The Allocation of Risks in the Saudi Arabian Domestic and Regional Aviation Construction Projects

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Dedication

TO YOU MY FATHER, FOR ALL THE PAIN THAT YOU HAVE HAD WHILE I AM AWAY, I DEDICATE THIS THESIS TO YOU

And

To You My Mother, for all the prayers you have made while I am away, I dedicate this thesis to you

To You My Aunt, for all you sacrifices to make me the one you wanted to be, I dedicate this thesis to you

To You My 4 month Daughter, for making my life so meaningful, I dedicate this thesis to you

To You My Wife, for the ultimate love that you have given me, I dedicate this thesis to you

To You My Brothers and Sisters, for your support, I dedicate this thesis to you

Declaration

This thesis is an original work and it has not previously been submitted for any degree or similar award. The materials in this thesis, to the best of my knowledge and beliefs has not been previously written or published by another person except where due reference is made. However, material that has been published in international peer review journals and as proceedings in conferences has been stated in Appendix 3 and Appendix 4.

Abstract

Airports projects, amongst other construction projects, are considered very complex as they face a number of challenges that inevitably cause them to become exposed to risks. In Saudi Arabia, the sector of aviation is considered an important sector owing to the fact that, on an annual basis, it is recognised as the first destination for Muslims. However, it has been found that projects continue to be delivered with a significant number of time and cost overruns. Moreover, the absence of a risk allocation framework has been identified. Hence, the aim of the research underpinning this thesis is to develop a framework detailing how such risks can be allocated properly in the specific context of aviation construction projects in Saudi Arabia.

A robust methodology that been designed and outlined in the research—which notably includes the use of semi-structured interviews and questionnaires with highly experienced senior project managers representing GACA, their contractors and consultants. The aim of conducting the interviews was twofold. Firstly, to identify risks associated with GACA construction projects. Secondly, to examine the risk allocation practice that is been carried by GACA. While, the questionnaire method was adopted to identify the importance of the risks identified, based on quantifying each risks' probability of occurrence and impact. In addition, to test the perception of risk allocation within GACA construction projects. As a result, Fifty-four risks are associated with the construction of aviation projects in Saudi Arabia, with the decision on such an allocation of risks within GACA found to be based on a number of criteria that are subjective in nature, such as the authority of project managers, experience from different projects and so on, coupled with the absence of well-defined principles of risks allocation. Importantly, a number of risks have been found to have undecided allocation, with no allocation on any risk found to be shared amongst parties.

A framework of risk allocation was developed in an effort to replace the current practice applied within GACA and their projects. This framework is presented in flow chart to make it easy to follow its steps. It incorporates a well-defined strategy that imposes GACA, as a client, to perform a solid risk management practice, taking into consideration the best practice of risk- allocation principles. It further allows GACA contractors to make their decision on whether the allocation made by GACA should be accepted, or alternatively whether to withdraw from the bidding otherwise. As a means of validating the framework, a number of interviews were carried out with professionals representing GACA, contractors and consultants. The research is the first of its nature to focus on an existing problems of risk allocation practice within the aviation sector in the country and accordingly solving these problems by introducing a framework for a proper allocation of risks. In this sense, the study is believed to make a contribution to knowledge as it provides a tool from which GACA can benefit with regards their current issue of risks-allocation.

Key words: Risk Allocation, GACA, Construction, Aviation, Saudi Arabia.

Chapter One: Introduction

1.0 Background

Until the 1980s, there were only three airports in the Kingdom of Saudi Arabia (KSA) (Al-Jarallah, 1983). Currently, the number of airports in Saudi Arabia has increased to 26 airports, as shown in Figure 1.1, with the inclusion of four international airports in Jeddah, Riyadh (the country's capital city), Dammam and Medina, eight regional airports, and 14 domestic airports (GACA, 2013).

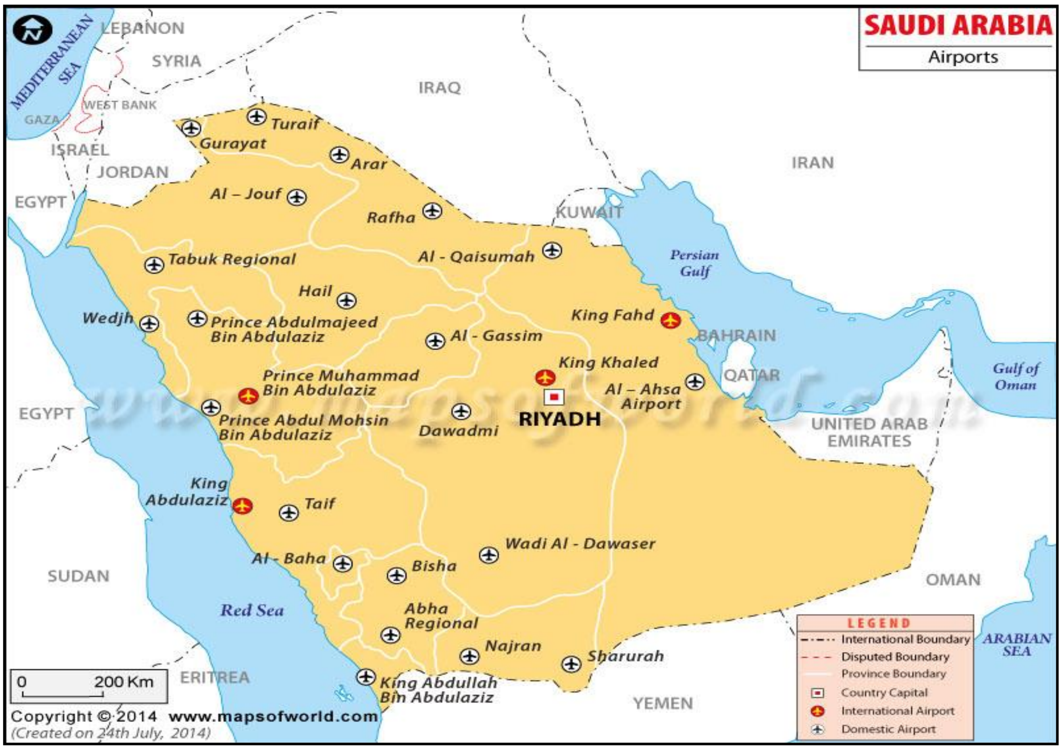


Figure 1.1: Airports in Saudi Arabia (GACA, 2013)

As a result of this significant increase in the number of airports, the number of travellers has also increased over the years, and is further expected to reach 200 million travellers in 2020, according to General Authority of Civil Aviation (GACA), as shown in Figure 1.2. Moreover, the main vision of the General Authority of Civil Aviation in Saudi Arabia—which plays the role of client representative (for the Saudi government)—is centred on facilitating the development of air travel by way of applying the strictest standards in terms of construction, management, operation of airports and aeronautical navigation infrastructure, and the maintenance of systems (GACA, 2013).

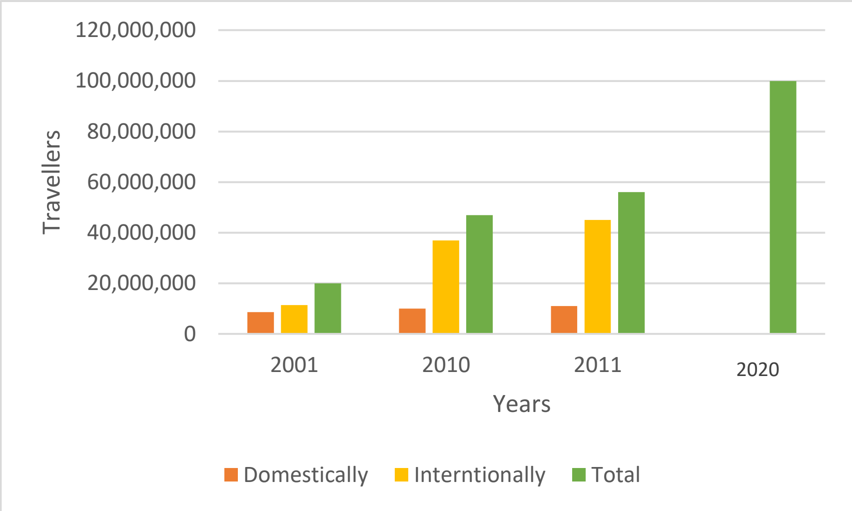


Figure 1.2: The number of travellers at Saudi Airports (GACA, 2013)

1.1 Challenges Facing GACA Projects

Amongst the different types of construction project, aviation projects or airports are recognised as important and complex (Nassim & Mahmoud, 2009). On the one hand, their importance is recognised owing to the fact that they represent the country's economy, development, and overall production level (Kapur, 1993). Furthermore, challenges and difficulties are all part of the industry of construction; the level of involvement is increased in the context of airport construction (Alnasseri *et al*., 2013). A considerable number of authors and organisations have outlined and explained the challenges associated with airport projects, such as Adrem *et al*. (2006) and Binnekade *et al*. (2009), amongst others. Some of the challenges concerned with airport construction or aviation projects are shown in Figure 1.1.

With regard to construction at Saudi airports, all the following challenges are applicable to this context, and recognised as increasing the construction risks associated with these projects:

- On-going or expected expansion and renewal projects: as many airports undergo expansion, such as the building of new terminals, for example, this process can induce risks for a number of reasons, such as the fact that it has new contracts which need to be established (meaning other risks should be allocated, especially to contractors), in addition to the issuance of compatibility needing to be achieved between old and new facilities (Ghavamifar *et al*., 2010). In Saudi Arabia, a number of domestic, regional and international airports are undergoing expansion in an effort to increase their capacity to face high demand; this can be seen in the case of King Khaled International Airport in Riyadh, Prince Naif Regional Airport, in Al-Qassim, Altaif Airport (field survey).
- The variance of stakeholders involved, all of whom have a large involvement in the project lifecycle. As a result, the achievement of consensus amongst them is quite challenging (Flouris & Lock, 2102). This is can be seen clearly in the context of Saudi Aviation Projects, especially in the on-going Medina Airport undertaken by the Public private partnership (PPP).

- A wide variety of activities and functions is involved, which might force the design concept and specification of airports to be produced and prepared by an airport organisation before the initiation of the construction process (Adrem *et al*., 2006).
- The time element, with airport clients usually concerned with the completion time of their projects; this can be seen in the case of Brazil's

airports, as the country was set to host the 2014 World Cup and 2016 Olympic Games (Alnasseri *et al*., 2013). For Saudi Arabia, the issue of airports being completed on schedule is crucial as it hosts the visits of millions of Muslims to perform Haj and Omrah (Islamic obligations) every year.

- Special systems and specifications are needed. A number of systems can make airports more complex, such as sophisticated devices for security, electrical and data systems, distinct fire-fighting and alarm systems, special baggage and handling systems, distinct requirements for spatial concerns, the circulation of planes and equipment, and crowd flow—all of which might add additional levels of complexity to the design and construction process (Engineering News Record, 2003; Urfer & Weinert, 2011).
- Security, with its level in airports needing to be consistently high, both internally and externally (Alnasseri *et al*., 2013).
- The religious significance of the country, as it is considered the main destination for all Muslims across the world due to the two holy cities Makkah and Medinah. This means that millions of travellers visit the country on an annual basis. Figure 1.2 above shows the number of travellers to Saudi airports from 2001–2011 according to the latest GACA's statistics (2013).
- The aviation sector contributes SR 53.8 billion (1.8%) to the Saudi Arabian GDP (Oxford Economics Report, 2011).

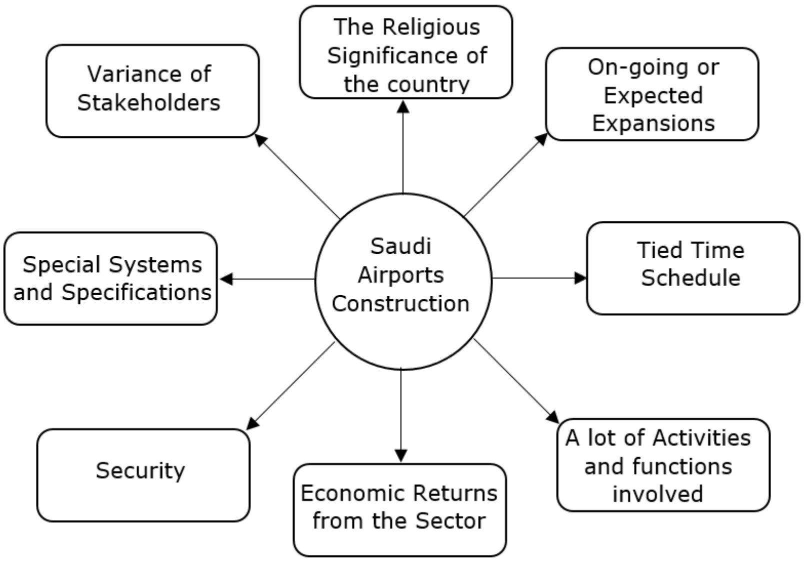


Figure 1.3: Challenges facing airport construction projects in Saudi Arabia, adopted from (Adrem *et al*., 2006; Ghavamifar *et al*., 2010; Flouris & Lock, 2012; and Alnasseri *et al*., 2013)

1.2 Problem Statement

Aviation is one of the most important sectors in the Kingdom of Saudi Arabia owing to the immense number of travellers journeying to and from the Kingdom each year due to it is being the first destination for Muslims on an annual basis. In recent years, the Kingdom of Saudi Arabia has initiated a largescale construction programme with the objective of building more airports (Al-Jarallah, 1983). In 2010, tenders for approximately US$4.5 billion were released by the government for developing and building infrastructures for the air sector only. By 2020, it is expected that investment in the air sector will be US$10–20 billion with private investors. This investment reflects the increasing demand for more infrastructure for travellers (Emerging Markets Monitor, 2010). Moreover, GACA is also adhering to plans to expand its coverage of airport development projects worth approximately US$667 million. Currently, GACA has already begun to develop 16 domestic airports, taking into consideration the demand of travellers (Fenton, 2010).

Nonetheless, risks are typical reasons for delays or cost overruns (Akintoye & MacLeod, 1997). Moreover, time delay and cost overruns are common elements inherent in construction projects in Saudi Arabia. In a study performed by the academics Assaf & Al-Hejji in 2006, which, notably, is based on a survey including a number of clients, contractors and consultants involved in large construction projects in Saudi Arabia, it was found that 70% of all projects involved in the study experienced some degree of time delay. Although cost overruns and time delays are typical outcomes stemming from risks and uncertainties involved in construction projects (Wang & Chou, 2003 and Wysocki, 2009), it is still the case that such outcomes increase the overall importance of the completion of risk allocation (Ghavamifar *et al*., 2010). Furthermore, according to an initial field survey (Preliminary Study) completed by the researcher in 2013, domestic and regional airports are found to be facing a number of time delays and cost overruns in the majority of their projects, such as the case of Al-Qassim, Al-Taif, and Jizan. One of the main reasons for the occurrence of such delays, according to the body of Domestic and Regional Department of the GACA, is that risks are not allocated to the party with the ability to manage them, or the party who caused the risks. In addition, international airports are also encountering delays such as in the case of the new Jeddah International Airport, which was due to be operating in 2011 but which subsequently announced its opening date of 2014; it now expects to operate in 2015 (KFH Research Ltd, 2013). However, the commencement of operations for the airport has not been announced until now.

Waite & McDaniel (2012) clarify the importance of utilising a suitable and comprehensive risk management process, and further highlight what it can bring to airports from two different perspectives: the first is internal, which is created by assisting administrators and managers to increase understanding in terms of risk profiles, the anticipation of financial performance, risk mitigation, decision-making, and the increase of opportunities; whilst the second is risk management, which assists organisations in achieving external stakeholders' and legislators' expectations. Therefore, adequate risk allocation has to be applied as part of the overall risk management process as it enables risks in the completion of airport projects to be managed properly (Nielsen, 2007). However, it is stated that appropriate risk allocation is essential to the success of these construction projects, and obviously depends on the risk, and several other factors, such as client appetite (Ghavamifar *et al*., 2010). Moreover, Levitt & Ashley (1980) state that the allocation of construction risks between owners and their contractors has a significant impact on the total construction costs paid by owners.

Hence, this research has been carried out with a view to devising such a solution to the current problem of risk allocation for risks associated with aviation projects in Saudi Arabia. Furthermore, it is aimed at replacing the existing practice of risk allocation with a risk allocation framework that is based on a well-developed strategy, taking into consideration the well-defined principles of risks.

1.3 Aim and Objectives

The aim of this research is to develop a framework for adequate risk allocation in specific consideration of GACA projects. This will be achieved through a number of objectives, outlined as follows:

O1. To carry out a comprehensive literature review of aviation construction project risks.

O2. To identify the risk factors associated with GACA projects.

O3. To assess the overall importance of the identified risks, by:

O3.1 Examining the impacts of the identified risks in the context of GACA projects; and

O3.2 Examining the likelihood of occurrence of the identified risks in the context of GACA projects.

O4. To find out the basis on which risks are allocated to parties in the context of GACA projects.

O5. To investigate the perception of risks allocation performed in the context of GACA projects.

O6. To develop a framework for suitable risk allocation within GACA projects.

1.4 The Impacts and Outcomes of the Research

It is thought that identifying the stakeholders for this research would be valuable in order to determine the potential outcomes and impacts of the research upon all parties (see Figure 1.4).

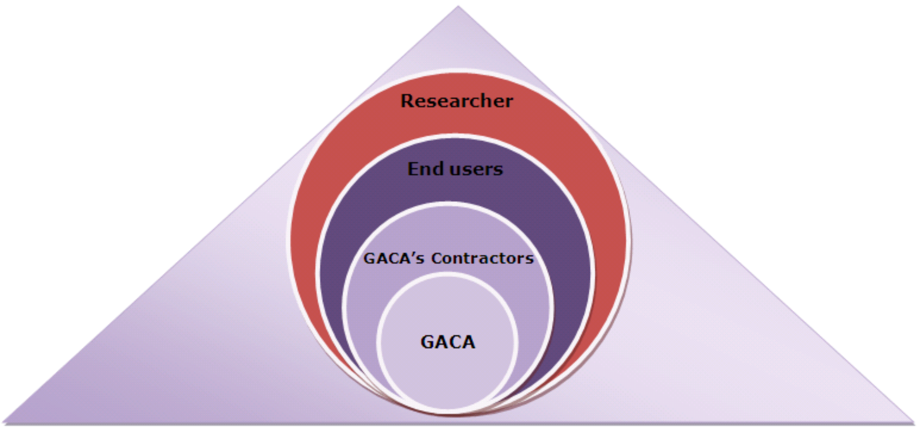


Figure 1.4: The stakeholders of the research

However, the expected outcome of the research—which has been stated previously—is to develop a framework in line with objectives believed to have major impacts on the stakeholders of the research. These impacts are as follows:

1. To minimise the number of time delays found within the majority of GACA projects.
2. To determine the party most capable of handling the risks arising in aviation construction projects in Saudi Arabia (financial and technical impacts).
3. To minimise, reduce or altogether eliminate the risks and uncertainties, and their consequences, associated with aviation construction projects in Saudi Arabia (namely financial and technical impacts).
4. To assist the GACA in Saudi Arabia in planning their future projects in the light of a proper risk allocation framework (strategic impacts).

