrets	30%	46%	24%
Allow owner access to all aspects of work	9%	59%	33%
Cooperation to facilitate inspection of work	9%	59%	33%
QA/QC (inspection and testing of work)	9%	43%	48%
Preserving articles of value, archaeological or geological interest	9%	61%	30%
Site conditions including surface and subsurface	4%	76%	20%
Safeguarding title to design, confidential information and patents	26%	35%	39%
Obtain owner's approval before issuing publicity releases	9%	72%	20%
Criminal misappropriation and misapplication	4%	63%	33%
Issue and document change	63%	22%	15%
Working on undocumented change	13%	74%	13%
Liquidated damages for delay (up to 10% of contract value)	14%	70%	16%
Liquidated damages (consequential damages)	17%	67%	15%
Conflict of interest	17%	48%	35%
Force majeure	48%	22%	30%
Special risks (limited to outbreak of war)	52%	28%	20%
Standby time controlled by owner	72%	9%	20%
Standby time controlled by contractor	9%	76%	15%
Maintenance period	13%	78%	9%
Cost of contractor's search for defects controlled by owner (implied)	57%	39%	4%
Cost of contractor's search for defects controlled by contractor	13%	83%	4%
Cooperation with other contractors working for owner in the area	9%	67%	24%
Warranty of work	0%	85%	15%
Guarantee for 10 years	4%	96%	0%

his representative of any proposed change in design before implementing that change, which in turn, upon the consent of the owner, shifts the responsibility away from the contractor.

4.1.1. Government-related activities: Paying taxes and fees, licenses and permits

Risks associated with government-related activities was found to be an area of disagreement. No decision has been reached yet on most of the listed risks. The undecided upon risks related to government activities are: Giving notices and paying fines to public authorities applicable to work, obtain necessary licenses and permits, and performing government relations activities. However, an agreement was found that paying taxes (named Zakat in Saudi Arabia) and duties belongs to the contractor by 83% of the respondents. Anyhow, according to Al Salman's study, risks associated with permits and regulations were ranked very low in importance, which might indicate that such risks are agreed upon differently for each project, since some party might have the leverage needed to perform these activities and the other party does not. Moreover, these risks were found to be usually shared in the literature.

Table 10. Proposed allocation (percentages)

Risk Description	Owner	Contractor	Shared
Answer clarifications during bidding period	96%	0%	4%
Stipulate payment method	96%	0%	4%
Stipulate definitions and contractual responsibilities	96%	0%	4%
Stipulate methods for claims and dispute settlement	89%	0%	11%
Confidentiality of bid details	41%	9%	50%
Bid mistakes	30%	26%	43%
Obtain necessary guarantees, insurances and bonds	13%	63%	24%
Obtain necessary licenses and permits	37%	35%	28%
Third party and liability	13%	57%	30%
Pay Zakat, taxes and duties	13%	78%	9%
Sufficient quantity and skill of labour	0%	76%	24%
Labour housing transportation and medical treatment	0%	87%	13%
Maintaining labour roaster at work	0%	89%	11%
Availability of resources to execute work	0%	91%	9%
Adequacy and suitability of equipment	0%	91%	9%
Provide and maintain temporary structures	0%	80%	20%
Provide site superintendence during execution	17%	43%	39%
Site housekeeping and sanitary conditions	0%	85%	15%
Site first aid trained personnel and supplies	0%	96%	4%
Site security (including material yard)	0%	83%	17%
Site safety	4%	46%	50%
Pollution control caused by work	0%	80%	20%
Noise control and undue disturbance of public	0%	78%	22%
Unnecessary or improper interference with public convenience	4%	57%	39%
Mobilisation and demobilisation	0%	96%	4%
Dumping debris in an approved location	4%	72%	24%
Prepare schedules (bar charts, CPM, ...) for owner's approval	4%	69%	27%
Maintain progress and overcome schedule slippage	4%	48%	48%
Notify owner of actual or anticipated delay	26%	35%	39%
Promotion of local manufacturers and suppliers	29%	29%	42%
Utilise Saudi airline and maritime carriers	24%	41%	35%
Maintaining procurement records	9%	67%	24%
Preservation of existing structures, facilities and utilities	13%	72%	15%
Preserve vegetarian (other than marked for removal) on or near site	9%	76%	15%
Subcontractors' and suppliers' acts and omissions	13%	70%	17%
Obtain approval before subcontracting	9%	78%	13%
Guarantee no further subcontracting	23%	58%	19%
Obtaining SASO approval on imported material and equipment	9%	57%	35%
Adherence to laws and customs of Saudi Arabia	4%	35%	61%
Adherence to import and customs laws	4%	43%	52%
Perform government relations activities	39%	37%	24%
Giving notices and paying fines to public authorities applicable to work	17%	39%	43%