1.5 Scope of the Research

There are three types of airport in Saudi Arabia, all of which are in operation under the GACA, namely domestic, regional and international. It was the intention that this research would cover the previous three different types of project; however, due to the difficulties of reaching the project managers of international airport projects, and the conservativeness that has been shown by contractors of these projects, it was decided that both international projects would be excluded from the scope of the research (International King Abdulla Airport in Jeddah and International Prince Mohammed Airport in Medinah).

The projects (domestic and regional airports) included were all undertaken in line with traditional type of procurement (Design-Bid-Build); this is believed to impact on the proposed framework of risk allocation to be applied to GACA projects. On the other hand, it has been found that international airports in Saudi Arabia vary in their use of procurement.

As a result, this research focuses on the following:

- Risks associated with GACA projects undertaken by traditional type of procurement; this includes domestic and regional airports.

- The perception of the GACA concerning the allocation of these risks.
- The way risks are allocated.
- Establishing a framework for the adequate allocation of risks, which incorporates a solid strategy based on well-defined principles of risks allocation.

1.6 Research Methodology

This research benefited from the use of a mixed method approach. This was chosen to help to achieve the aim and objectives outlined previously in this chapter. This approach begins with the completion of a wide-ranging review of the literature centred on the risks associated with aviation construction projects and other types of project, and their allocation. This is followed by a series of interviews. The interviewees represent the three main groups involved in GACA projects, namely GACA, contractors and consultants.

Subsequently, the designed questionnaire is distributed amongst professionals who are involved, or have been involved, in GACA projects. Again, the selection of the questionnaires' respondents is made according to the three categories of interviewees, as identified above. The questionnaire aims to investigate the importance of the risks identified, in addition to their actual allocation. As two tools are involved in the data collection process, there are two types of analysis: quantitative and qualitative. Finally, the framework is outlined and practically validated. However, the methodology used in this research will be discussed in more detail in Chapter 3.

1.7 Structure of the Thesis

The thesis is structured as follows:

Chapter One—Introduction: This chapter provides a general background on aviation construction projects in Saudi Arabia, and their overall importance to the country and its economy. Following this, the research problem is stated, as well as the research aim and objectives. The chapter also covers the research's originality and scope, and concludes with a briefing about the methodology of the current research.

Chapter Two—Literature Review: This chapter provides a critical review of topic-related previous studies. A revision of the risk management process is conducted with emphasis on the risk allocation process and its principles. Subsequently, similar studies on the various risks associated with aviation and similar projects in different contexts are outlined. This is followed by a critical review of studies focusing on the perception of risks within different contexts; this sheds light on frameworks that have been developed by different authors in the suitable allocation of risks.

Chapter Three—Methodology: This chapter explains the methodology undertaken across the study, in four different stages. An explanation of the initial stage of the research is provided after, with expansions on the data collection, data analysis and development stages then discussed. The chapter clarifies the methods used for data collection, as well as the sample selected and statistical methods used for analysis.

Chapter Four—Results and Analysis: The fourth chapter presents the research results, as generated from the interviews and questionnaires. The chapter is broken down into three parts: the first part deals with a qualitative analysis of the results generated with interviews; the second part provides a quantitative analysis of the results generated from the questionnaire on the risks associated with GACA projects and the importance of such risks; and finally, the third part details the quantitative analyses of the results garnered from the second part of the questionnaire in regard to the allocation of risks.

Chapter Five—Discussion and Framework Development: This chapter discusses the achievement of the research objectives in the light of the results generated from the research, as presented in Chapter Four. Following this, the framework is presented, with its individual steps explained. The chapter ends by providing a practical validation of the developed framework. This is presented in a series of interviews.

Chapter Six—Research's Summary, Conclusions, Contribution to Knowledge, Limitations and Recommendations: The final chapter provides a general summary of the work carried out throughout the course of the research, followed by the conclusions that can be drawn. The contribution of the research, specifically in relation to knowledge, is explicated, with the limitations of the research also provided. The chapter ends by providing recommendations for future work to be undertaken.

Chapter Two: Literature Review

2.0 Introduction

The literature review undertaken in this research aims to help to achieve the outlined research objectives. This chapter is divided into two main parts: firstly, risk and its management process in construction. In this part, various related studies on risks associated with construction projects are listed and critically discussed. Notably, a greater emphasis will be on studies conducted in the context of the Saudi Arabian construction industry. This part ends by proposing a structure of risks associated with GACA projects. The second part focuses on the allocation of risk in construction projects. The emphasis in this part will be on three aspects: firstly, the principles and strategy of risk allocation in construction projects; secondly, a review of studies on risk allocation in different contexts is outlined; thirdly, a review of developed frameworks for risks allocation in construction in different contexts is outlined and critically studied. The chapter ends by identifying the knowledge gap that is found by the researcher, which will be filled by the end of this thesis.

2.1 Risk in Construction

The word 'risk' is generated from the Italian verb 'riscare', meaning 'to have the cheek to do something' (Skorupka, 2008). Moreover, the Oxford Dictionary (2013) identifies the word 'risk' as 'a situation involving exposure to danger'. With regard to the construction industry, risk is assigned different meanings in the literature; most of the literature focuses on the downside of the word, defining the term as loss, damage or adverse events with little consideration of its upsides, which can result in profits or gains.

Risks in construction projects are affected by a number of factors including: experience of the project staff, management stability, size of the project team, availability of resources, time and compression (Mahendra *et al*., 2013). In addition, there have been many attempts in the literature to link and assess the interdependency between risks and the complexity of construction projects (Lazzerini and Mkrtchyan, 2011).

Regarding the existence of risks in construction projects, some authors, such as Renuka *et al*., (2014), Banaitiene and Banaitis (2012), and Godfrey (1996) consider the early stages of a project to be the riskiest due to the lack of information availability. Hassanein & Afify (2007) disagreed with that tendency, believing what they describe as the conceptual phase to be the riskiest. Furthermore, Zou *et al*. (2006) believe that the construction phase is riskier than the conceptual phase. Hence, due to the riskiness of the construction phase the risks associated with GACA projects that have the potential to both impact these projects and to occur in these projects, particularly in the construction phase only, will be examined. However, that does not mean risks relating to other important stages of the lifecycle of construction projects will be excluded, such as planning and/or the design stage.

2.2 Risk Management in Construction

The objective of risk management has been recognised by various authors, such as Winegard & Warhoe (2003), De Azevedo *et al*., (2014), Serpell *et al*., (2015) amongst others. Furthermore, the Project Management Institute (PMI) (2004) acknowledges that risk management aims to increase the overall probability and likelihood of occurrence, as well as the consequences, of positive events, and to reduce the probability and likelihood of occurrence, and the consequences of negative events. The lack of an effective process of risk management is believed to be responsible for time delays and cost overruns in the construction industry (Shehu and Akintoye, 2010). Hwang *et al*., (2013) reported that implementing risk management is low priority in small construction projects compared to what happens in larger scale projects, and this is attributed to lack of time and budget, as well as low profit margin. Renuka *et al*., (2014) confirmed this using results which indicated a positive correlation between the application of risk management and improvement in project quality, cost and schedule performance of small projects.

The importance of risk management in construction projects has been widely discussed in literature as in Hwang *et al*., (2014), Kelly *et al*., (2015), and Walker (2015) and others. Accordingly, risk management has recommended for each stage of the lifecycle of construction projects. In early phases, such as the concept and the design phase, where major issues might occur due to the existence of potential risks in that phase, proper risk management needs to be performed throughout the design stage (El-dash *et al*., 2006). In addition, Chapman (2001) stressed the application of risk management in the design phase of the project and the benefits that could be gained from applying it, such as improving the project performance. On the other hand, risk management in the construction phase has been emphasised on a wider scale in the literature. The major problem with the construction phase is that risks related to other project stages can be transferred and impact on the construction phase (Coral, 2007).

There have been a number of authors who have endeavoured to devise a risk management framework in construction, namely Al-Bahar & Crandall (1990), Brown & Chong (2000), Wysocki (2009), Smith *et al*. (2013), and others. The PMI (2004) have divided the risk management framework into five processes including: risk planning, risk identification, risk analysis, risk response, and risk monitoring and control. The PMI's framework covers the main aspects of risk in projects; however, does not simply show why and how the planning step is different from the identification. Also, it separates the monitoring from the controlling step, which adds to the complexity. Hence, this framework is not considered for adoption since the researcher aims to adopt a simpler approach for risk management as the focus of the research is on one aspect of the whole process, namely risk allocation. Zavadskas *et al*., (2010) adopted a 3 steps risk management approach, including: risk identification risk analysis, and risk control. For this approach it was not clear where the response to risks is taking a place. As the focus of the current research is on the allocation of risk which is normally performed in the response step, this approach is not considered. Smith *et al*. (2013) approach the issue differently, whereby risks have to go through four main processes to be managed, including: identification, analysis, response and control. However, this research adopts the risk management model of Smith *et al*. (2013), as shown in Figure 2.1 below.

The reason for such an adoption is that the framework represents the whole process of risk management in a simple and inclusive way, as it merges risk planning and risk identification stages into one stage, defined as the risk identification stage. Moreover, it incorporates risk monitoring and control in one stage, defined as the risk review stage. This incorporation is thought to be logically valid, as monitoring and controlling are two activities that cannot be separated from each other. Nevertheless, the adopted framework is discussed below.

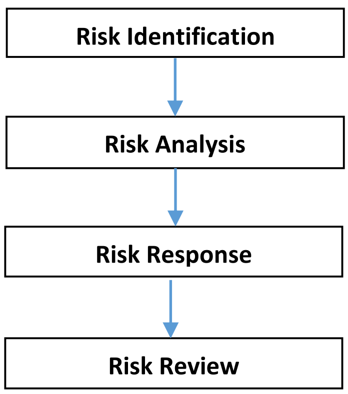


Figure 2.1: The process of risk management (adopted from Smith *et al*., 2013)

2.2.1 Risk Identification

In this process, risks that have an impact on the project, as well as their attributes, should be identified, specified and documented in a way that facilitates the project team in getting back to them when necessary (Gardiner, 2005). Williams (1995) describes this stage as the most difficult process amongst the processes of risk management. Bajaj (1997) states that, if the process of risk identification is not applied, risk management actions, such as control and transfer, will not exist. Moreover, a number of risk-identification techniques are outlined by Adams (2008), including brainstorming, checklists, risk records, prompt lists and interviews.

However, Al-Bahar & Crandall (1990) justify the importance of the use of the categorisation technique in the identification step, considering two reasons, namely increased awareness surrounding those risks that may be involved in a project and the variance of mitigation strategies potentially resulting from the nature of a certain risk. Therefore, a number of authors have classified risk differently, such as Bing *et al*. (2005), El-Sayegh (2008), Tsai & Yang (2010), and Ogunsanmi *et al*. (2011). The most common classification found in the literature is the classification of risks into sub-categories and risk-related factors.

2.2.2 Risk Analysis

This process is identified as 'the process of identifying and analysing programme areas and critical technical process risks to increase the likelihood of meeting cost, performance and schedule objectives' (Kerzner, 2006). Moreover, risk analysis aims to determine the overall likelihood, severity and impact of risks (Adams, 2008).

There have been a number of risk assessment methods adopted by various authors. For example: Project Evaluation and Review Technique (PERT) by Reiss (2013), Probability and Impact (P&I) by Mills (2001), Monte Carlo Simulation (MCS) by Kwak and Ingall (2007), Analytical Hierarchy process (AHP) by Dey (2002) and Abdelgawad *et al*. (2010), Likelihood occurrence of risk (LR), and Fuzzy Logic by Tamosaitiene *et al*. (2013). Renuka *et al*. (2014) realised the tendency towards using AHP, MCS and LR compared to other techniques. Also, they confirmed that the adoption of these techniques has given good results in assessing project risk in construction projects. However, as these three techniques require a certain amount of data and information at the initial stage, applying these techniques is difficult in certain projects where practitioners may not have enough data at that time. Also, it is important to utilise a simple approach for assessing risks as simplicity can be a vital factor for encouraging professionals to use risk assessment tools in practice (Renuka *et al*., 2014).

Hence, due to the abovementioned reasons, this research has adopted the simple approach of risk assessment by Mills (2001), which measures the risk impact (RI) by multiplying the likelihood occurrence of the risk (L) and the risk negative consequence (C), as shown in the following equation: $RI = L \times C$. This approach is centred on the two main pillars of any risk that might be faced in projects, namely, the impact and likelihood of occurrence of the risk itself. Furthermore, this approach will also be used later on in the research to assess the risks associated with GACA projects. The researcher was also aware that the assessment step is not the focus of the research; hence, a simple approach to assess risk in the context of the research is adopted. This approach is considered to be one of the most prevalent methods of analysing risk in construction projects is the evaluation of risk from two perspectives, namely impact (severity) and likelihood (probability) (ACRP, 2012). However, Burduk & Chlebus (2009) and Banaitiené *et al*. (2010), amongst others, divide the techniques used in the process of risk analysis into two categories, namely qualitative and quantitative.

- **Qualitative Methods**

Smith *et al*. (2013) claim that, in any risk management process, the first stage is always recognised as qualitative in nature, and as forming the ultimate foundation of any subsequent stage (Smith *et al*., 2013). However, PMB (2008) identifies a number of qualitative techniques, such as probability and the impact assessment of risk, probability and impact matrix, risk data quality assessment, and risk classification (or risk categorisation).

Risk probability and the impact assessment technique investigate the positive and negative consequences of any identified risk. Early on in this technique, interviews with parties who have the ability to deal with risk are required, including individuals from outside as well as inside the project. Following this, the identified risks should be classified into different levels, according to the likelihood of occurrence and the potential impact, as shown in Table 2.1 and Table 2.2 (Martin, 2001).

Tables 2.1 and 2.2 Risk Impact and Risk Probability Rating (Martin, 2001)

Impact Rating	Meaning
Zero	There is no impact of this risk
Low	The impact on the project is minor
Medium	The impact on the project is not insignificant and would

Probability Rating	Meaning
Zero	There is no chance that risk will occur
Low	The probability that this event will occur is between 1-40 %
Medium	The probability that this event will occur is between 41-70 %

	cause the team to miss the deadline		
High	The impact on the project is significant	**High**	The probability that this event will occur is between 71-99 %

- **Quantitative Methods**

The quantitative analysis is applied in order to measure the consequence of risks through the use of techniques such as the decision tree, sensitivity analysis and Monte Carlo. The objective of this analysis is to specify the extent of exposure of risk, as well as identifying risks and their corresponding areas, in order to develop such a responding decision (Gardiner, 2005). The application of quantitative methods in the process of risk analysis is not common. A significant number of projects have been delivered successfully without applying such an analysis. In most cases, the use of the quantitative methods usually follows the use of qualitative methods (Gardiner, 2005).

2.2.3 Risk Response

The process of risk response, as identified by Kerzner (2006), is 'the process that realises, assesses, decides, and carries out one strategy or more to deal with risk at acceptable levels'. However, Champ & Ward (2007) identify four strategies that can be selected in the process of response, namely risk avoidance, risk reduction, risk transfer and risk retention. Also, these strategies were agreed by Akintoye *et al*., (2000).

- **Risk Avoidance:** If any contractor uses this strategy, he/she knows that they will not be exposed to any loss event or gain (Al-Bahar & Crandall, 1990). One of the most common uses of risk avoidance is when a contractor withdraws from bidding on a very risky project or due to failure in the negotiation of risk allocation (Baker *et al*., 1999).

- **Risk Reduction or Prevention:** Al-Bahar & Crandall (1990) identify two programmes aimed at decreasing exposure towards risk events that contractors might encounter, including reducing the probability of risk and reducing the financial severity if such a risk occurs. |A risk reduction strategy can be carried out by adjusting specific features and characteristics of the project (Smith *et al*., 2013).
- **Risk Retention or Acceptance:** When a contractor decides to assume the risk and its financial impact by him-/herself. Nevertheless, there are two types of risk retention, including planned retention, when a contractor identifies risks and retains the risk in line with their own capabilities, and unplanned retention, which is when the contractor underestimates the likelihood of risk occurrence and the consequences of risk (Al-Bahar & Crandall, 1990).
- **Risk Transfer:** According to Thompson & Perry (1992), the transfer of risks can lead in two different directions: (1) transferring the property or activity responsible for the risk, as in the case of hiring a subcontractor to perform a hazardous work, for instance; or (2) the retention of the property or activity, with the transfer of the financial risk, such as through the use of insurance, for example.

2.2.4 Risk Monitoring

This process aims to evaluate the overall efficiency of the strategy adopted in the process of risk response; however, this evaluation, consequently, may lead to implementing more response strategies in an effort to guarantee the coverage of all associated risks. Within this process, some new risks can arise (Kerzner, 2006).

2. 3 Studies on Risks and their Classifications in Construction Projects

A number of studies have focused on the risks inherent in construction projects, as explained below. As per the context of this research—centred on aviation construction projects in Saudi Arabia—thus far, there has not been a study conducted in Saudi Arabia or elsewhere that has provided a clear identification of risks and their categories; hence, a number of studies which have focused on risks in construction projects have been considered in this research, which highlights risks in different contexts, in an effort to help the researcher in terms of understanding the topic, as well as narrowing down the study scope to achieve the second objective, as outlined in Chapter One.

However, the top priority when selecting studies was to focus on those studies conducted in the context of Saudi Arabia. Following this, a number of studies in different contexts were reviewed, from closer locations, such as the Arabian Gulf, through to America. This was thought to keep the focus on the risks that might be associated with aviation construction projects in Saudi Arabia. However, the studies reviewed are listed and accordingly discussed below.

- **The Saudi Arabian Context**

With regard to the Saudi construction industry, the researcher identified eight studies focusing on the risks leading to time delays and cost overruns, covering a wide variety of construction projects across the country, as shown in Table 2.3. It has to be noted that, despite the wide coverage of projects in the abovementioned studies, as far as the researcher is concerned, there has not been any study that has attempted to capture risks inherent in the aviation sector within the country.

Table 2.3: Studies on risks in construction projects in Saudi Arabia

Authors and Year	**Location and Type**	**Number of Risks**	**Methods Used**
Al-ghonamy and Aichouni (2015)	Construction projects in Northern province	53 Risks	Literature + Survey + Interviews
Ikediashi *et al*. (2014)	Infrastructure projects in the city of Jeddah	30 Risks	Literature + Interviews (Pilot) + Survey
Al-Kharashi and Skitmore (2009)	Public utility projects in unknown areas	112 Risks	Literature + Survey
Albogamy *et al*. (2012)	Public construction projects in unknown areas	63 Risks From literature reduced to 31 Risk	Literature + Survey
Assaf and Al-Hejji (2006)	Public construction projects in unknown areas	73 Risks	Literature + Interviews + Survey
Arain *et al*. (2006)	Construction projects in unknown areas	42 risks	Literature + Interviews
Al-Khalil and Al-Ghafly (1999)	Public construction projects in unknown areas	60 Risks	Literature + Interviews + Survey
Assaf *et al*. (1995)	Large building projects in unknown areas	56 Risks	Literature + Interviews + Survey

The most recent study carried out by Al-ghonamy & Aichouni in 2015 reveals that there are 33 risks that could potentially impact construction projects in the Northern Province of the country. Moreover, a total number of 51 consultants were interviewed and questioned to identify the important risks faced in the context of the study. As a result, five risks were found to be very important, including a bid award for the lowest price, changes in material types and specification during construction, contract management, the duration of the contract period, and the fluctuation of material prices. The authors made use of statistical analysis to determine whether or not an agreement amongst respondents' answers could be established in regard to the importance of the risks; this was successful. The use of such an analysis gives the study credit due to the fact that statistical analysis can be used to test the overall reliability of the answers; however, the authors failed to establish the views of other experts representing clients and contractors, which could have given the study a more cumulative overview.

In 2014, Ikediashi *et al*. established 30 risks as having an impact on infrastructure projects in the city of Jeddah. In this study, which included respondents from clients, contractors and consultants who had participated in largescale construction projects in Jeddah, an agreement amongst respondents was found in relation to the risks with the highest importance. The risks of a poor risk management plan, budget overruns, poor communication between parties, project schedule delays, and poor estimation practice were found to be amongst the most important risks. The authors classified the risks into eight classifications, as follows: Project management deficiencies, Risk challenges, Project team commitment, Ethical issues, Government interference, Constraints imposed by stakeholders, Financial and schedule challenges, and User requirements.

Al-Kharashi & Skitmore (2009) studied the risks inherent in public construction projects. The authors identified a total of 112 risks, and accordingly classified the risks into six main classifications according to their sources, as follows: client, contractor, consultant, materials, labour and contract. A general disagreement on the most important risks was identified amongst the three categories of the study respondents (client, contractor, and consultant); however, the client and consultant groups agreed that the risks of contractor experience and contractor poor qualification were amongst the most important risks (in their view). Furthermore, the risk of shortage in labour was the only risk that was agreed upon by three categories of respondents as being amongst the most important risks. This study involved a lack of statistical analyses, which is recognised as potentially able to improve the process of qualitatively identifying the differences between respondents' views on risks. Moreover, the study included five undefined major projects in the country; these were undefined, making it hard to glean a clear indication of the construction industry in the country in general.

Another study by Albogamy *et al*. (2012) identified a total of 31 risks from 63 risks, identified from the literature review, related to public construction projects in Saudi Arabia. These risks were classified into 7 groups according to their sources, as follows: Materials, Project and development, Supplier and contractor, Owner, Consultant, Design and scheme, and External. The study was based on a survey distributed to a total number of 38 owners, 29 contractors and 31 consultants, all of whom were seen to have wide-ranging experience in the construction industry of the country. The authors found that a poor tendering system, delays in sub-contractors' work, poor qualifications, skills and experience amongst contractors' technical staff, poor planning and scheduling of the project by the contractor, and pPayment delays by the owner are the risks that have the highest impact and likelihood of occurrence amongst other identified risks. Nevertheless, this study failed to show whether a significant difference could be statistically realised between the three groups of participants, which could have strengthened the reliability of the results and the study in general.

A number of large construction projects have been studied by Assaf & Al-Hejji (2006) with regard to the risks that have impacted on these projects. The authors carried out the survey as a method of identifying the most important risks amongst a number of construction experts, including owners, contractors and consultants. As a result, 73 risks were identified and classified into 9 groups, in line with their sources, including project, owner, contractor, consultant, design, material, equipment, labour, and external. The results regarding the most important risks were analysed, taking into consideration each group of respondents' most important risks. The client group perceived the risk of labour shortage and disqualification of labour as being amongst the top risks impacting their projects. On the other hand, the contractor group put the risks of payment delays and delay in obtaining approval from the owner as their top risks. The consultant group assigned most responsibility to the system of bidding used by the owner and the shortage of labour as being amongst the most important risks. Therefore, general disagreement between the three groups concerning the importance of risks was noted; however, change orders was the only risk captured by the three groups of respondents as being amongst the top five most important risks. One of the weaknesses of this study is that the authors determine the importance of each identified risk without paying attention to the impact and likelihood of occurrence. Moreover, as in some of the previous aforementioned studies, a statistical analysis could have been employed to enhance the overall reliability of the results and to accurately determine the differences between the participants.

Arain *et al*. (2006) investigated the risks in a number of construction projects, and accordingly found 48 associated risks. The risks identified were only related to the causes of inconsistencies between design and construction. The authors found that the involvement of the consultant as a designer, communication gap between contractor and designer, insufficient working drawings details, lack of coordination between parties, and lack of personnel in design firms were amongst the top risks in the views of the 27 questioned and interviewed participants. The study did not consider the views of owners or consultants, as it was based on the views of contractors only, which means the study was not cumulative. Furthermore, the authors did not state the projects involved in the study or the sample method implemented.

In 1999, Al-Khalil & Al-Ghafly carried out a study centred on examining the risks associated with public utility projects in the country. Clients, contractors and consultants were interviewed and surveyed. The findings revealed that 60 risks were believed to impact on utility projects, which then were classified into six groups, including contractor performance, owner administration, early planning and design, government regulations, site and environmental conditions, and site supervision. The authors statistically calculated the following risks to be amongst the five most important risks, according to the respondents' views collectively: cash flow problems faced by the contractor, difficulties in financing the project by contractor, difficulties in obtaining work permits, tendering system (choosing the lowest), and payment delays. However, blaming relationships was realised amongst the participants as being one of the most important risks, with obvious disagreements realised amongst the participants, particularly the groups of clients and contractor. Again, the study did not determine the risks' impact and likelihood of occurrence, but instead considered importance.

A study by Assaf *et al*. was introduced in 1995 with a view to identifying the risks associated with large construction projects across the country. This study has been well-cited in the context of Saudi construction literature as it is considered to be one of the first studies focusing on risks in that particular context. In this study—which notably used a survey as the main tool for obtaining data—determined 73 risks, as identified by owners, contractors and consultants, all of whom had been involved in the construction industry in Saudi Arabia. The risks identified were classified into nine groups, according to their sources, including Material, Manpower, Equipment, Financing, Environment, Changes, Government relations, Contractual relationship, and Scheduling and controlling. The authors found the financial group of risks to be the most significant risks impacting construction projects in the country; however, the study examined the risk ranking for each group of participants, performed on an individual basis, and found that design errors, bureaucracy, and labour issues were amongst the top risks according to clients. The contractor blamed the consultant for delaying approvals and payment, and for changes made to the design. The consultants ranked cash flow and slow decision-making as amongst the top risks. The authors did not respond to the issue of disagreements from the point of view of the contractor; in other words, no statistical test was conducted in order to determine the statistical differences between the groups' views.

➢ **The Arabic Gulf Context**

With regard to the literature on the risks associated with construction projects, three studies observed the risks inherent in the construction industry in three different Arabian Gulf countries, namely United Arab of Emirates, Oman and Kuwait, as shown in Table 2.4. The reasons for including these studies are due to the fact that such regions are neighbouring countries in terms of geographical location, as well as the fact that they share a number of factors that potentially could impact on the construction industry, such as similarities in culture, high dependability on foreigner labour, and other factors.

Table 2.4: Studies on risks in construction projects in the Arabic Gulf

Authors and Year	**Location and Type**	**Number of Risks**	**Methods Used**
El-Sayegh (2008)	Construction projects in UAE	42 Risks	Literature + Survey
Alnuuaimi & AlMohsin (2013)	Construction projects in Oman	49 Risks	Literature + Interviews (Pilot) + Survey
Kartam & Kartam (2001)	Construction projects in Kuwait	26 Risks	Literature + Survey

Abdulaziz *et al*. (2015)	Construction projects in Qatar	37 Risk	Literature + Survey

In the United Arab Emirates, a well-established study was conducted in 2008 by El-Sayegh. The study identified 42 risks concerning construction projects in the country, all of which were classified into two main groups according to their sources, namely internal risks and external risks. The internal classification of risks deals with risks that project participants have control over; hence, there were also five sub-classifications, including owner, designer, contractor, subcontractor and supplier. On the other hand, the external risks dealt with risks that were out of the control of any of the projects participants, including political, social and cultural, economic, natural and others. As the external risks appear to be generated as a result of the project environment by the author, a need for a third classification to deal with risks that do not occur due to the project environment is obvious here, such as that of force majeure risks. The study surveyed a number of construction practitioners in the UAE, including owners, designers, contractors, and consultants. As a result, inflation, tight schedules by owners, poor performance by subcontractors, delays in material supplies by suppliers, and design changes by owners were found to be amongst the most important risks believed to cause time delays and cost overruns in the context of the study. The study provided a strong statistical analysis, as well as qualitative analysis with regard to the results from the different respondents that impacted on the reliability of the study's results. Another strength of the study is that the values of the risks' impact and the overall likelihood of risks was calculated in order to determine the importance of each risk, which is a very accurate way of determining the importance of risks.

Alnuuaimi & AlMohsin (2013) investigated the risks in construction projects in Oman across two different periods, namely 2007/8 and 2009/10. The study did not specify the method used for gathering the data from the participants, who were clients and consultants. Moreover, it also failed to include contractor views with regard to the risks faced in the context of the study, which is recognised as enhancing the study and making the results more comprehensive. However, the authors found Weather, Variations and claims, Design changes, Lack of funds, and Changes of laws to be the most important risks amongst 15 risks encountered during the period 2007/8. On the other hand, 34 risks were identified in the period 2009/10, with five risks found to be amongst the most important risks, including Planning and programming construction work, Poor construction experience, Material shortage, Failure in the practical work programmes, and Design changes. The researchers further found that risks relating to the client are believed to have a strong impact on construction projects in Oman in terms of cost overruns and time delays.

In Kuwait, Kartam & Kartam (2001) interviewed and surveyed 31 contractors who had been involved in the construction industry in the country, and accordingly identified 26 risks associated with construction projects in Kuwait. Financial failure, Payment delay, Labour, Material and equipment availability, Defective design, and Coordination with subcontractor were found to be amongst the most important risks, according to the views of the respondents. Importantly, although the authors attempted to use statistical analysis to quantify the importance of risks in line with the views of contractor respondents, the results of the study are thought to be biased. In other words, the lack of consideration for clients' and other construction participants' views is an obvious weakness of the study.

In Qatar, Abdulaziz *et al*. (2015) found 37 risks to be associated with construction projects in the state. The study targeted 127 contractors, all of whom were involved in the Qatari construction industry, and found that client-related risks are the most critical, followed by consultant-, and contractor-related groups. The authors investigated the importance of each risk, and found that slow decision-making processes by clients, delays in payment processes by clients, frequent changes in orders by clients, errors and omissions in design drawings, and unavailability or shortage in specified materials are the most important risks. However, the authors did not attempt to quantify the impact and the probability of risks; rather, they went straight on to importance in the questionnaire.

- **The Middle East Context**

In the Middle East, where Saudi Arabia is located, a number of studies have considered risks in the context of construction projects in different countries, such as Turkey, Iran, Jordan and Egypt, as shown in Table 2.5. It should be noted that the countries previously mentioned in the Arabian Gulf are still located in the Middle East region. However, because of the similarities those countries have in common with Saudi Arabia, this research separated them.

Table 2.5: Studies on risks in construction projects in the Middle East

Authors and Year	Location and Type	Number of Risks	Methods Used
Khodeir & Mohamed (2015)	Construction projects in Egypt	63 Risks	Literature + Survey
Sweis *et al*. (2008)	Residential building in Jordan	40 Risks	Literature + Interviews + Survey
Gündüz *et al*. (2012)	Construction projects in Turkey	26 Risks	Literature + Survey
Khoshgoftar *et al*. (2010)	Construction projects in Iran	28 Risks	Literature + Survey

In Egypt, Khodeir & Mohamed (2015) studied 65 risks associated with construction projects. A large sample was obtained, including consultants, contractors (large projects with a budget of more than US$40 million), and governmental companies. This study was based on the following: Literature (Initial identification of risks), Interviews (Validation of the initial risks identified) and Questionnaires (for ranking risks). The study identified five risks as having the highest importance amongst others: currency fluctuation, changes in taxation, change energy cost/lack of fuel, safety/ unsecured roads, and official changes.

Sweis *et al*. (2008) investigated the risks associated with residential buildings in Jordan, and identified 40 risks. The authors were seen to rely on the Drewinis Open Conversation System to classify the risks into thee levels: Input factors (including labour, material, and equipment), Internal environment (including owner, contractor and consultant) and Exogenous factors (including weather and government regulations). This classification is a sophisticated version of the previous classification adopted by El-Sayegh (2008), where internal and external levels of risks were introduced; however, in this study, the authors allocated a third classification of risks—that is, risks that do not relate at all to the environment of the project, such as force majeure risks. In this study, a random sample was taken to represent respondents from three groups, namely client, contractor and consultant. The client and consultant groups were seen to focus the blame on the contractor group in causing delays in delivery and cost overruns, by indicating poor planning by the contractor, and financial difficulties by the contractor, as the most important risks. In contrast, the contractor respondents blamed the owner for making too many changes during construction and the shortage of labour.

In Turkey, Gündüz *et al*. (2012) studied the risks inherent in construction projects in the country. A total of 83 risks were realised and categorised into 9 classifications, including client, contractor, consultant, design, equipment, labour, material, project-related factors, and external factors. Contractor-related risks were found to be the first category of most important risks impacting on construction projects, particularly inadequate contractor experience, ineffective project planning and scheduling by the contractor, and poor site management and supervision. This was followed by owner-related risks, more specifically, design changes throughout the stage of construction. However, no statistical test was employed to determine the differences in responses between the 64 highly experienced project managers, site managers, technical office managers, technical office engineers, procurement managers, and technical consultants. Moreover, the authors failed to determine the impact and likelihood of occurrence of the risks, a point which has been noted for the majority of the reviewed studies.

Khoshgoftar *et al*. (2010) chose to implement convenience sample, including samples from clients, contractors and consultant groups, to investigate risks and their importance associated with construction projects in Iran. The results of this study revealed that the risks of finance and payments of completed work, improper planning by contractors, site management, contract management, and lack of communication between parties were the five most important risks affecting Iranian construction projects. Again, no calculation of any difference between the three groups of respondents was realised, which is seen to have an effect on the validity and reliability of the results. Moreover, the impact and likelihood of the occurrence of risks were not ascertained, with the authors asking the respondents to directly rank the importance of risks in the questionnaires.

- **The Asian Context**

Regarding studies conducted in Asia, the researcher found three studies that investigated risks and their importance in construction projects in Pakistan, Indonesia and China, as summarised in Table 2.6. Although one can argue that the context of these projects is different compared to that of Saudi Arabia, the researcher believes that, with a greater involvement of studies in different contexts, there will be better understanding, which will positively impact on the research.

Table 2.6: Studies on risks in construction projects in the Asian context

Authors and Year	Location and Type	Number of Risks	Methods Used
Choudhry & Iqbal (2012)	Construction projects in Pakistan	20 Risks	Literature + Survey + Interviews
Andi (2006)	Residential building in Indonesia	27 Risks	Literature + Interviews + Survey
Zou *et al*. (2007)	Construction projects in China	85 Risks	Literature + Survey

Choudhry & Iqbal (2012) studied the risks associated with construction projects in four Pakistani areas, and accordingly identified 20 risks. The risks were ranked according to their importance, without acquiring their impact or likelihood of occurrence, based on the views of 80 respondents who were represented through three groups, namely client, contractor and consultant. Financial factors, economic factors, quality, premature failure of facility, and lack of planning and management were the five most important risks; however, the authors employed a statistical analysis to show the difference between the three groups' views on risk importance. As a result, only six risks were shown to have differences with regard to the respondents' views. Nevertheless, the authors conducted a number of interviews with a number of the respondents after having all results of the questionnaires analysed.

In Indonesia, Andi (2006) identified 27 risks concerning construction projects in the country. In the study, which included clients and contractors, the risks identified by the study participants were design-related risks and unstable client requirements. Moreover, significant differences in the respondents' perceptions concerning the importance of risks related to the contractor's competence were realised as a result of completing a one way ANOVA test. As with the previously mentioned study, the authors carried out a number of interviews with experts to discuss the results generated from the study prior to its publication.

Zou *et al*. (2007) investigated the risks associated with Chinese construction projects, including infrastructure, housing, public assets and commercial buildings, and accordingly highlighted 85 risks. The risks identified were classified into seven groups: client, designer, contractor, subcontractor, government agencies related risks, and external issues. As a result of conducting a number of interviews and in consideration of the data obtained from 83 construction practitioners in China, project-funding problems, contractors' poor management abilities, difficulties with reimbursement, unwillingness to buy insurance and a lack of awareness of construction safety and pollution were the risks found to be the most important in the context of Chinese construction projects. The majority of significant risks were contractor-related risks, followed by designer-, and client-related risks. The study concluded that the contractor-related risks can influence all the project objectives, whilst risks related to designers, subcontractors/suppliers, government bodies and external issues have a lesser influence.

- **African Context**

With regard to the risks inherent in African construction projects, Table 2.7 summarises two studies carried out in Nigeria and South Africa. Once again, the purpose of having to review studies in different contexts is thought to reflect on the understanding of the researcher and thus is useful for widening his views on risk that could be relevant to the context of the current study (GACA construction projects).

Table 2.7: Studies on risks in construction projects in the African context

Authors and Year	Location and Type	Number of Risks	Methods Used
Aibinu & Odeyinka (2006)	Construction projects in south western Nigeria	46 Risks	Literature + Survey
Mukuka *et al*. (2015)	Construction projects in Gauteng in South Africa	27 Risks	Literature + Interviews + Survey

In 2006, Aibinu & Odeyinka found 44 risks associated with south-western construction projects in Nigeria. The authors categorised the risks into nine groups: client, quantity surveyor, architect, structural engineer, services engineer, contractor, subcontractor, supplier-related factors, and external factors. A total of 100 construction managers were sent a questionnaire to rank risks according to their importance. This resulted in five risks being found to be the most important risks, including Contractors' financial difficulties, Clients' cash flow problems, Architects' incomplete drawings, Subcontractors' slow mobilisation, and Equipment breakdown and maintenance problems. A statistical test was carried out in order to establish the significant differences between the respondents' opinions; however, the authors failed to determine the risks' impact and overall likelihood of achieving more accurate values for the importance of the risks.

In Gauteng in South Africa, Mukuka *et al*. (2015) highlighted 54 risks inherent in construction projects. These risks were categorised, according to their relationships to their causes, into seven groups, including Owner-related, Contractor-related, Consultant-related, Material-related, Equipment-related, Labour-related, and External Factors. The sample of the study's participants was a combination of architects, quantity surveyors, civil engineers, construction mangers and project managers, all of whom have worked in construction projects in Gauteng. The results of the questionnaires reveal that the risks of slowness in the decision-making process, reworks due to errors during construction, delays in approving major changes in the scope of work, delays in material delivery, shortages in skilled equipment operators, the low productivity level of workers, delays in obtaining permits from municipalities, and workers' risky behaviours are the most significant risks.

➢ **The European Context**

In Europe, two studies have been identified as associated with construction projects and their importance and classifications; these are summarised in Table 2.8. The two studies were undertaken in two different countries, namely the United Kingdom and Lithuania.

Table 2.8: Studies on risks in construction projects in the European context

Authors and Year	**Location and Type**	**Number of Risks**	**Methods Used**
Bing *et al*. (2005)	Construction projects in UK under PPP	46 Risks	N/A
Banaitienė *et al*. (2010)	Construction projects in Lithuanian	13 Risks	Literature + Interviews + Survey

In the UK, Bing *et al*. (2005) completed a well-established study to investigate the risks involved in medium and large construction projects that have been undertaken through the Public Private Partnership (PPP). Both public and private bodies were surveyed, and 46 risks were identified. The authors came up with a distinctive way of categorising the risks in line with the nature of risks found, including: Marco Level, which involve political, social, economic, legal and natural risks; Meso Level, where project selection, project finance, residual risks, design, construction, and operation risks are involved; and Macro Level, which involves third-party and relationships risks. As the focus of this study was centred on the allocation of risks, the authors did not attempt to highlight risks according to their importance.