(*Continued*)

Risk Description	Owner	Contractor	Shared
Prepare as-built drawings	0%	70%	30%
Prepare shop and work drawings	0%	65%	35%
Documenting by photographs	9%	50%	41%
Delayed progress payments	72%	13%	15%
Infringement of patents, copyrights and trade secrets	22%	41%	37%
Allow owner access to all aspects of work	4%	54%	41%
Cooperation to facilitate inspection of work	11%	54%	35%
QA/QC (inspection and testing of work)	20%	26%	54%
Preserving articles of value, archaeological or geological interest	20%	43%	37%
Site conditions including surface and subsurface	13%	67%	20%
Safeguarding title to design, confidential information and patents	37%	22%	41%
Obtain owner's approval before issuing publicity releases	9%	63%	28%
Criminal misappropriation and misapplication	4%	63%	33%
Issue and document change	72%	0%	28%
Working on undocumented change	26%	48%	26%
Liquidated damages for delay (up to 10% of contract value)	17%	67%	15%
Liquidated damages (consequential damages)	17%	63%	20%
Conflict of interest	17%	22%	61%
Force majeure	61%	4%	35%
Special risks (limited to outbreak of war)	48%	24%	28%
Standby time controlled by owner	72%	9%	20%
Standby time controlled by contractor	13%	67%	20%
Maintenance period	9%	74%	17%
Cost of contractor's search for defects controlled by owner (implied)	67%	13%	20%
Cost of contractor's search for defects controlled by contractor	17%	74%	9%
Cooperation with other contractors working for owner in the area	13%	59%	28%
Warranty of work	4%	80%	15%
Guarantee for 10 years	4%	87%	9%

4.1.2. Delay consequences: Liquidated and consequential damages

Liquidated and consequential damages are delay consequences occurring from loss of operation of the intended facility and costs of supervision incurred by the owner. In this research, 67% of the respondents have agreed that the contractor is responsible for delay consequences. This result also matches the findings of other studies. The UCPW have established rules that govern delay, where it stipulates on a delay fine as a representation of liquidated damages and supervision costs as a representation of consequential damages. The reader may refer to the original text of UCPW for further explanation on liquidated damages and consequential damages.

4.1.3. Payment-related issues: Payment method and progress payments

Two statements governed payment-related issues. These are: Stipulation of payment methods and delay in progress payments. Both risks were found to be under the control of the owner

Table 11. Perceived allocation of risks

Risk Description	Allocation
Answer clarifications during bidding period	Owner
Cost of contractor's search for defects controlled by owner (implied)	
Delayed progress payments	
Issue and document change	
Special risks (limited to outbreak of war)	
Standby time controlled by owner	
Stipulate definitions and contractual responsibilities	
Stipulate methods for claims and dispute settlement	
Stipulate payment method	
Adequacy and suitability of equipment	Contractor
Adherence to import and customs laws	
Adherence to laws and customs of Saudi Arabia	
Allow owner access to all aspects of work	
Availability of resources to execute work	
Cooperation to facilitate inspection of work	
Cooperation with other contractors working for owner in the area	
Cost of contractor's search for defects controlled by contractor	
Criminal misappropriation and misapplication	
Documenting by photographs	
Dumping debris in an approved location	
Guarantee for 10 years	
Guarantee no further subcontracting	
Labour housing transportation and medical treatment	
Liquidated damages (consequential damages)	
Liquidated damages for delay (up to 10% of contract value)	
Maintain progress and overcome schedule slippage	
Maintaining labour roaster at work	
Maintaining procurement records	
Maintenance period	
Mobilisation and demobilisation	
Noise control and undue disturbance of public	
Notify owner of actual or anticipated delay	
Obtain approval before subcontracting	
Obtain necessary guarantees, insurances and bonds	
Obtain necessary licenses and permits	
Obtain owner's approval before issuing publicity releases	
Obtaining SASO approval on imported material and equipment	
Pay Zakat, taxes and duties	
Perform government relations activities	
Pollution control caused by work	
Prepare as-built drawings	
Prepare schedules (bar charts, CPM, …) for owner's approval	
Prepare shop and work drawings	
Preservation of existing structures, facilities and utilities	