In 2010, Banaitienė *et al*. found only 13 risks in Lithuanian construction projects. The authors classified the risks into two major categories, namely internal and external. Only 38 contractors were surveyed, identifying Statutory, Energy crises, Natural forces, Inflation and interest rates, and Fiscal policies as the most important risks under external risks. On the other hand, Level of complexity/technology, Specified quality levels, Size of project, Labour and material shortage, and Site characteristics were found to be the most important internal risks, according to respondents' views. The study shows a strength in that it uses a reliability test for the results, and includes calculations of risk impact and probabilities to quantify the significance of each risk. However, it does not make use of the opinions of other construction experts who could have different views on risks and their importance, which generally biased the study.

- **The American Context**

In the American context, two studies were reviewed, namely in Florida (USA) and in Venezuela, as summarised in Table 2.9.

Table 2.9: Studies on risks in construction projects in the American context

Authors and Year	Location and Type	Number of Risks	Methods Used
Calzadilla *et al*. (2012)	Construction projects in Venezuela	16 Risks	Literature + Interviews
Ahmed *et al*. (2002)	Construction projects in Florida (USA)	50 Risks	Literature + Survey

In 2012, a number of project managers were interviewed as part of a study conducted by Calzadilla *et al*. aiming to investigate the risks associated with Venezuelan construction projects. The study, based on a case study method, identified 16 risks classified into internal and external risks. The risk management process, organisational structure, labour unions and economic factors were realised to be the most important risks. However, due to the small sample utilised for interviews, the authors acknowledged that the results of the study cannot be generalised to the entire construction industry in Venezuela. Notably, the study used a qualitative approach to analyse the results from both case studies and the interviews.

In the USA, particularly Florida, Ahmed *et al*. (2002) surveyed 35 construction companies that have been involved in construction projects in Florida, and identified 50 risks believed to cause delays in the context of the study. Notably, the majority of the risks identified were found to be related to the contractor. The authors classified the risks (Causes of delay) into sub-categories, including Code-Related delays, Design-Related delays, Construction-Related delays, Financial/Economical delays, Management/management delays, and Acts of God. Unlike other studies, the risks identified were ranked according to their occurrence likelihood. As a result, Change order, Building permit approvals, Changing in drawings, Incomplete design, and Construction inspection were recognised as the top risks with the highest chance of occurring. On the other hand, the study examined the ranking risks' categories in terms of their chance of occurring, and found that the Design-related category had the highest chance of occurrence amongst the classifications.

2.4 A Proposed Structure of Risks Associated with GACA Projects

From reviewing the aforementioned studies, the researcher proposes a structure of risks associated with GACA projects. However, this structure is subject to verification (as will be shown in Chapter Four). The structure is based on three levels of risks, namely Internal, External and Acts of God. In the majority of the studies, there are two levels of risk—internal and external—where Acts of God risks are classified under the external level, such as in the works of Aleshin (2001), Wang & Chou (2003), El-Sayegh (2008), and Banaitienė *et al*. (2010). On the other hand, other authors, such as Kartam & Kartam (2001) did not attempt to classify the identified risks at all, but instead listed them. However, the classification performed in this research was based on the degree of control which project parties have over risks; in other words, the internal level comprises risks over which project parties have complete control, whilst the external level encompasses risks over which the project parties have partial control, whilst the Acts of God include those risks over which project parties have no control. It can be seen that, unlike other groups, the Acts of God category is considered to be at a separate level to other risks in this research. This is due to the abovementioned reason that no party has any control over these risks. The reason why the identified risks are categorised in such a way is due to the fact that knowing the party who has control of risks is one of the criteria (principles) by which risks are properly allocated within construction projects (Lam *et al*., 2007), which is one of the aspects on which the current research focuses.

Again, the studies reviewed differ in the way that they subcategorise the risks. As has been noted, as some risks were used commonly, there are a number of risk subcategories identified to fit into the proposed structure of risks, as follows:

- For the internal level: Client-related, Designer-related, Contractor-related, Subcontractor-related, and Consultant-related subcategories are included. This was decided based on the fact that these parties are the main players in GACA projects.
- For the external level: Political, Financial, Social and Environmental categories were included. The identification of these subcategories was guided by the study of El-Sayegh (2008) in the United Arab Emirates.
- For Acts of God: Natural phenomena and Weather issues were included as subcategories. Again, these two subcategories encompass risks over which project parties have no control.

A total of 44 risks were identified and thought to be associated with GACA projects. Again, the identification of these risks was driven by the review of literature and, as mentioned earlier on in this chapter, is subject to verification. The author selected the risks that were mentioned regularly in the reviewed studies, with a greater consideration given to studies that had been conducted in the Saudi Arabian context. Also, the initial preliminary study (field work) impacted on the selection of risks as a number of risks were clearly associated with GACA projects. These risks are identified and described in the following table (Table 2.10):

Table 2.10: The identification and description of risks associated with GACA projects

	Risk	**Risk Description**
R1	Payment delays	Delaying paying contractor for work that has been done
R2	Setting tight schedule by client	Imposing a very tight time schedule on contractor
R3	Inappropriate intervention by client	Client intervening inappropriately in contractor's or other parties' work
R4	Design changes by client	The amount of changes to the design made by client during the construction phase
R5	Inadequate scope	Poor scope of projects set by client and his consultant
R6	Site access delays	The increase in project time caused by difficulty of obtaining the access of a project land.
R7	Contract breaching by client	A breach of any of the contract conditions made by client
R8	Client financial failure	Difficulty in financing a project facing the client
R9	Lack of experience of client	Insufficient experience in project construction amongst client personnel
R10	Obtaining/issuing required approval	A complicated and lengthy process is required for project of work to be approved by client
R11	Design errors	Mistakes and errors committed by the designer in the design phase
R12	Incomplete design	Incomplete version of design produced by designer in the design phase
R13	Design constructability	Poor constructability of design in design phase
R14	Poor quality of design	Poor quality of design produced by designer who has not met the client expectations
R15	Poor quality of construction	Poor quality of construction produced by contractor who has not met the client expectations
R16	Lack of experience of contractor	Insufficient experience in project construction amongst the contractor personnel
R17	Contractor financial failure	Difficulty in financing a project facing the contractor
R18	Contractor low or poor work productivity	A low level of productivity caused by the contractor personnel
R19	Errors during construction	Unintentional errors occurring in the construction phase caused by contractor personnel
R20	Accidents and safety	Injuries or death cases occurring during the construction phase for contractor personnel
R21	Quality and control assurance	The process of checking and monitoring the required standard of work that is being carried out by contractor

R22	Contractor breaching by contractor	A breach of any of the contract conditions made by contractor
R23	Subcontractor poor work productivity	A low level of productivity caused by the subcontractor personnel
R24	Subcontractor breaching contract	A breach of any of the contract conditions made by subcontractor
R25	Subcontractor financial failure	Difficulty in financing a project facing subcontractor
R26	Material availability	Loss occurring due to delayed delivery of raw materials, resources, machines and equipment
R27	Material quality	Loss occurring due to poor quality of raw materials, resources, machines and equipment
R28	Lack of experience of consultant	Insufficient experience in project construction amongst the consultant personnel
R29	Inadequacy of specifications	Inappropriateness of specification sheet drawn up by consultant
R30	Quality assurance	The process of checking and monitoring the required standard of work that is being carried out by consultant
R31	Bureaucratic problems	Delay caused due to bureaucracy by client
R32	Threat of wars	The stability of the country with regard to external and internal wars
R33	Labour issues	The legality roles that have been set by governments for workers to stay in the country
R34	Corruption	Corruption behaviour by government officials
R35	Changes of law	the increase in project cost and time caused by changes of law and regulations and governmental policies
R36	Crime rate	The amount of negative social behaviour in the project area
R37	Cultural differences	Cultural differences that are encountered by foreign project team
R38	Inflation	The increased cost of project caused by an increase in the price level of the materials
R39	Currency fluctuation	The uncertainties of the interest rate volatility
R40	Poor site conditions	Poor environmental status of the project site
R41	Pollution	An increased level of pollution caused by the existence of project
R42	Earthquakes	Loss that might be caused by the occurrence of earthquakes
R43	Fires	Loss that might be caused by the occurrence of fire at the project site
R44	Severe weather conditions	Unfavourable weather events that might have a damaging consequence for the work

2.5 Risk Allocation in Construction

There has been an enormous number of contributions in the area of risk allocation in construction, such as in the works of Bradford & Hanna (2012), Peckiene *et al*. (2013) and others, with the allocation of risks in construction projects found to be a significant concern in construction worldwide (CIRC, 2001). Zhao & Li (2013) identify risk allocation as 'the process to allocate risk events with related and responsible project participants, and it also provides another way in the perspective of project participants to identify and classify risk issues'. These two identifications of risk give the research insight into the entire process of risk allocation, and what might occur.

As a contract is the main tool for risk allocation (Ghavamifar *et al*., 2010), Wang & Chou (2003) researched the effect of the allocation of risks on the handling of risks in construction contracts, as shown in Figure 2.2. The study concludes that risks can be allocated to contract and out-of-contract groups. The allocation of risks to the contractor within the contract clauses can be either clearly or sketchily stated. Even in the case of clearly stated allocation of risks to the contractor, such an allocation can be either debated or undebated, depending on the willingness of the contractor to accept the allocation. On the other hand, risks where allocation is not stated in the contract documents can be allocated to the owner or to the contractor, upon their agreement. However, Wang & Chou (2003) point out that various allocations of risk are neither mentioned in contract nor agreed upon amongst project parties.

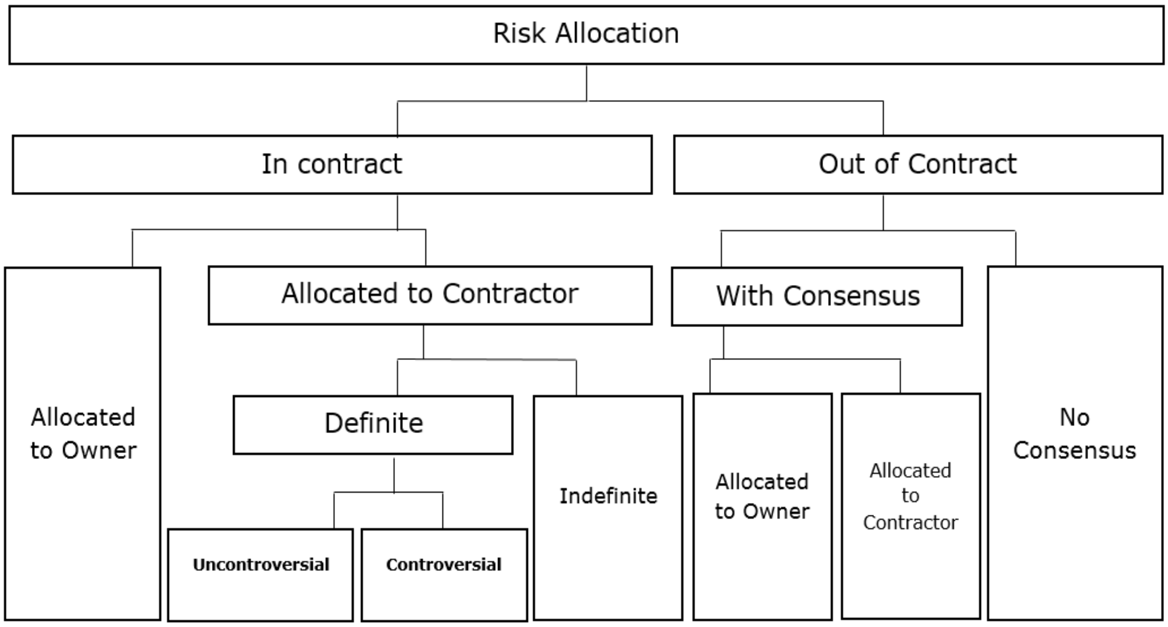


Figure 2.2: Risk allocation framework by Wang & Chou (2003)

2.6 Risk Allocation within the Process of Risk Management

Although there are a number of authors claiming that risk allocation should be conducted early on in the project lifecycle, very few have detailed where risk allocation, as a standalone process, fits within the process of risk management. Looking back at the previous section of risk allocation identification, as performed by Zhao & Li (2013), the process comprises risk identification; this implies that risk allocation should take place following project risk identification. Moreover, Tieva & Junnonen (2009) claim that risk allocation has to be considered after the identification of risks. On the other hand, Smith (1995), Jergeas & Hartman (1996), and Hanna *et al*. (2013) agree that the process of risk allocation occurs during the process of risk response—particularly in the form of strategy transfer. Moreover, Peckiene *et al*. (2013) claim that risk response is also known as risk allocation because, at this stage, decisions relating to risk transfer or retention are made.

Accordingly, based on the aforementioned opinions, it is thought to be useful to consider risk allocation within the process of risk management. Hence, a proposed graph was produced to pinpoint where risk allocation might occur within the process of risk management, as shown in Figure 2.3.

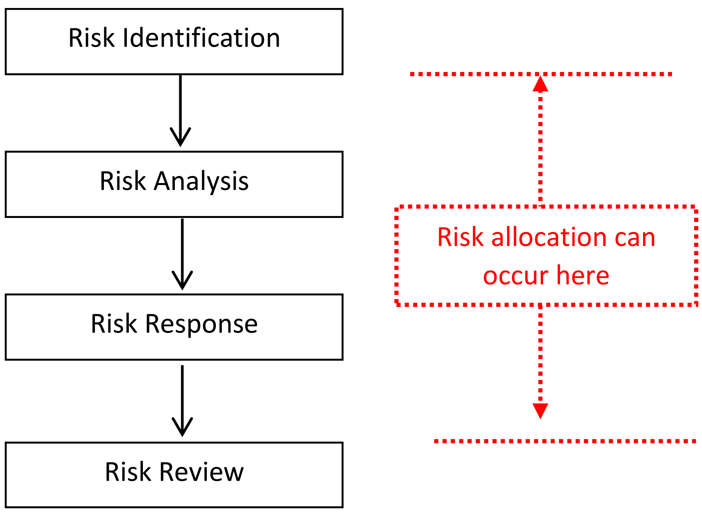


Figure 2.3: Risk allocation fit within the process of risk management

2.7 Proper vs Improper Risk Allocation

Within the process of risk management, risk allocation—particularly equitable risk allocation—is identified as the most challenging step of the process (Lam *et al*., 2007). Moreover, Irwin (2007) describes the core aim of conducting a proper risk allocation as ultimately increasing the performance of projects. In addition, Grimsey & Lewis (2004) explain how fair risk allocation can be achieved, which is by making benefits of taking the risk and its consequences for a party.

On the other hand, Swanson (2006) identifies the improper risk allocation process as 'the practice of allocating risk without separately considering which party may be in the optimal position to evaluate, control, bear the cost, or benefit from the assumption of the risk'. Chapman & Ward (2007) regard the misallocation of project risks as the root cause of poor performance in construction projects. As the highest ability and influence of such a party to handle a risk is considered to be the basic norm for achieving proper risk allocation amongst parties, Hanna *et al*. (2015) describe the occurrence of the misallocation of risks as risks allocated to the party with the least ability, influence and managerial resources over risks (Hanna & Swanson 2007; Lam *et al*., 2007). Consequently, the improper allocation of risk can have damaging impacts on project times and costs, particularly in the case of risks with high impact and probability of occurrence, such as changed conditions (Hanna *et al*., 2015). Furthermore, Lam *et al*. (2007) discuss the consequences of improper risk allocation on the contractor as these add to the contingency (cost) and affect the quality of the work.

However, three aspects of risk allocation are considered in this study, namely the principles of risk allocation, the perceptions of risk allocation in different contexts in construction literature, and risk allocation frameworks, as discussed below. The review of the three aspects is thought to aid the research by providing insight into the allocation of risks in different contexts, guidance on how risks should be allocated, and the most appropriate method and tools needing to be employed so as to achieve the proper allocation of risks.

2.8 Principles of Risk Allocation

The subject of risk allocation principles have been realised in the literature by an enormous number of authors, such as Casey (1979), Barnes (1983), Ward *et al*. (1991), Thompson & Perry (1992) and Abrahamson (1984), amongst others. Grove (1998) and Lam *et al*. (2007) agree on the usefulness of applying these principles, for both parties—owner and contractor—to achieve equitable allocation of risks in construction projects.

In addition, Abednego & Ogunlana (2006), as based on the previous study conducted by Ward *et al*. (1991), Flanagan & Norman (1993), and Edwards (1995) devised conditions that need to be satisfied in order to achieve the proper allocation of risks, including the risk bearer being capable of controlling the risk and its occurrence, parties needing to perform sound risk identification and evaluation, the risk bearer needing to be technically capable to manage the allocated risks, the risk bearer needing to be financially able to sustain the loss in the case of risk occurrence or to prevent risk from occurring, and the risk bearer needing to be willing to accept the risk.

However, Lam *et al*. (2007) argue the application of some of the principles identified by Abrahamson (1984), as they have been ambiguously stated, such as in the case of the term 'in his control', as noted by Abrahamson (1984) in the following principle 'a party should bear a construction risk where it is in his control'. The claim here is that, in real life, the control of some risk by such a party is not complete; rather, it is partial. This allows reliance on qualitative judgement and experts' experience to take a place in interpreting such principles. Based on this, Lam *et al*. (2007) perceive these principles to be implicit. Hence, Lam *et al*. (2007) benefited from the use of different principles of risk allocation, as stated in the literature, particularly in the works of Casey (1979), Barnes (1983), Abrahamson (1984), and Thompson & Perry (1992). Accordingly, seven criteria have been considered as follows:

1. The ability of a party to foresee the risk before it occurs, as mentioned by Kuesel (1979).
2. The ability of the party bearing the risk to assess the likely magnitude of the risk consequences, as mentioned by Casey (1979).

3. The ability of the party bearing the risk to control the risk if it occurs, as mentioned by Thompson & Perry (1992), Barnes (1983) and Abrahamson (1984).
4. The ability of the part bearing the risk to manage the risk and its impacts if it occurs, as mentioned by Thompson & Perry (1992).
5. The ability of the party bearing the risk to sustain the impact of risk if it occurs, as mentioned by Thompson & Perry (1992) and Chapman & Ward (2007).
6. If bearing the risk is beneficial to the party which intends to bear the risk, as mentioned by Abrahamson (1984).
7. If the price from transferring the risk to the owner is reasonable, as mentioned by Thompson & Perry (1992).

Loosemore *et al*. (2007) made a contribution concerning the principles of allocating risks in construction projects, which are the awareness of the risk bearer to the risk, the power and expertise capacity of the risk bearer over the risk, the ability and the resources of the bearer to manage the risk, the willingness of the bearer, and the need for the risk bearer to be given sufficient time to price the risk and charge for taking it. Bing *et al*. (2005) found a fourth root for risks to be allocated, aside from taking the risks by either party solely or sharing them, which relies on the circumstances of the project and that risk cannot be allocated to either party. Examples of the risks allocated through the fourth root are force majeure risks.

Furthermore, Hanna *et al*. (2015) studied the allocation of risks in highway projects, which are delivered under the traditional method (Design-Bid-Build), and conclude that, although the adoption of this method can offer a better management for the client, it directs less attention to design, construction and communication of information.