(*Continued*)

Risk Description	Allocation
Preserve vegetarian (other than marked for removal) on or near site	Contractor
Preserving articles of value, archaeological or geological interest	
Provide and maintain temporary structures	
Provide site superintendence during execution	
Site conditions including surface and subsurface	
Site first aid trained personnel and supplies	
Site housekeeping and sanitary conditions	
Site safety	
Site security (including material yard)	
Standby time controlled by contractor	
Subcontractors' and suppliers' acts and omissions	
Sufficient quantity and skill of labour	
Third party and liability	
Unnecessary or improper interference with public convenience	
Utilise Saudi airline and maritime carriers	
Warranty of work	
Working on undocumented change	
Bid mistakes	Undecided
Confidentiality of bid details	
Conflict of interest	
Force majeure	
Giving notices and paying fines to public authorities applicable to work	
Infringement of patents, copyrights and trade secrets	
Promotion of local manufacturers and suppliers	
QA/QC (inspection and testing of work)	
Safeguarding title to design, confidential information and patents	

and an agreement of over 90% of the respondents has been reached. The same result was arrived at by Al-Barghouthi (1994) but not by the remaining researchers where no decisions were made.

4.2. Contractors categorised risks

Contractors on the other hand, are perceived to bear much more risks than they should as shown in the proposed allocation. That is, all of the risks proposed to be shared or are still undecided upon, except for one, were originally allocated to the contractor in perception. The resulting proposed allocation of risks to the contractor alone conforms with the literature finding. Risks that have not changed from perception to proposal are found to be under the control of the contractor and are mostly related to the construction process itself. For instance: Adequacy of equipment, availability of resources, skill of labour, standby time controlled by contractor, subcontractors and suppliers hired by the contractor. On the other hand, risks that have been shifted away from the contractor, are either out of his control or the owner may also have some control over it, mostly the latter. Confidentiality of bid details, for example, was proposed to be shared, since it can be breached from both sides, the owner's side and the contractor's side. More examples are: Working on undocumented change, obtain necessary licenses and permits and performing government relations activities.

Table 12. Proposed allocation of risks

Risk Description	Allocation
Answer clarifications during bidding period	Owner
Cost of contractor's search for defects controlled by owner (implied)	
Delayed progress payments	
Force majeure	
Issue and document change	
Standby time controlled by owner	
Stipulate definitions and contractual responsibilities	
Stipulate methods for claims and dispute settlement	
Stipulate payment method	
Adequacy and suitability of equipment	Contractor
Allow owner access to all aspects of work	
Availability of resources to execute work	
Cooperation to facilitate inspection of work	
Cooperation with other contractors working for owner in the area	
Cost of contractor's search for defects controlled by contractor	
Criminal misappropriation and misapplication	
Documenting by photographs	
Dumping debris in an approved location	
Guarantee for 10 years	
Guarantee no further subcontracting	
Labour housing transportation and medical treatment	
Liquidated damages (consequential damages)	
Liquidated damages for delay (up to 10% of contract value)	
Maintaining labour roaster at work	
Maintaining procurement records	
Maintenance period	
Mobilisation and demobilisation	
Noise control and undue disturbance of public	
Obtain approval before subcontracting	
Obtain necessary guarantees, insurances and bonds	
Obtain owner's approval before issuing publicity releases	
Obtaining SASO approval on imported material and equipment	
Pay Zakat, taxes and duties	
Pollution control caused by work	
Prepare as-built drawings	
Prepare schedules (bar charts, CPM, …) for owner's approval	
Prepare shop and work drawings	
Preservation of existing structures, facilities and utilities	
Preserve vegetarian (other than marked for removal) on or near site	
Provide and maintain temporary structures	
Site conditions including surface and subsurface	
Site first aid trained personnel and supplies	
Site housekeeping and sanitary conditions	
Site security (including material yard)	
Standby time controlled by contractor	