However, Abednego & Ogunlana (2006) add that the principles of risk allocation are limited to deciding the best party to whom to allocate the risk. However, in order to devise a complete risk allocation strategy, a lot of work is needed. Hence, Abednego & Ogunlana (2006) introduced a risk allocation strategy for public private partnership projects in Indonesia, based on the acknowledgement of four aspects (Four Ws). The first aspect encompasses those risks that should be allocated (What). Then, the party to whom risks should be allocated (Who). After that, when and how factors should also be considered. Figure 1 shows the four factors forming the strategy of risk allocation. In order to validate the above-mentioned guidelines, Abednego & Ogunlana (2006) formed a table comprising the four factors (Four Ws) to evaluate the actual allocation of risks practised by Indonesian owners and to introduce alternatives for them with regard to enhancing the overall efficiency of risk allocation, as shown in Figure 2.4.

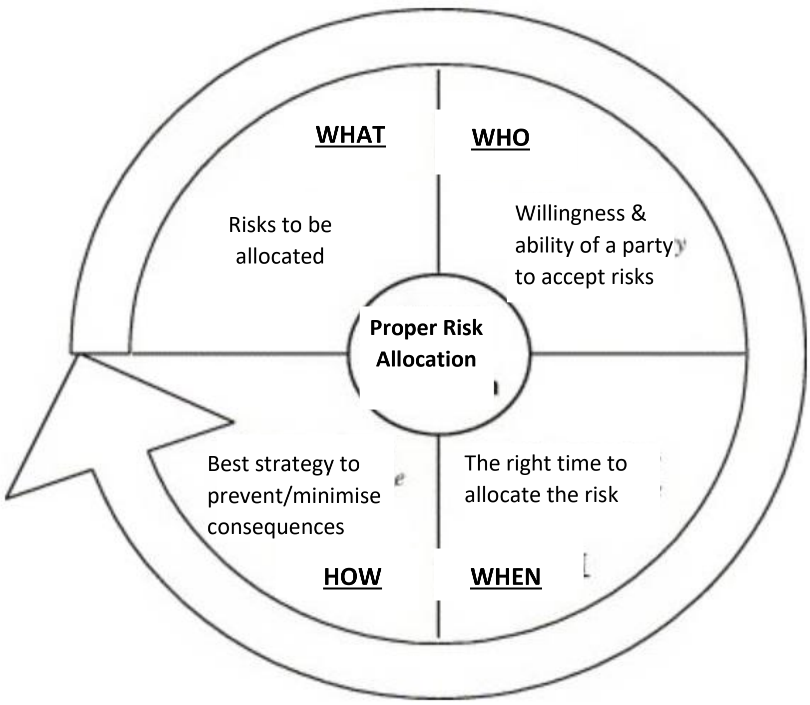


Figure 2.4: Risk allocation concept of strategy developed by Abednego & Ogunlana (2006)

This strategy is designed to help the owner to properly allocate risks in a construction project within the context of Indonesian construction projects, particularly public private partnership projects. The authors did not specify the applicability of the proposed strategy to be used in different contexts. As far as the researcher is concerned, nothing can be seen as an obstacle to applying this strategy for projects undertaken by any other types of procurement.

The results of applying this strategy revealed the following: the strategy builds the owner's confidence concerning their actual abilities to bear and control certain risks, as they were allocated to other parties. Furthermore, this strategy provides owners with a preventative approach to dealing with risk consequences, rather than the current approach of problem-solving. However, it seems that relying on these strategies alone, without the use of such principles for risk allocation, cannot achieve the benefits intended from this strategy.

Moreover, as seen in the discussion above, the subject of risk allocation principles has been well-documented in the literature, as an enormous numbers of authors have attempted to develop such norms for guidance; Moll (2015) identifies the gap that previous authors have not yet filled. Moll (2015) claims that the existing principles of risk allocation in general focus on the party's overall ability and willingness to manage and accept risks; however, a few have focused on the one missing element of such a process, which is the negotiation and agreement of parties over such allocation. This can be true with the context of the current research, where contractors, who deal with GACA projects, are not fully satisfied with such an allocation of risks.

2.9 Risk Allocation in Different Contexts

A number of studies instigating the allocation of risks that are inherent in construction projects have been conducted in different contexts. These are summarised and discussed below in Table 2.11.

Table 2.11: Studies on the allocation of risks in different countries

Authors	Type and Location of Study	Method Used
Andi (2006)	Indonesian construction projects (housing, road, dam, manufacturing & building, and others)	Questionnaires + Interviews (53=25 owners + 28 contractors)
Al-Salman & Al-Mahasheer (2005)	Construction projects in Eastern Province of Saudi Arabia	Literature + Questionnaires (30 grade one contractors in Eastern Province of Saudi Arabia)
Seraj Aldeen (2006) (Saudi Arabia)	A proposed risk allocation plan	Literature based
El-Sayegh (2008)	Construction projects in UAE	Literature + Questionnaires
Kartam & kartam (2001)	Construction projects in Kuwait	Literature + Questionnaires
Hameed & Woo (2007)	Construction projects in Pakistan	Literature + Interviews of 5 key experts + Questionnaires of contractors
Hanna *et al*. (2015)	Highway construction projects in USA	Literature + Questionnaires
Perera *et al*. (2009)	Road construction projects in Sri Lanka	Case study + Interviews
Kangari (1995)	Risk in construction projects in USA	Literature + Questionnaires

Ke *et al*. (2010)	public-private partnership projects	Literature + Questionnaires
Wang & Chou (2003)	Highway projects in Taiwan	Case studies

In Saudi Arabia, Seraj Aldeen (2006) proposed a risk-allocation distribution of 27 risks that were found to be likely to appear in in the Saudi Arabian construction industry. In this study, which is mainly based on literature, the author analysed and interpreted the conditions of the construction contract through which construction projects are undertaken. The author assumed that the majority of the risks need to be allocated to the owner, with a focus on risks that could be shared amongst parties. The author emphasised that risks should be allocated to the party causing them, with the owner needing to take more risks rather than allocating them to a contractor. It is obvious that this study is purely theoretically based; in other words, the author did not attempt to investigate the real practice, but merely proposed an allocation plan based on theory.

In the same context as the previous study, Al-Salman & Al-Mahasheer (2005) studied the allocation of 25 risks associated with construction projects in the Eastern Province of Saudi Arabia, as based on the questionnaires sent to 30 Grade 1 contractors. Unlike the previous study, the author found that no risk had been allocated to the owner, with the majority of the risks allocated to the contractor. Two shared risks were found whilst six were undecided. The study concluded that contractors in Saudi Arabia want clients to retain and share a larger number of risks. This could be due to: firstly, the better control of some risks clients might have, such as with regard to Payment on contract, Changes in work, and Scope limitations and work definition; and secondly, because of the high competition in the market as well as a recent slowing of the economy. Noticeably, this study has shown a degree of a lack of bias in terms of taking only contractor opinions and neglecting other project participants, who may hold different views on allocation, and thus could affect the results.

Similar results were found in the context of Indonesian construction projects, where Andi (2006), for example, found that 12 risks out of the 27 study-identified risks were allocated to the contractor. Only four risks were borne by owners, with one risk shared amongst parties. After interviewing and surveying a number of owners and contractors, the study affirmed the common norm that, in practice, owners tend to allocate as large a number of risks as possible. Nevertheless, the majority of risks fall under the category of undecided allocation, where these are within the control of owners. This study relied on two criteria for risks to be allocated to such a party: firstly, a subjective criterion, in which over 55% of respondents have to agree on such an allocation; and secondly, through the application of a statistical test, which has to show no significance amongst respondents' views for risks to be allocated to such a party.

The findings of the study conducted by El-Sayegh (2008) were in alignment with the general trend that owners are considered to be risk-averse. The authors looked at the allocation of 42 risks associated with construction projects in the UAE, and found there is a tendency to allocate risks to the contractor (15 out 42) and to share risks (10 out of 42). This reflects the unwillingness of owners to bear risks. As a result of the two main parties (owner and contractor) having less control over the external risks, the study showed the perception of respondents about sharing these risks amongst them. Moreover, most of the risks where allocation was undecided are related to the owner or designer. However, this paper used a subjective assumption for risks to be allocated to such a party, where 50% or more of the respondents allocated each risk to any of the two parties or for sharing the risk.

Kartam & Kartam (2001) in Kuwait identified 13 risks out of 26 as being allocated to the contractor. The remaining allocation of risks was as follows: four risks were allocated to the owner, four were shared risks, and five risks were undecided in terms of their allocation. However, this study only considered the opinions of the contractors who had participated in the construction projects undertaken in Kuwait, neglecting other parties' opinions, such as client and consultant. The authors assumed a high rate of 70% of respondents for risks to be allocated to such a party. Any allocation failing to achieve this percentage is considered undecided.

A similar study was conducted in Pakistan in 2007 by Hameed & Woo, which takes the views of contractors only into consideration for the actual allocation of risks associated with construction projects. The study utilised interviews (as a first tool after reviewing literature) and questionnaires, which resulted in the following: out the 31 risks identified in this study, 7 risks were allocated to owner, 13 to the contractor and 11 risks were shared amongst the two parties. Despite the use of 65% as a subjective criterion to be achieved by the overall respondents agreeing on such an allocation, no risk was found to be undecided in terms of its allocation. Also, one of the findings of this study was that most of the shared risks are political risks. In addition, owners were allocated design- and owner-related risks only. Nevertheless, the results of this study would have been enhanced in terms of reliability and validity if the authors considered other opinions by other participants.

In Sri Lanka, Perera *et al*. (2009) studied the allocation of risks associated with road construction projects and identified 23 risks. The study conducted a comparison between the actual allocation of risks and the party to whom risks which are not allocated properly should be allocated, based on a case study and interviews approach. The magnitude of the two allocations of risks to contractor (7 out of 23) and owner (6 out of 23) was similar. In addition, shared risks totalled even more than risks whose allocation was borne by one party (9 out of 23). It was noticed that, although the risk of Acts of God was allocated to the owner through the contract, it was found that the contractor shares this risk with the owner in reality. Additionally, the risk of late handing over of the site was allocated to the owner in the contract; that risk was found to be shared after investigation. The owner was allocated the risk of changing the scope of the contract, whereas the contractor takes some of the responsibility for this risk because of delays in the completion of a project.

Hanna *et al*. (2015) looked at the allocation of risks associated with highway construction projects in the USA. In the study that was undertaken through surveys, five risks were thought to be misallocated, including: "Design adequacy (including incomplete design, constructability issues, and errors in design); Specification interpretation (including unclear or ambiguous specifications); Third-party delay (including unknown and unanticipated discovery of utilities); Changed conditions (including differing site conditions, inadequacy of geotechnical investigation, unsuitable subgrade, and significant change in the character of work)"; and Claims process. The researchers have come up with flowcharts that provide good guidelines for the contractor and owner to allocate risks properly. The flow chart works using risk allocation principles developed by Loosemore (2007).

A well-cited study by Kangary was conducted in 1995 in the USA, which included 100 contractors and investigated the allocation of 23 previously identified risks. The results showed that contractors were willing to accept and share risks as there were nine risks allocated to them, and four risks shared with clients. Three risks were found not to meet the criteria for risk allocation set by the author, where 70% of the respondents had to agree on such an allocation for each risk. These risks were: Acts of God, Third-party delays, and Defensive engineering. So, the allocation of these risks was considered to be undecided. The absence of other projects' parties' views could affect the credibility of results.

With regard to risk allocation in public private partnership construction projects, Ke *et al*. (2010) surveyed 103 respondents in China and 95 respondents in Hong Kong to compare the allocation of risk in these two countries with the results of two studies conducted in the UK by Li *et al*. (2005), and Greece by Roumboutsos & Anagnostopoulos (2008). The study identified 46 risks, with their allocation decided on the basis that 50% of the respondents had to agree to such an allocation. The results generated from this study seem to be in alignment with two comparable studies (UK and Greece) as the private sector showed more willingness to accept risks as they were allocated a number of 22 risks in China and 20 risks in Hong Kong. Again, the four studies support the common trend of risk allocation, where the client (Public) tends to allocate as many risks as possible to the contractor (Private). Notably, although a number of different respondents from different entities (Public and Private) were involved, the study did not show any attempt to employ a statistical test in order to establish any significant difference in the answers of these groups.

Wang & Chou (2003) analysed six highway projects to determine how risks were allocated between contracting parties. Again, the results were not different from the majority of the above results, where the owner passed off the largest number of risks to contractors (19 out of 32 risks). The authors were not certain about the allocation of six risks, including changed labour safety laws and regulations, increased payment in response to changed labour standards law, inflation, faulty design of construction methods, weather conditions, and inefficient owner supervisors, despite the fact that the contractors seem to have been charged when the risks occurred. However, as far as the research is concerned, the use of the case study method in determining such an allocation has the disadvantage of not benefiting from quantitative statistical analysis, which gives a study strength and the results reliability.

2.10 Risk Allocation Frameworks

The subject of developing a framework for risk allocation in construction reviews has been well considered in the literature. The contributions in the literature regarding this subject can be divided into two main categories based on their natures, namely qualitative and quantitative, as in the cases of Jin (2011), Nasirzadeh *et al*. (2014), and Ameyaw & Chan (2016) amongst others. For the purpose of this research, the focus will be centred on qualitative frameworks only; this is due to the fact that qualitative frameworks are usually considered to be the basis for quantitative ones.

Although the usefulness of the models and frameworks presented in the literature concerning the allocation of risks in construction being inevitable for both owner and contractor and public and private organisations, according to Ng & Loosemore (2007), however, such proposed frameworks have limits with regards to the analysis and management of risks to be conducted on a project-by-project basis. Hence, Ng & Loosemore (2007), and Moll (2015) agree that the risk allocation models presented in the literature are not entirely helpful. Although a number of authors have proposed frameworks for risk allocation in construction in different contexts, the literature has not realised the allocation of risk allocation in Saudi contexts or in the aviation area in particular.

Fu & Li (2009) studied the allocation of risks in projects undertaken by the Agent-Construction method in China in which the government appoints a private professional company to manage the projects until they are handed back to the government. The authors designed a framework for risks to be allocated, which was mainly based on three principles of risks. The framework adopts the form of a flowchart diagram, as shown in Figure 2.5 below.

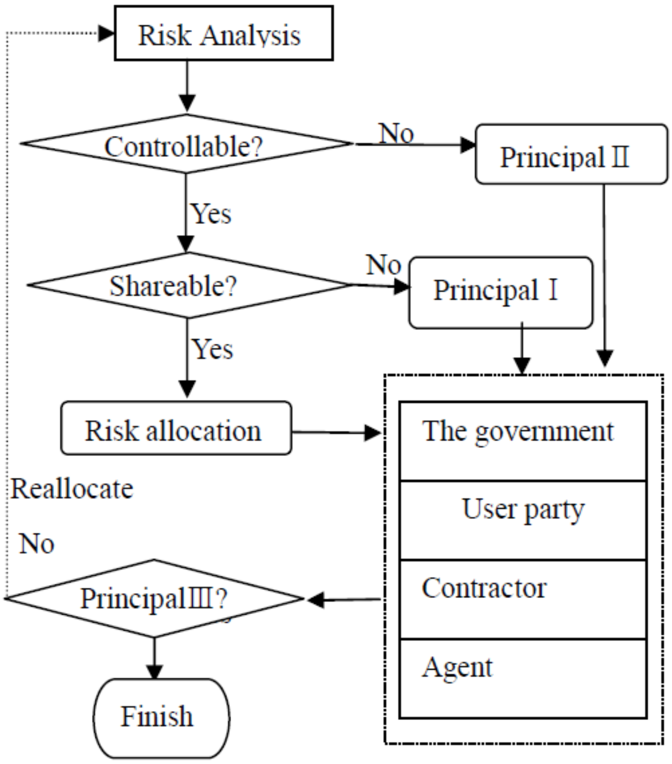


Figure 2.5: The risk allocation process in agent-construction projects in China (Fu & Li, 2009)

The framework begins with the provision of an analysis of risks, followed by a classification of risks, as based on its controllability by project parties. If a risk does not fall under any party's control, risk allocation principle 2 is introduced, which states that 'a party should have been given the chance to charge an appropriate premium for taking it'. However, risks falling under the control of such a party need to be shared. If the risk is not sharable between parties, risk allocation principle 1 is offered, which states that ‘risk should be allocated to the party with the best capability to control the events that might trigger its occurrence or have the technical/managerial capability to manage the risks for the least cost’. Even if a risk is agreed to be allocated to such a party, who is the government, user party, contractor or agent, principle 3 is used to test the financial capability of the party. Failing to meet this principle condition will impose a reallocation to be undertaken using the same previous process and principles.

The framework developed by Fu & Li (2009) provides a good illustration of risk allocation principles; however, it lacks the involvement of a contractor in the process, which forces the owner or the agent to make the decision on his own. It also shows an overall negligence of willingness of parties to be considered as this is one of the important considerations (principles) developed by Loosemore (2007). Moreover, no further details on the conduct of risk analysis are offered by the authors.

Moreover, the proposed risk allocation framework by Zhao & Yin (2011) is based on a theory referred to as ‘Incomplete Contract’. Zhao & Yin (2011) define the complete contract as a contract that ‘sets out contract parties’ rights and obligations, the risk allocation, the way of performance of the contract and the final result to be achieved when unforeseen events occur, and it can be compulsory performance and achieve the contracts’ target effectively, so it is the most efficient contract’. In the framework, the division of the initial risk allocation and risk reallocation results from an economic aspect of contracts (Wang *et al*., 2005), where a contract is divided into initial contract and renegotiation; therefore, the owner identification of risks needs to be comprehensive and used as the main step for the initial risk allocation process. As the project further proceeds and the information flows heavily—especially in the contract implementation period—there is a recognised need for another identification of risks, especially those that have not been identified or estimated in the first identification in the reallocation process. Hartman (1997) and Amdt (1998) emphasise the dynamic of risk allocation as a process, which should be flexible to any situation and condition. Based on the above explanation, the authors divide risk allocation in the proposed framework into two steps, namely Initial Risk Allocation and Risk Reallocation, as depicted in Figure 2.6.

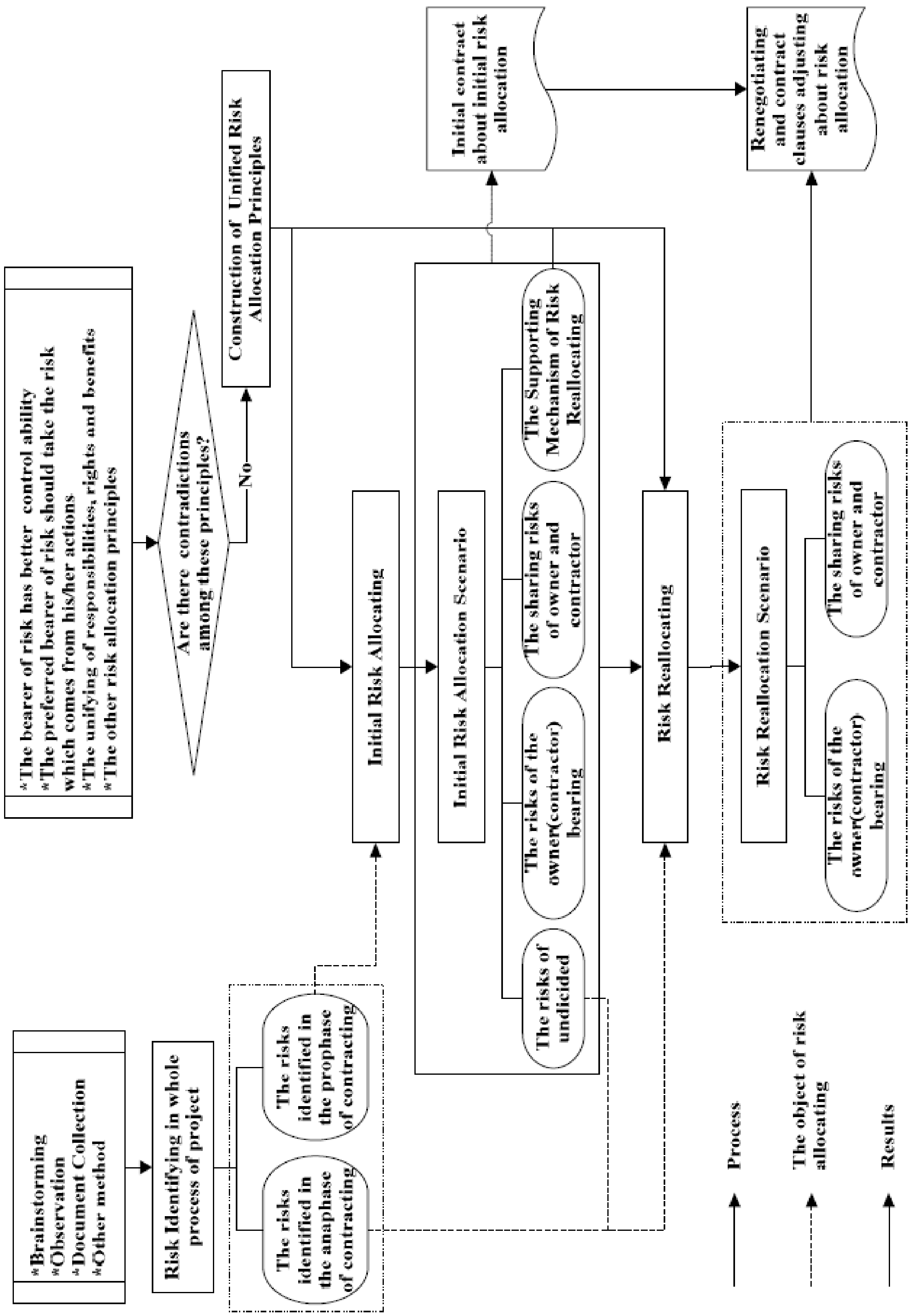


Figure 2.6: Dynamic Risk Allocation Mechanism by Zhao & Yin (2011)

- **The Initial Risk Allocation**

The initial risk allocation process essentially aims to distribute risks, and includes identification of project risk factors in the pre-contract phase, taking into consideration that the principles for such an allocation—the major outcomes of this process—are to determine the proper risk bearers. The initial allocation process includes the following steps:

- The confirmation of the risk bearer.
- For the risks that have not been estimated in terms of their probability of occurrence and impact due to the difficulty of gaining information at early stages, to be dealt with in the following process (reallocation process).
- Contractors should establish a supporting mechanism and an effective agreement for the risks that have not been allocated in the initial risk allocation process.
- The outcomes of the initial risk allocation process should be translated into the contract with contractual language that is accepted by both contract sides.

- **Risk Reallocation**

Risk reallocation is defined by Zhao & Yin (2011) as 'the process of adjusting and reallocating the new occurrence risks, uncertain risks in initial risk allocation, risks scenario in initial risk allocation execution hard to continue, or other risks factors management responsibility between the transaction parties'. Furthermore, due to the changing nature of the construction phase, a number of unexpected and new risks can be seen to appear in the construction phase, which point ot the need for another risk allocation process to be adopted (Rahman & Kumarrswamy, 2002). Hence, risk reallocation should concentrate on the risk allocation mechanism for those risks whose allocation has not been achieved in the initial risk-allocation and the finding of a support system that helps achieve a satisfying and benefiting allocation to the project parties to be obtained.

The framework designed by Zhao & Yin (2010) provides a good use of risk management in the construction project as the process of risk identification is repeated in the reallocation phase. However, although the authors have taken the risk allocation principles into consideration, they did not specify what these principles are, as it is left to clients to decide which ones to take. On the other hand, the framework fails to show how the risk bearer can deal with allocated risks (Risk Response). This is one of the criteria for the adequate risk allocation strategy, as developed by Abednego & Ogunlana (2006).

Hanna *et al*. (2013) designed a flow chart, as shown in Figure 2.7, for risks to be allocated to the right party in the construction industry. The flow chart focuses on a number of factors, including the likelihood of riskoccurrence (LORR), the impact of risks (RI), the financial ability of the party to deal with risks, appropriateness to insure risks, benefit of sharing risks, benefit of delaying the project, or adopting a new strategy for the project. It is proposed by the authors that this flow chart should be undertaken by both owner and contractor. The flowchart is a form of questions that need to be answered, and is coloured according to the actions needing to be implemented. The authors stress the use of this chart for projects undertaken by only a traditional type of procurement. The flow chart is read from the top-left of Figure 2.7 and answers the questions as they appear.

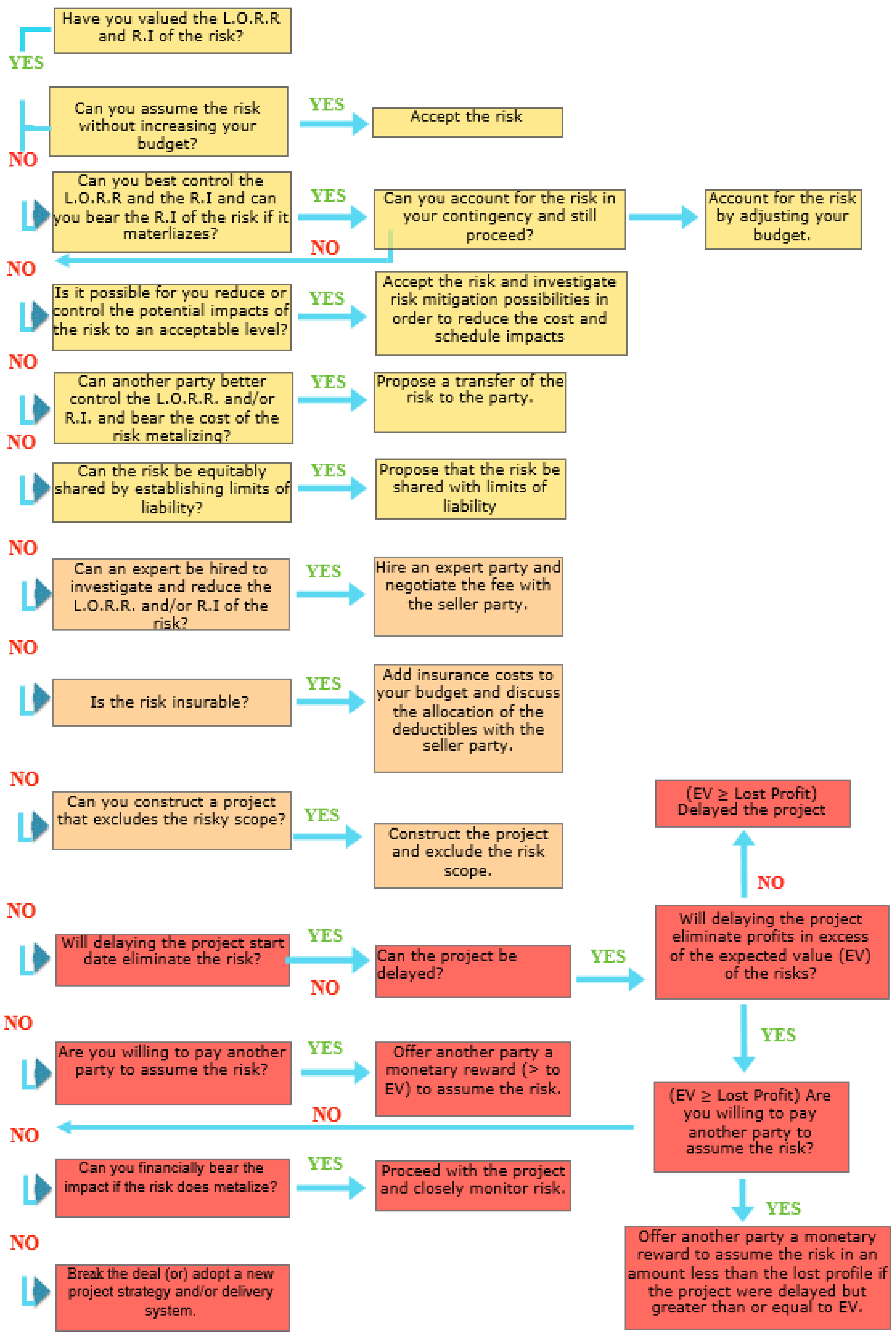


Figure 2.7: The Risk Allocation Flow Chart developed by Hanna *et al*. (2013)

The framework developed by Hanna *et al*. (2013) makes good use of flowchart form, which leads to the proper decision of risk allocation to be made. The authors have benefited from the analysis of risk likelihood and impact. It also takes into consideration the sharing of risks between parties, when possible, as well as the option of insuring against risks. However, the authors seem to focus on risk allocation, such as the financial ability of a party, whilst not taking into consideration technological ability. Moreover, there is little consideration of the willingness of a party to take risks, which is important. In addition, although the framework offers alternatives for the client and contractor to stop the deal of risk allocation, it does not offer any type of dialogue or negation to achieve an agreement of such an allocation. One of the issues that the framework does not cover is that the risks are not identified by the owner in the first instance, or how these should be handled. Lastly, the framework fails to detail the timing for such a risk allocation decision to be made within the lifecycle of the project, and this is one important element of the risk allocation strategy developed by Abednego & Ogunlana (2006).

Moreover, Bing *et al*. (2005) devised a risk allocation framework for use in public private partnership projects, which focuses on the role of negotiation in the process of allocating risks between private and public sectors, as shown in Figure 2.8 below. In this framework, the allocated risks to private partners are priced by them. The public sector has the option of whether to accept or reject the bid based on how reasonably the private sector has priced the risks. In the case of rejecting the bid, negotiation takes place to give the bidder another try to submit a new bid or the public to reallocate risks.

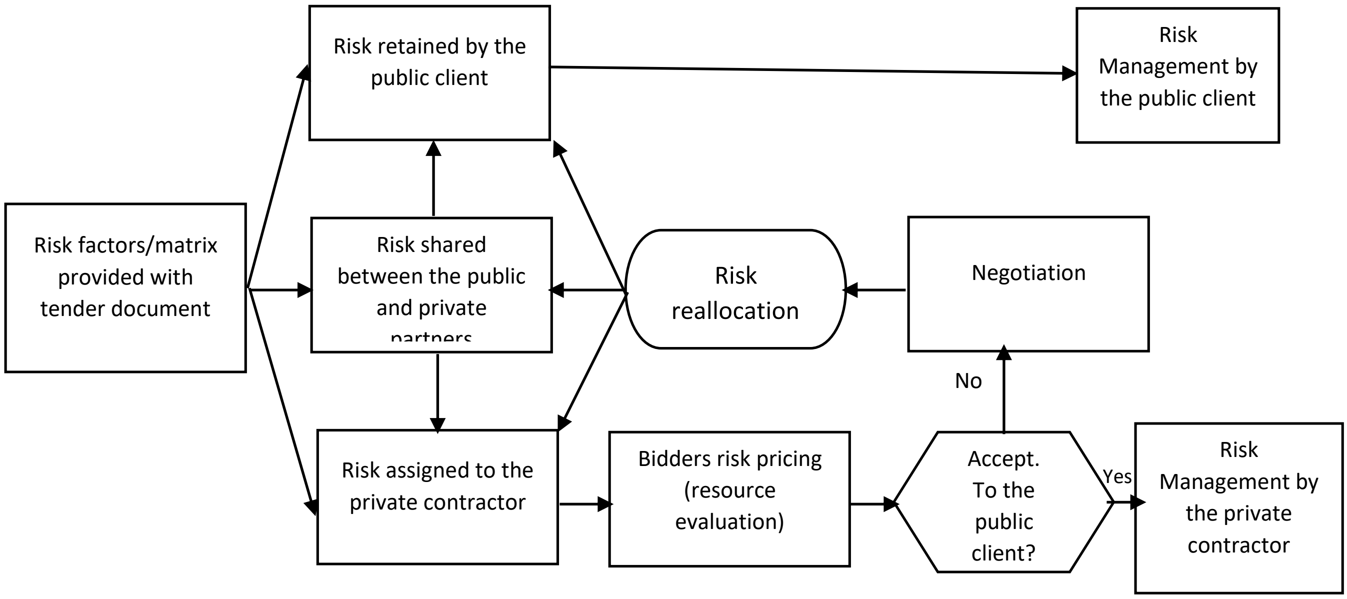


Figure 2.8: Risk Allocation Framework proposed by Bing *et al*. (2005)

Nielsen (2007) proposed a framework for risk allocation in airport projects. The steps for allocating risks are performed by both the owner of the project, as an initial and important step, and the project stakeholders. The concept behind this framework is based upon the utilisation of sound risk management with regard to the steps of risk identification, risk analysis, and risk response. Furthermore, only one of the risk-allocation principles has been taken into consideration with regard to the framework; this relates to the risks that should be allocated to the party which has the ability to control it. As Nielsen (2007) proposes, the process of risk allocation should be considered within the first two stages of the project, which are the planning stage and bidding stage. Below is an explanation of the steps of the risk allocation framework proposed by Nielsen (2007) for the Chinese airport project, as shown in the following Figure 2.9.

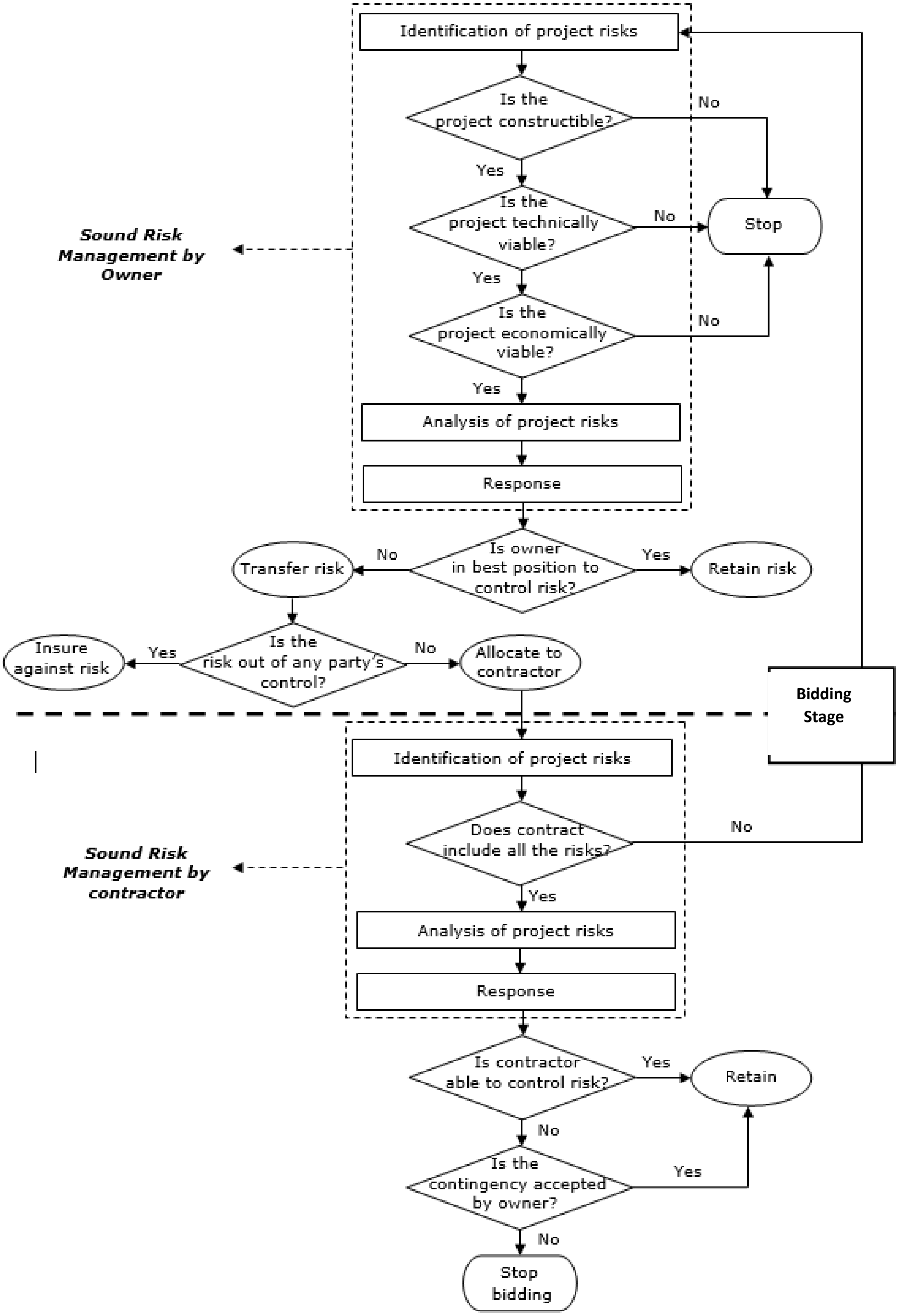


Figure 2.9: The Risk Allocation Framework proposed by Nielsen (2007)

- **Risk Management by Owner**

The process of risk allocation in any project has to be mainly and solely conducted by the owner. Owners always have the authority to decide the allocation of risks according to their risk perception and ability to handle them (Nielsen, 2007). Therefore, solid risk management training is proposed for the owner in the first instance, which includes the following:

- **Risk Identification**

In the planning stage of a project, and before any action, the owner needs to conduct a risk identification process, which includes any risk that might have an impact on the project. Any further steps or decisions are based on the identification of risks in a project; therefore, based on the identification of risks within the project, three aspects of the project need to be tested by the owner. These are: the ability of the project to be constructed and engineered, the existence of the technology to construct and engineer the project versus the project objectives, and the expense parameters versus the return on the investment.

Any failure on the owner's and stakeholders' side to meet any of the three mentioned aspects means the project should not be built. However, there are many examples where infrastructures have been built without consideration of one or more of the three aspects. On the other hand, garnering three positive answers to the three questions means the project is feasible and can be carried out.

- **Risk Analysis**

After identifying the risks involved in the project, the owner should then commence analysing these risks by garnering understanding of the nature of the risks, realising the likelihood of risk occurrence, and the impact of these risks on the project's objectives (Nielsen, 2007).

- **Risk Response and Allocation**

At the beginning of the bidding stage, the owner should have prepared request for a bid based on the previous steps. This request should contain the allocation of project risks. The options of the allocation of risks will be going through one of the following: the owner bears the risk which then he has to choose the right response to it or the owner transfers the risks to other party such as contractor, subcontractors, or insurers. Again, the decision regarding allocation should be taken after considering the above-mentioned steps (Nielsen, 2007).

➢ **Risk Management by Contractor**

Up until the beginning of the bidding stage, the contractor has no role to play in the project with regard to risk management. Following the issuance of the request for a bid, the contractor should conduct his/her own risk management concerning the project. The following provides an explanation of the steps included in the framework by Nielsen (2007):

- **Risk Identification**

The first step for the contractor in terms of risk management is to identify the risks allocated by the owner in the bid and to prepare a risk profile. The identification includes discrete items borne with the scope of work in the project, such as deliverables. Nonetheless, contractors are usually faced with two difficulties after receiving the request for a bid, which might hinder their risk management behaviour: the tied time imposed by the owner for preparing the tender, which might inhibit a proper process of risk analysis by the contractor, and the risk of the initial cost of preparing the tender by the contractor, which may not be returned as the project might not be awarded to the contractor. Furthermore, contractors also often experience confusion because of the contract overlooking some risks that have not been identified by the owner. This issue could affect the risk-allocation behaviour of the contractor and ultimately could force him to make his own assumptions about allocating the unidentified risks. However, in real-life, risk-identification is always performed as the first step within the process of risk allocation.