(*Continued*)

Risk Description	Allocation
Subcontractors' and suppliers' acts and omissions	Contractor
Sufficient quantity and skill of labour	
Third party and liability	
Unnecessary or improper interference with public convenience	
Warranty of work	
Adherence to import and customs laws	Shared
Adherence to laws and customs of Saudi Arabia	
Confidentiality of bid details	
Conflict of interest	
QA/QC (inspection and testing of work)	
Site safety	
Bid mistakes	Undecided
Giving notices and paying fines to public authorities applicable to work	
Infringement of patents, copyrights and trade secrets	
Maintain progress and overcome schedule slippage	
Notify owner of actual or anticipated delay	
Obtain necessary licenses and permits	
Perform government relations activities	
Preserving articles of value, archaeological or geological interest	
Promotion of local manufacturers and suppliers	
Provide site superintendence during execution	
Safeguarding title to design, confidential information and patents	
Special risks (limited to outbreak of war)	
Utilise Saudi airline and maritime carriers	
Working on undocumented change	

4.2.1. Bidding and contractual related issues: Scope, confidentiality of bid details, bid mistakes, claims and changes

Bidding and contractual related issues are generally controlled by the owner as per the literature. Looking at the perceived and proposed risk allocations resulting from this study shows that all of the risks related to project scope and the delivery system of that project were allocated to the owner. Examples: Answering clarifications during bidding period, stipulate definitions and contractual responsibilities, stipulate methods for claims and dispute settlement and stipulate payment method. All of these examples had more than 90% agreement that it should be borne by the owner in perception and proposal. The owner has also been found to be responsible for issuing and documenting change with an increasing agreement from perception to proposal of 63% to 72%, respectively. This result differs from what was found by Al-Bargouthi in 1994, where the responsibility for issuing change has been proposed to be shared by both parties instead of being borne by the owner alone.

Looking at bids, the responsibility for the confidentiality of bid details and bid mistakes was disagreed upon in perception. While it is still undecided on who should be responsible for bid mistakes, confidentiality of bid details has been proposed to be shared, but with a very small percentage of 50%. The indecision on responsibilities related to bid mistakes might have occurred from the vagueness of the statement in survey questionnaire. Anyhow, bid mistakes has been studied in the literature and found to have different interpretations and established rules regarding

this issue are used to allocate responsibility within certain limits. Compared to Al-Barghouthi study in 1994, confidentiality of bid details was allocated to the owner in perception then proposed to be shared by both parties. Bid mistakes on the other hand was allocated entirely to contractor in perception and proposal. The issue of bidding has not been considered in the remaining studies by the remaining researchers.

4.2.2. Construction process related risks: Subcontracting, suppliers, labour and equipment
It was found that an agreement between the surveyed populations exists on the responsibility for risks related to the construction process itself. As all of the risks related to construction process, in despite of respondents' types, were allocated to the contractor in perception and proposal. This result also conforms with the literature as found (Al-Barghouthi, 1994; Al Sabah, 2014; Al Salman, 2004; Khaliluddin, 2010).The trend also matches the findings of other researchers such as Kangari (1995) and Erikson (1979). Basically the contractor is responsible for the site, anything within that site and the methods and resources he finds necessary to complete the work, as soon as he is handed the site from the owner. This fact can be considered to be the reason behind the results of the perceived and proposed allocations of risks found in this research. Owners realize that work related risks are out of their control and contractors understand that these risks are under their control and accept them.