- **Risk Analysis**

The second step towards achieving the proper allocation of risk is to evaluate the identified and allocated risks by the owner using the same tools that have been used by the owner. This step should be performed by the contractor.

- **Risk Response**

Based on the analysis carried out by the contractor concerning the risks that have been allocated to him in the tender, the contractor has three choices as options for reacting to such an allocation. These are:

- Not to bid for the project, if the amount of allocated risk is overly significant or the contractor is unable to bear some of the risks allocated by the owner.
- If a risk is likely to emerge during the execution of the project, the contractor can charge some money, in the form of direct cost or contingency, in order to cover any damage occurred due to materialisation of risks.
- The contractor offers not to bear some of the risks allocated by the owner, which can be in return for a shorter completion time or cheaper price.

2.11 Knowledge Gap as Identified in the Literature Review

The researcher identified a number concerns with regard to risk allocation in aviation project studies that have been captured in the reviewed literature. The first one is that, apart from the above explained framework developed by Nielsen (2007), no other attempts have been made to come up with such a framework or model for risk allocation in that type of construction project. This also includes the context of this research where not a single study has been realised in the literature on Saudi Arabia. Hence, this research can benefit from the originality that comes from covering the abovementioned point. Notably, the focus of studies proposing such frameworks for risk allocation was on the projects that have been undertaken by public private partnership (PPP).

The second issue is that, although there have been a number of authors who have tried to come up with such qualitative frameworks for risk allocation, no study has been found to capture a well-established strategy of risk allocation such as the one developed by Abednego & Ogunlana (2006). Moreover, despite the fact that the aforementioned studies have sought to benefit from the use of risk management practice and risk allocation principles, these studies happened to adopt various principles, such as those developed by Loosemoore (2007), Thompson & Perry (1992), Casey (1979), Barnes (1983) and Abrahamson (1984). There has also been a claim that, with the availability of risk allocation principles in the literature, neglecting such principles is very common in real life in the construction industry.

Lastly, the challenge, for the researcher, is to devise a practical framework that captures good practice in risk-allocation principles alongside a robust risk-allocation strategy. Importantly, the validity of any framework is no less important than its design; however, this has not been shown in any of the reviewed studies. Therefore, a lesson is to be learned concerning the importance of validating the proposed framework in a practical way.

2.12 Chapter Summary

The review of the literature has provided guidance for proposing a structure of risks associated with GACA projects as a critical review has been carried out of similar studies in different contexts, with greater focus on studies conducted in Saudi Arabia. In addition, the allocation of risks associated with construction projects in different contexts has also been examined, in addition to capturing the well-established principles of risk allocation. This chapter has also reviewed attempts towards suitably allocating risks in the construction literature by investigating the proposed frameworks of risk allocation. Lastly, gaps in the literature have been identified. It has been shown that, despite the various authors who have designed frameworks to achieve suitable risk-allocation, no study thus far has been found to capture the principles of risk allocation in a practical sense. Moreover, no attempt has been made to centre the identified framework on a robust strategy. Moreover, the allocation of risks in the context of Saudi aviation projects (the context of the study) has never been considered.

As an important outcome stemming from the completion of the literature review, it has been possible to select the most suitable methodology to be adopted in this current research. Furthermore, a perception concerning the most appropriate data collection methods has been achieved.

The following chapter, which presents the research methodology, follows. This covers both theoretical and practical aspects.

Chapter Three: Methodology

3.0 Introduction

Generally, the methodology can be described as the way in which research is conducted. Researchers choose the methodology in an effort to answer questions that eventually might lead to a defined problem (Jonker & Pennink, 2010). Moreover, methodology is not limited to undertaking the research only; it is about acting. Researchers often regard methodology as plans that are drawn, in which questionnaires are written, data are gathered, and data are analysed statically. However, according to Jonker & Pennink (2010), such perceptions of methodology are naïve and incorrect. There has always been a misinterpretation of the terms 'Research Methodology' and 'Research Method'. Hence, the two terms are further explained in this chapter.

Jonker & Pennink (2010) developed a means called the 'Research Pyramid' aimed at directing how research behaviour is appropriately defined in an orderly manner, as is shown in Figure 3.1; in other words, the 'Research Pyramid' helps researchers to structure their research and justify their choices of the three defined levels to ensure robust research. This pyramid comprises four levels upon which research needs to act, namely Paradigm, Methodology, Methods and Techniques. Moving from the top to the bottom of the pyramid, a research question can lead to the formulation of a research question, which is based on a clear argument. Accordingly, the choices made on each level are directed by the nature of the research question.

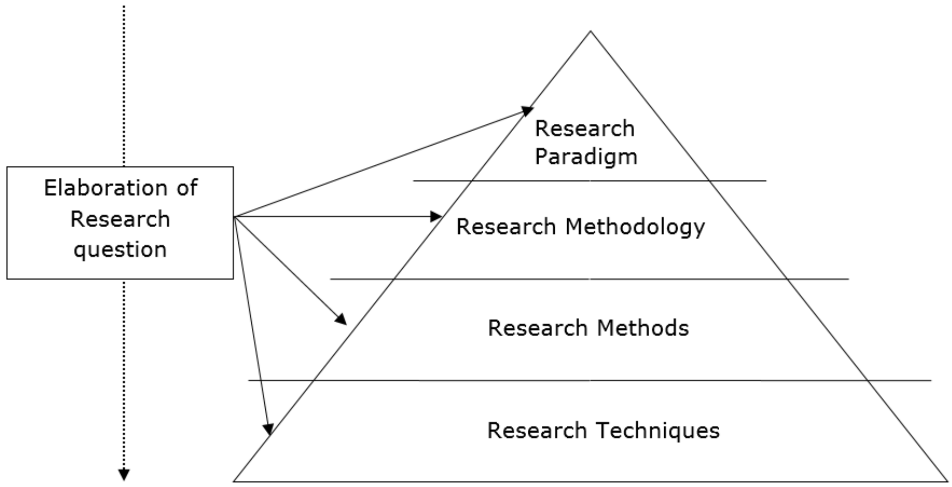


Figure 3.1: Research Pyramid (adopted from Jonker & Pennink, 2010)

The following is a detailed explanation of each level of the Research Pyramid and the choices of each level that a researcher can make so as to direct the research.

- **Research Paradigm**

Fellows & Liu (2015) identify the paradigm as ‘a theoretical framework which includes a system by which people view events (a lens)’. Moreover, Sale *et al*. (2002) and Neumann (2003) view the Research Paradigm as an exhibition of a clear structure, with a convinced philosophical assumption that guides researchers in selecting the most suitable tools and methods for completing research to facilitate the examination of the reality and potentially observe relationships between different variables.

Three types of Research Paradigm have been introduced by Cecez-Kecmanovic *et al*. (2002), which are classified according to the varied approaches of interpreting the reality of the intended phenomena to be studied, namely positivist, interpretive and critical. However, some authors, such as Mackenzie & Knipe (2006) and Creswell (2013), amongst others, have introduced a fourth type of paradigm, referred to as the pragmatic paradigm. These four types of research paradigm are explained as follows:

- **Positivist**

The focal idea behind positivism is that the social world exists independently from the researcher, and that its features are measured through observation. Such a paradigm argues the following: reality consists of tangible and sensible variables. The attempt to inquire into reality should rely on scientific observation; and methodological principles that deal with fact rather than values are all shared in the social and natural sciences (Gray, 2013). However, the approach to research undertaken by this paradigm is quantitative in nature (Dash, 2016).

- **Interpretive (Constructivism)**

The interpretivist paradigm aims to understand phenomena through research, and is considered to be a relative stance. In this paradigm, reality is socially constructed, unlike in the positivist paradigm, where reality exists independently in a world external from the research. In other words, researchers adopting this paradigm should attempt to seek perspectives of participants and interpret what they see (Fellows & Liu, 2015).

- **Critical Approach**

Critical social researchers underpin their research through a polemic perception, which endeavours to delve deep under the surface of historically certain, oppressive, and social structures (Harvey, 1990). A critical social researcher perceives knowledge as being structured by existing sets of social relations that are oppressive; this might refer to class, sex or race. In critical social research, the researcher aims to alter or change suppressive acts.

- **Pragmatic**

Creswell (2013) claims that there is no commitment between a pragmatic researcher and any other systems, philosophies or reality. He or she can ask questions that are posed in different paradigms at the same time, such as 'how' and 'what'. Moreover, Pragmatists avoid relying on a single methodical method to approach the reality of the world (Mertens, 2007).

- **Research Methodology**

Kothari (2004) describes the research methodology as the systematic steps by which the problem of the research is solved. In other words, it is the science of how to conduct research systematically. In research methodology, researchers adopt different steps to achieve the aim of the research. For researchers, knowing the research methods and techniques (as will be explained in detail in this chapter) is important; however, it is even more important for them to know the relevance of these methods and techniques, as well as their meanings and purposes, and the applicability of solving the research problem.

- **Research Methods**

Research methods are simply defined by Kothari (2004) as the method employed by a researcher in the completion of research. They not only involve the methods used for gathering data, but rather involve the method used for defining the problem of the research from the beginning. Hence, Kothari (2004) classifies research methods into three groups in terms of their application: data collection methods, data analysis methods, and methods used for the purposes of research accuracy evaluation.

- **Research Techniques**

Research techniques are the instruments researchers use to perform research processes, such as data recording, making observations, analysing data, and so on.

The research techniques are mainly generated from research methods (Kothari, 2004).

3.1 The Research Pyramid for this Research

After establishing the four levels making up a research pyramid, each is discussed in this section. The following provides an evaluation of the research objectives (presented in Chapter One) in the light of the four levels of the research pyramid mentioned earlier on in this chapter.

3.1.1 Research Paradigm

In order to decide which paradigm the researcher should adopt, the approach to underpinning this research—the research objectives—are discussed in Tables 3.1–3.6 in consideration of the definitions of each type, as stated in this chapter. The decision regarding the type of research paradigm is implicit.

Table 3.1: The type of research paradigm adopted for achieving research objective O2

Objective O2	To identify the risk factors associated with GACA projects
Research Paradigm	Pragmatic
Research Approach	Mixed (Qualitative and Quantitative)
Rationale	This objective stated above entails quantifying the number of risks associated with GACA construction projects. Hence, a quantitative method is needed to achieve this objective. Before that, it entails knowing the risks through the literature first and then interviews to verify them, which require a qualitative method to be used too.

Table 3.2: The type of research paradigm adopted for achieving research objective O3.1

Objective O3.1	Examining the impacts of the identified risks in the context of GACA projects
Research Paradigm	Positivist
Research Approach	Quantitative

Rationale	This objective stated above entails an examination of each identified risk's impact on GACA projects. Hence, a quantitative method is needed to achieve this objective.

Table 3.3: The type of research paradigm adopted for achieving research objective O3.2

<u>Objective O3.2</u>	Examining the likelihoods of occurrence of the identified risks in the context of GACA projects
Research Paradigm	Positivist
Research Approach	Quantitative
Rationale	This objective stated above entails an examination of each identified risk's probability of occurrence. Hence, a quantitative method is needed to achieve this objective.

Table 3.4: The type of research paradigm adopted for achieving research objective O4

<u>Objective O4</u>	To find out the basis on which risks are allocated to parties in the context GACA projects
Research Paradigm	Interpretive
Research Approach	Qualitative
Rationale	This objective stated above entails an investigation of the practice of risk allocation itself within GACA. This can only be achieved through the use of a qualitative method.

Table 3.5: The type of research paradigm adopted for achieving research objective O5

<u>Objective O5</u>	To investigate the perception of risk allocation performed in the context GACA projects
Research Paradigm	Pragmatic
Research Approach	Mixed (Qualitative and Quantitative)
Rationale	This objective stated above entails an investigation of each identified risk's allocation (party who actually bears the risks), which can be done through the use of both quantitative and qualitative methods.

Table 3.6: The type of research paradigm adopted for achieving research objective O6

<u>Objective O6</u>	To develop a framework for suitable risk allocation within GACA projects
Research Paradigm	Pragmatic
Research Approach	Mixed (Qualitative and Quantitative)
Rationale	This objective stated above entails the development of a framework for risk allocation within GACA. This is done after

	the achievement of the above mentioned objectives, which means quantitative and qualitative methods will be employed to achieve this objective.

3.1.1 Research Methodology, Methods and Techniques:

As the research methodology involves the remaining two levels—namely research methods and techniques—it has been decided that these two levels are embedded within and emerged at the wider level, which is the research design. As shown in Figure 3.2 below, the research is to be undertaken through four stages, namely Initial Stage, Data Collection, Data Analysis and Development Stage.

The research design aims to establish solutions and answers to the research's problem as stated. Essentially, 'it is about stating the way in which the researcher accomplishes the research objectives' (Fellows & Liu, 2015). Designing research involves four actions be taken into consideration, namely the type of research, the approach of the research, the methods of data collection, and the methods of data analysis, all of which will be discussed later on in the study.

However, there are three types of research approach, as identified by Fellows & Liu (2015), namely Exploratory, Descriptive and Causal. In this research, according to the nature of the research objectives, it seems that the use of various types of exploratory approach would be valuable as this will help to discover the current risks associated with aviation projects and the ways in which such risks are allocated. Moreover, a descriptive type will also be used as this research is centred on describing the risk allocation strategy of the risks discovered. Therefore, the decision concerning the deployment of a mixed-method approach in this research is compatible with the pragmatic paradigm (the paradigm adopted in this research) recommendations on the methodology used for this type of research.

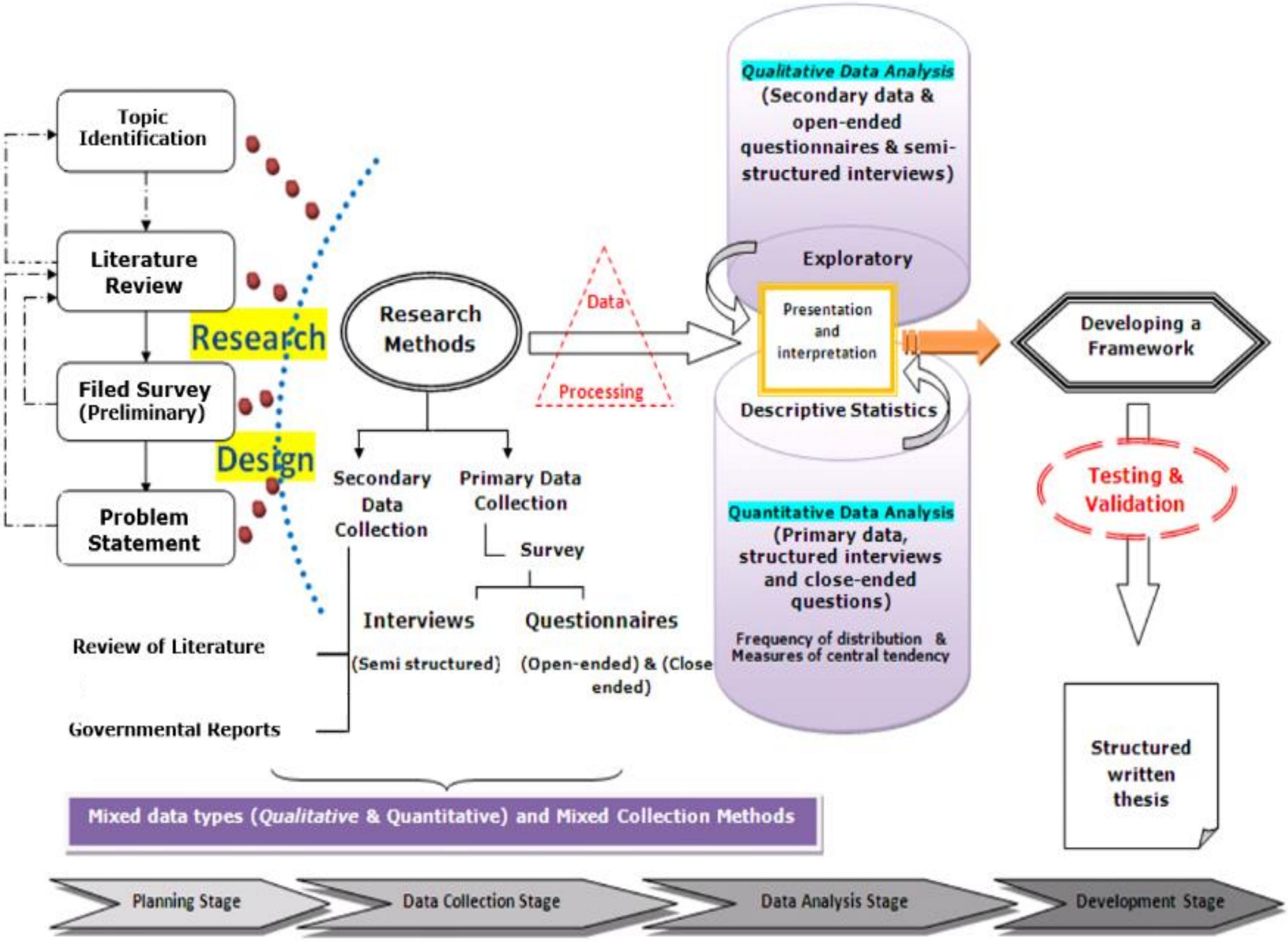


Figure 3.2: Research design

The following is a discussion of each of the four stages the research completes. This includes the actions, methods used, and the outcome of each stage.

3.1.1.1 Initial Stage (Planning Stage)

Firstly, in the initial stage, four activities were involved, namely the identification of the topic, which is ‘The Allocation of Risks in the Context of Saudi Aviation Construction Projects’, followed by the undertaking of an extensive literature review relating to the topic, which included the use of topic-related academic journals, such as the Journal of Construction Engineering and Management, the International Journal of Construction Project Management, and so on. Moreover, published or unpublished research, governmental reports completed by GACA, such as the GACA periodical reports, GACA annual statistical reports and mainly GACA (2013) have also contributed to the enhancement of the literature review.

While the researcher has been progressing with the research, an initial survey (Preliminary Study) was conducted in the Department of Domestic and Regional Airports in GACA, Jeddah, Kingdom of Saudi Arabia in 2013; this is recognised as an important step in progressing the current research. It helped in the process of acquiring more knowledge regarding the subdivisions (departments) the GACA use to manage their airports, as well as the type of procurement used within GACA projects. Moreover, it provided the researcher with valuable data concerning the time overruns experienced in a number of projects. Furthermore, after completing a number of informal, non-structured interviews with senior management and project managers working with GACA, an overall agreement was identified concerning risk allocation not being suitably completed in the case of GACA projects, thus leading to the problem of this research. Moreover, as an additional and important outcome concerning the initial surveys, a considerable number of contacts have been built between the researcher and key bodies within the GACA.