4.2.3. Construction site related risks: Site conditions, safety and third-party liability
It was established in the previously that site responsibility is transformed to the contractor upon hand out from the owner as per the conditions of the contract. On this basis, risks associated with the construction site are under the responsibility of the contractor in general. This statement has been proved by the findings of this study, where all risks associated with the site and its contents has been allocated to the contractor with varying agreement levels, mostly more than 65% in both cases. For instance: Site security, site housekeeping and sanitary conditions and site conditions (surface and subsurface). The allocation of the previous examples is found to conform with the previous studies mentioned earlier in this article. Site safety is the only site-related risk that has been proposed to be shared because safety is the responsibility of everyone, where it should be maintained and abided to by the contactors and should be insured by the owners through the contract.

Third party liability was allocated to the contractor in perception and was not proposed to be shared. The result is found to be different from what was found in 1994 where it was proposed to be shared. Other sources have not addressed third-party liability anywhere in their research.

4.3. Shared risks between owners and contractors or undecided risks
Risks that might be under the control of the two parties, or beyond the control of one party, and the other party has little control over, were either proposed to be shared or are still undecided upon. Examples on risks that were proposed to be shared are: Adherence to import and customs laws, adherence to laws and customs of Saudi Arabia and conflict of interest. All of which, the two parties may take role in control. The owner might request a certain brand or quality of materials that can only be provided by a certain source that is banned or boycotted by the government. Conversely, the contractor might have alternatives to that source, yet, chooses to import the materials from that source. Inspection and testing of work, site safety and confidentiality of bid details are more examples on risks proposed to be shared.

Moving on, risks that are still undecided upon share the same characteristics of risks proposed to be shared, but, one party might have greater control over them, yet refuses to accept them. Such behaviour might be explained in that such risk might not be severe, but it is too much of a burden to be taken. For instance: Obtaining necessary licenses and permits, giving notices and paying fines to public authorities. Dealing with the government and public agencies might sometimes need leverage. While both parties might have this leverage, they might tend to save it for other uses or one party might have further reach than the other. Anyhow, such risks might be perceived and managed differently for different contracts, where an agreement might be reached and is appended to the supplementary conditions.

Another type of risks that falls under this category are risks that are beyond the control of both parties, i.e. neither owner nor contractor. These risks are declared as undecided category or "Force Majeure" risk. It has been addressed in this research that the UCPW provides definitions of what is considered to be a force majeure or a special risk and what is not. The UCPW also delineates a general procedure to deal with such risks. The perception of how the "Force Majeure" risks bearing varies between both parties. Force majeure was disagreed upon in perception then was proposed to be shared by 61% of the respondents. Conversely, special risks were allocated to the owner in perception and was disagreed upon in proposal (still undecided). Different views were found in the literature regarding special risks and force majeure. Where in Al-Barghouthi (1994), both risks were proposed to be shared, in Al Salman (2004), the risk was allocated to the contractor. This divergence in opinions might be due to the nature of the risk, as the probability of occurrence of such risk and its magnitude is surrounded by ambiguity and vagueness, it might still be undecided upon until such risk materialises.

5. Summary and conclusions

This research is carried out to study the balance of risk sharing in the UCPW in Saudi Arabia by surveying Saudi owners and contractors' perception towards the statement of the clauses. The research specifically, addresses the different views of Saudi owners and contractors about the level of risk sharing and their needed allocation in the Saudi UCPW.

The results of this study show clearly that the current format of the UCPW places more burden on the contractor than it should be. In the opinions of the respondents, the owner should handle more risks. In summary, Table 13 summaries the current perception of UCPW articles as follow: 9 risks on the owner, 52 risks on the contractor, and 9 undecided with no risk sharing. The proposed risk distribution is as follow: 9 risks on the owner, 41 risks on the contractor, 6 risks should be shared and 14 risks are undecided.

In fact, this unbalanced risk sharing between the contractor and the owner jeopardise the health of construction industry in Saudi Arabia. It is also seen by the respondents, this unbalance in risk sharing will have the potential to create claims and disputes between different parties. Although the research is done in Saudi Arabia which still other neighbouring GCC countries, namely: Bahrain, UAE, Qatar, Kuwait and Oman can benefit from the findings of this research as they share similar working conditions. However, each country uses its own general conditions. The Saudi contract is highly influenced FIDIC's general conditions which is practiced in many parts in the world. Hence, this research may enable future comparative studies with other contracting practices in the world.

It is concluded that the owners and contractors are in agreement to share the following risks: Adherence to import and customs laws, confidentiality of bid details, conflict of interest, QA/QC (inspection and testing of work), and site safety. Furthermore, this research has revealed that owners and contractors have different perceptions of the conditions of the UCPW. However, the areas of disagreement were resolved when the respondents proposed a better allocation of risks, except (still undecided upon): Bid mistakes, fines for contract violation, infringement of patents, copyrights and trade secrets. In addition, new areas of disagreement emerged in the proposals of the owners and contractors. These new areas of disagreement are: Maintain progress, overcome schedule slippage and notify the owner of project delay (actual or anticipated). Also, the contractor should obtain

Table 13. Risk allocation totals by all

Allocation	Perceived	Proposed
Owner/Engineer	9	9
Contractor	52	41
Shared	0	6
Undecided	9	14
Total	70	70

necessary licenses and permits, perform government relations activities and preserve articles of value, archaeological or geological interest. In addition, the contractor is requested to promote local manufacturers and suppliers in the public projects including Saudi airlines and maritime carriers. It is also undecided on the: Requested work without documented change (field order), providing site superintendence during execution, safeguarding title to design and keeping confidential information and patents. Special risks are undecided only in the case of act of war but other Special kinds of risks are considered as force majeure. It is found that the number of risks allocated to each party is independent from the type of respondent, nevertheless the allocation of these risks differs based on the type of respondent. That is, there is an agreement on the amount of risks borne by each party, but the disagreement is on what risks should be borne by each party.

Considering the results of this study, it is recommended for both, the contractor and the owner, to seek a proper allocation of risks through effective communication and partnership. It is also recommended that risks are allocated on the basis of control as has been proven through literature review and the findings of this study. The findings of this study can be used for future review of the current UCPW version, and be considered by owners and contractors in the preparation of bids.

As a future research, the barriers and obstacles discouraging risk sharing, and, solutions and enablers that might encourage risk sharing, should all be investigated in future research. The disagreement was on 14 risks that are still undecided upon which needs further investigation. It is suggested to have future comparative studies to compare UCPW with other internationally accepted standards in different parts of the world.

Acknowledgements
The authors would like to thank King Fahd University of Petroleum and Minerals (KFUPM) for facilitating this research. The anonymous reviewers are also thanked for their constructive suggestions that improved the quality and presentation of this research. Last but not least, we would like to thank the industry participants who contributed positively to this research.

Funding
The authors received no direct funding for this research.

Author details
Khaled Ashmawi[1]
E-mail: g200992130@KFUPM.EDU.SA
Laith A Hadidi[1]
E-mail: lhadidi@kfupm.edu.sa
ORCID ID: http://orcid.org/0000-0003-4353-9156
Sadi Assaf[1]
E-mail: assaf@kfupm.edu.sa
Firas M Tuffaha[1]
E-mail: tuffaha@kfupm.edu.sa
Khalaf Al-Ofi[1]
E-mail: kaluwfi@kfupm.edu.sa
[1] Construction engineering and management department, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia.

Citation information
Cite this article as: Risk assessment and allocation in the contract for public works used in Saudi Arabia construction industry, Khaled Ashmawi, Laith A Hadidi, Sadi Assaf, Firas M Tuffaha & Khalaf Al-Ofi, *Cogent Engineering* (2018), 5: 1490148.

References

Al Sabah, R. (2014) *Evaluating the Impact of Construction Risks on Project Success in the Arabian Gulf* Region *(AGR) Construction Industry from the Perspective of Multinational Firms*. The University of Wisconsin-Madison.

Al Salman, A. (2004) *Assessment of risk management perceptions and practices of construction contractors in Saudi Arabi* (Master Thesis). King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia.

Al-Barghouthi, M. (1994) *Liability allocation among the parties of fixed-price construction contractors in Saudi Arabia* (Master Thesis). King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia.

Assaf, S. (1982) *A systematic approach to the selection of a risk retention level for construction insurance* (PhD thesis). University of Illinois at Urbana-Champaign.

Bubshait, A. A., & Almohawis, S. A. (1994). Evaluating the general conditions of a construction contract. *International Journal of Project Management*, *12*(3), 133–136. doi:10.1016/0263-7863(94)90027-2

Charoenngam, C., & Yeh, C. Y. (1999). Contractual risk and liability sharing in hydropower construction. *International Journal of Project Management*, *17*(1), 29–37. doi:10.1016/S0263-7863(97)00064-1

Chui, K. W., & Bai, Y. (2010). Comparison of contract general conditions between United States and China. *Journal of Architectural Engineering*, *16*(4), 119–125. doi:10.1061/(ASCE)AE.1943-5568.0000020

EJCDC. (2015). *Engineers joint contract documents committee (EJCDC)*. Madison.

El-Sayegh, S. M. (2008). Risk assessment and allocation in the UAE construction industry. *International Journal of Project Management*, *26*(4), 431–438. doi:10.1016/j.ijproman.2007.07.004

El-Sayegh, S. M., & Mansour, M. H. (2015). Risk assessment and allocation in highway construction projects in the UAE. *Journal of Management in Engineering*, *31* (6), 04015004. doi:10.1061/(ASCE)ME.1943-5479.0000365

Erikson, C. A. (1979). *Risk sharing in construction contracts*. Urbana-champaign: University of Illinois, Urbana-Champaign.

Fisk, E. R., & Reynolds, W. D. (2010). *Construction project administration* (9th ed.). Pearson Prentice Hall.

Hadidi, L. A., & Alkhaldi, A. F. (2016, December). Reliability improvement for electrical pneumatic arm loading

system. In *Industrial Engineering and Engineering Management (IEEM), 2016 IEEE International Conference on* (pp. 531–535). IEEE.

Husein, A. T. (2014). Construction and projects in Saudi Arabia: Overview. *Practice Law, Multi-Jurisdictional Guide* 2013/14.

Kalin, M., Weygant, R. S., Rosen, H. J., & Regener, J. R. (2010). *Construction specifications writing: Principles and procedures* (6th ed.). USA: Wiley Professional Development (P&T).

Kangari, R. (1995). Risk management perceptions and trends of U.S construction. *Journal of Construction Engineering and Management*, *121*(4), 422–429. doi:10.1061/(ASCE)0733-9364(1995)121:4(422)

Khaliluddin, M. (2010) *Contract risk allocation in Saudi Arabian construction projects* (Master Thesis). King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia

Liu, J., Zhao, X., & Yan, P. (2016). Risk paths in international construction projects: Case study from Chinese contractors. *Journal of Construction Engineering and Management*, *142*(6), 05016002. doi:10.1061/(ASCE)CO.1943-7862.0001116

NCB. (2016a). *NCB quarterly review of contract awards in the construction sector, NCB* construction contracts *index first quarter 2016*. Retrieved June 20, 2005, from http://www.alahli.com/ar-sa/about-us/Documents/NCB-Construction-Contracts-Index-1Q-2016.pdf

NCB. (2016b) *NCB quarterly review of contract awards in the construction sector, NCB* construction contracts *index second quarter 2016*. Retrieved August 1, 2016 from http://www.alahli.com/en-us/Documents/NCB-Construction-Contracts-Index-Q2-2016.pdf

Pratap, S., Kumar, M., Cheikhrouhou, N., & Tiwari, M. K. (2015, December). The robust quay crane allocation for a discrete bulk material handling port. In *Industrial Engineering and Engineering Management (IEEM), 2015 IEEE International Conference on* (pp. 1174–1178). IEEE.

The Unified Contract for Public Works. (2011). Riyadh: Ministry of Finance, Saudi Arabia.