Furthermore, 'field surveys' were conducted based upon the advice of Kothari (2004), who states that researchers should use 'pilot surveys' or 'field observations' as they help in clarifying the research problem by thoroughly immersing the researcher within the subject field. However, by the time the four activities involved in this stage were conducted, the research was inductively undertaken; in other words, the researcher followed systematic steps to gain understanding into the reality and accordingly create a pattern of meaning from the data collected, which has also been described by Creswell (2013) as an inductive approach to undertaking research. The inductive approach to undertaking research focuses on generating a hypothesis and testing it, which normally begins with a general observation

(Trochim, 2006). This is true for this research, especially in the planning stage, which, as stated above, starts with a review of literature before progressing onto an initial field survey to form a deep understanding of the problem of the research, as shown in Figure 3.3.

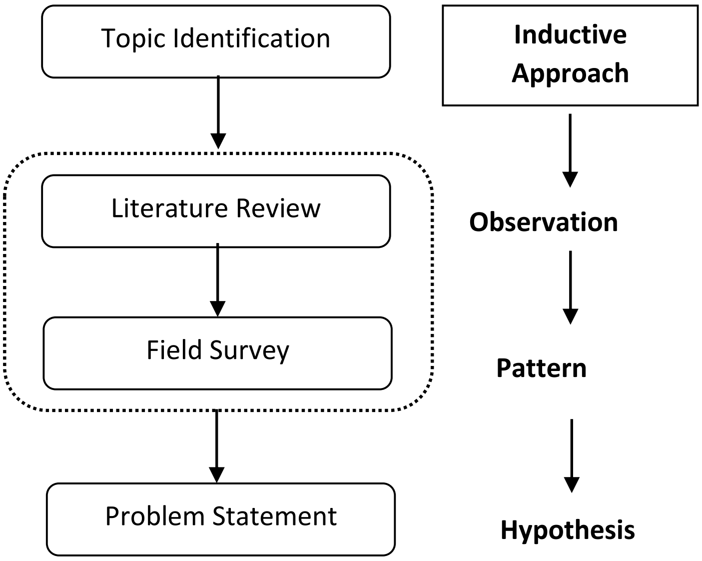


Figure 3.3: The inductive approach used in the research

Following this, and based on the abovementioned actions, a clear statement of the problem has been drawn. However, as is shown in Figure 3.2, the last four steps in the planning stage have overlapped; otherwise stated, these four activities have been revised and developed consciously. Hence the study moved towards testing the hypothesis. Lastly, the four main activities in the planning stage and the outcomes are summarised in Table 3.7 below.

Table 3.7: Steps achieved in the initial stage (Planning Stage)

Step	**Action taken**	**Outcome**
Topic identification	Choosing the topic and subject of the research	Risks and their allocation in the context of Saudi's aviation construction projects
Literature review	Reviewing: journals & conference articles, published and unpublished theses, GACA reports, and GACA annual statistics	Identifying a knowledge gap

Initial field survey	Conducting 4 non-structured interviews with 4 senior project managers from GACA	-Knowing more about the problem (procurement methods used, the magnitude of the cost and time overruns) -Validating the knowledge gap -Building contacts within GACA
Problem statement	A result of the above mentioned taken actions	Risks are not properly allocated in GACA construction projects

3.1.1.2 Data Collection Stage (Research Methods)

In this research, two types of data were collected; these were secondary data and primary data. The methods of collecting these data, as well as the results generated from such a collection, are explained below, taking into consideration the above classification of data:

- **Secondary Data**

Secondary data are identified as "those which have already been collected by someone else and which have already been passed through the statistical process" (Kothari, 2014). In the collection of secondary data, topic-related topic literature, as has been mentioned in the initial stage, such as governmental reports and the periodical reports issued yearly by GACA was used. Generally, the collection method for this type of data is considered qualitative in nature due to the information generated. Table 3.8 below provides a summary of the methods used for secondary data collection and the result of collecting these data, which is also explained in detail below.

Table 3.8: Primary data collection and results

Step	Method	Technique	Results
Literature review + GACA Statistical Reports	Qualitative	summarising, comparing, making notes, and tabulating	-General overview of airports in Saudi Arabia -Issues with the management of aviation construction projects in the country -44 risks found to be related to GACA projects (subject to verification) -Varied reviews on how risks are allocated in different contexts

			-Best practice for allocating risks in literature

- **Literature Review**

A broad literature review resulted in identifying 44 risks, assumed to be inherent in GACA construction projects. The assumption is based on reviewing related studies in the area of risk management in construction projects of a various number of studies carried out in different contexts, namely Saudi Arabia, the Arabian Gulf countries, the Middle East, Africa, Europe, and America. The reasons behind selecting similar studies conducted in these contexts were twofold: 1) to widen the research understanding of risks inherent in construction projects; and 2) to cover risks that have not been covered by other studies. However, the main focus was on studies conducted in both Saudi Arabia (as the context of this study is located in Saudi Arabia) and in the Arabic Gulf countries (which share similar features with Saudi Arabia such as, cultures, roles, and financial situations). The method of conducting a literature review was qualitative in nature as it included various techniques of a qualitative nature, such as summarising, comparing, making notes and tabulating. Nevertheless, the selection of the 44 risks resulting from the literature review was dependent on a number of criteria, including risks that were clearly repeated in construction projects in the Saudi context, risks that were frequently mentioned in the studies reviewed, and risks the researcher thought were related to GACA projects, regardless of the differing contexts.

Similarly, the allocation of risks was another concern to be reviewed in the literature. Hence, 11 relative studies were studied, including those in different contexts. Again, the researcher benefited from the use of qualitative methods such as summarising, analysing, and comparing for collecting this type of data.

- **Primary Data**

The primary data are identified as "those which are collected afresh and for the first time, and thus happen to be original in character" (Kothari, 2004). Firstly, initial field work (Preliminary Study) was conducted, which resulted in gathering some of the primary data. Then, the collection of primary data or fieldwork was undertaken mainly through a survey method. Two techniques are proposed for use for this method; these are questionnaires and interviews. As is apparent, the use of these two techniques in the research gives benefits stemming from triangulation, where two or more differently natured techniques are used. Fellows & Liu (2015) established a valuable benefit from adopting triangulation as it overcomes any disadvantage of the use of a single technique. Below is a detailed explanation of deploying these two techniques in this research, as well as the sample selected.

- **Initial Field Survey**

The initial field survey, which was conducted in 2013, aimed to discover the type of procurement through which the GACA's projects are undertaken; this mainly impacts on the way in which risks are allocated, and the magnitude of time and cost overruns resulting from the mismanagement of risks, which showed a number of domestic airports as having been affected. The method used adopted the form of non-structured interviews with four senior project managers working for GACA, all of whom were found to have ten years' experience within the GACA organisation; the interviews were considered qualitative in nature. Notes were taken during the open dialogues with the project managers. However, it needs to be mentioned that this step was followed again by a review of the literature. In other words, although it follows the steps of a literature review in Figure 3.2, a wide literature was reviewed after completing the initial field surveys. The questions that were asked are listed in Appendix 7. Questions to discover the types of project that are undertaken under the GACA umbrella and the types of delivery method used were asked due to the lack of this information in the literature. Also, interviewees were asked about the types of risk associated with projects that they have been involved in and the impact of these issues (risks) on the projects. This was undertaken by the use of open-ended questions to allow each interviewee to talk more about the risks inherited and their impacts. Moreover, the interviewees were asked to describe the way that risks are dealt with, as well as commenting on the effect of risks. The answers were thought to narrow down the focus of the problem of the research and give more clarity to existing issues faced by the GACA.

As a result of conducting the initial field work, the following results are obtained:

- Three types of aviation construction projects, namely domestic, regional and international airports.
- Domestic and regional airports are undertaken through the traditional type of procurement (Design, Bid, and Build).
- In the majority of these projects, the role of consultants is played by the designers.
- International airports are undertaken using different methods of procurement. For example: the new King Abdul Aziz Airport in Jeddah has been undertaken under the construction management approach; the newly opened Medinah International Airport was undertaken using the PPP method.
- Cost overruns have been shown to affect the three different types of project undertaken under the supervision of the GACA, as well as time delays.
- Arar, Aljouf and Alola domestic airports are among the airports that have been shown to be affected in terms of both time delays and cost overruns.
- Taif and Alqassim regional airports are among the airports that have been shown to be affected in terms of both time delays and cost overruns.

- There are a number of reasons for such problems, including: issues relating to design such as design changes, design errors; issues relating to contractors such as incompetence, and experience; political issues such bureaucracy and corruption.
- In terms of managing and dealing with risks, the interviewees complained about the way risks are managed currently. They criticised the lack of clear guidance on how to deal with risks in GACA projects.
- The allocation of risks was the element that was raised by the four interviewees as causing many of the problems.
- It was claimed that risks are allocated to parties who cannot deal with them properly.
- One of the main results of conducting the initial field work was that, a number of contacts were built with key persons in the GACA. This has had an impact on facilitating the research and the collection of necessary data.

- **Interviews**

The use of interviews in this research was undertaken in the form of semi-structured interviews, with the inclusion of a number of both open- and closed-ended questions posed during the interviews. The use of semi-structured interviews throughout the course of this research helped the research to achieve its objectives. The completion of this type of interview in this research is based on the fact that the semi-structured approach does not restrict the interviewees in terms of answering certain questions; rather, it allows a dialogue to be open, which gives the researcher the opportunity to ensure a better coverage of the risks associated with GACA projects (Gray, 2013). Moreover, the use of closed-ended questions (attached in Appendix 8) in the interviews in this research helped the researcher to gain accurate information, whilst also gaining quantity data from the interviewee. More importantly, it also helped in terms of structuring the questionnaire questions (Kothari, 2004) in the sense that it added accurate risks that are associated with specific projects.

The first objective of having interviews on board was centred on verifying the 44 risks identified from the literature. Each interviewee was asked to describe the risks he had come across in the completion of GACA projects. At the same time, each interviewee was provided with the proposed structure of risks (as presented in Chapter Two), which details 44 risks that are believed to be related to GACA projects.

Knowing the impact of the risks identified in the case of GACA projects was another objective concerning the completion of interviews. Accordingly, interviewees were asked to evaluate the impact, in terms of time delays and/or cost overruns, associated with the risks identified in the projects in which they have been involved. The results are shown and discussed in the following analysis chapter. Furthermore, the way in which risks are allocated within GACA projects was investigated in the interviews; each interviewee commented on the way in which risks are allocated within the context of the research. However, results are shown in the following chapter. Moreover, there are a number of similar studies that have utilised interviews in the same way as this research (used prior to the main questionnaire); amongst them are El-Sayegh (2008), Alnuuaimi & AlMohsin (2013) and Ikediashi *et al*. (2014).

Hence, questions were related to the projects that each interviewee was involved in within GACA construction projects and the role that he played. These were asked to ensure that each one of the interviewees had met the criteria set by the researcher for all the interviewees to be senior project managers and have been involved in many GACA projects. This helped the researcher to be confident that the answers were taken from professionals who work at a senior level. Then, open-ended questions on risks and the associations with the projects they have been involved in were asked, to allow the interviewees to talk freely on the kinds of risk they have faced. The questions asked were also guided by giving each interviewee a copy of the proposed structure of risks to verify it. This added to the accuracy of the structure and its relationship to the GACA context. Moreover, a question on the exact magnitude of time delays and cost overruns in the projects that the interviewees had been involved in were asked. Although similar questions were asked in the preliminary study on the impact of risks in GACA projects, the answers to the question asked here were meant to specify the level of risk impact in projects. Lastly, the interviewees were asked to comment on the way that risks are allocated to parties. The expected answers here were used to guide the researcher on the basis of risk allocation practice used in the GACA context (the focus of the research).

- **Interview Sampling**

A total of 13 people were selected for interview, based on a number of criteria, including level of seniority, experience, position within organisation, and availability of the person. Hence, the 13 interviewees were classified into three categories, according to the organisations for which they work, including six interviewees from GACA (representing the client), four interviewees representing three contractor companies who have been involved in a number of GACA projects, and three consultants who have also been involved in different GACA projects. The duration of each interview, as well as the interviewees' positions, language of interviews, and techniques used to save data, are summarised in Table 3.9.

Table 3.9: Interview details

	Duration	**Interviewee's Position**	**Language of Interview**	**Technique for Data Saving**
1	45 Minutes	Client	Arabic	Recording
2	45 Minutes	Client	English	Recording
3	45 Minutes	Client	Arabic	Recording

4	45 Minutes	Client	Arabic	Recording
5	55 Minutes	Client	Arabic	Recording
6	45 Minutes	Client	Arabic	Recording
7	45 Minutes	Contractor	Arabic	Recording
8	45 Minutes	Contractor	Arabic	Recording
9	45 Minutes	Contractor	Arabic	Recording
10	40 Minutes	Contractor	Arabic	Recording
11	55 Minutes	Consultant	English	Recording
12	50 Minutes	Consultant	Arabic	Recording
13	55 Minutes	Consultant	Arabic	Note taking

- **Questionnaires**

The other technique applied in this research was that of questionnaires, which involved both open- and closed-ended questions. Accordingly, the nature of the data collection methods used to collect the secondary data varied between quantitative and qualitative due to the use of different techniques, such as closed-ended (quantitative) and open-ended (qualitative) questionnaires. Furthermore, generally, the mixed method (quantitative and qualitative) of data collection is adopted in this research due to the nature of the used techniques. However, Amaratunga *et al*. (2001) argue that the use of a mixed-methods approach will maximise the strengths of each method (quantitative and qualitative), and will help to overcome the disadvantages of each method individually. The questionnaire has been used widely in similar studies, such as Assaf & Al-Hejji (2006), Calzadilla *et al*. (2012), and Motaleb & Kishk (2013) amongst others. Figure 3.4 shows how the data generated from analysing both the literature review and the conducted interviews impacted on the development of the questionnaire.

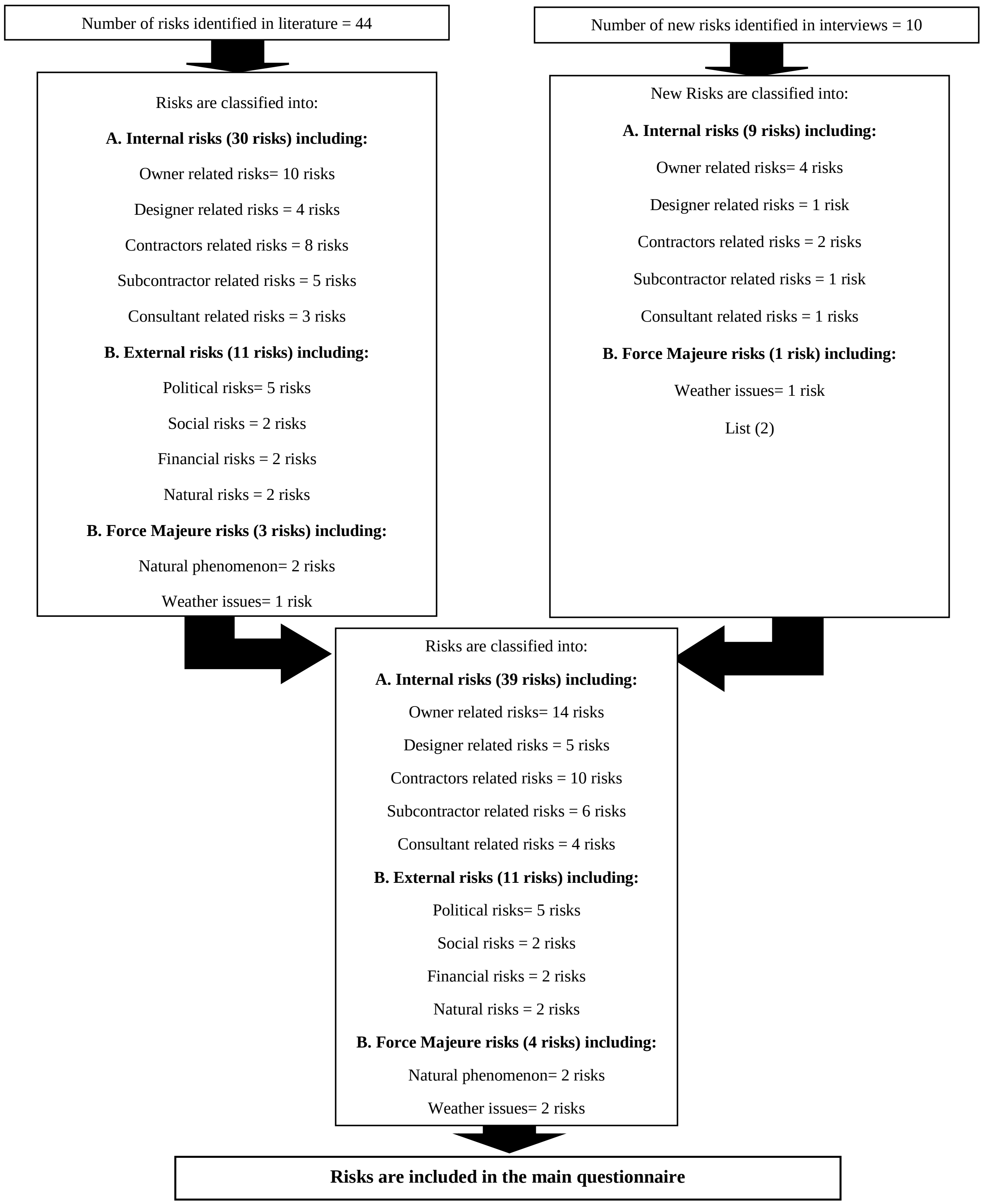


Figure 3.4: The Development of the questionnaire

The questionnaire, as shown in Appendix 1, is divided into three parts: general information about respondents, the importance of risks, and the actual allocation of risks.

- **Part One: General Information**

This part was designed to gather general information concerning the respondents of the questionnaire, including name, age, the organisation for which the respondent works, and GACA projects in which the respondents have been involved. Hence, open-ended questions were applied in this part. On the other hand, the other information included in this part was as follows: experience in years, educational background, and role in GACA projects. These questions were formed in a closed-ended style.

- **Part Two: Risks and their Importance**

In this part, the respondents were asked to go over each of the 54 identified risks, and answer the following questions:

1- Have you encountered any of the following risks within GACA projects? Again, the answers were designed to be in a closed-ended style (Yes or No). If the answer was yes for this question, then the following questions were asked:

2- To what extent do you measure the likelihood of occurrences of these risks and their impacts on GACA projects? a five-point Likert scale was used to allow the respondents to select the degree of impact and the probability of occurrence for each risk, where 1 = very low, 2 = low, 3 = medium, 4 = high and 5 = very high. Likert scales represent a very useful technique to determine the importance of risks and this was also used in other similar studies, such as that of Bing *et al*. (2001), and Motaleb & Kishk (2013).

- **Part Three: Actual Risk Allocation**

In this part, the respondents were asked to go over each of the 54 risks and allocate them to the actual party responsible for each risk. Although the questionnaires listed a number of parties—namely client, designer, contractor, subcontractor, consultant, construction manager and private sector (for projects that have been undertaken using a PPP delivery method)—to which risks were allocated, there are two main parties' risks in the context of the research (domestic and regional airports in Saudi Arabia). In other words, the client is responsible for any risks allocated by the respondents to himself as a client, designer, as the Design-Bid-Build formula is applied which implies that the design is already finalised and agreed upon by the client; or consultant as the GACA appoints the designer to play the role of consultant in the majority their projects. On the other hand, the contractor is responsible for risks that are allocated (by the respondents) to himself as a contractor, or subcontractor as the choice of selecting a subcontractor is made by the main contractor.

- **Questionnaire Piloting**

As a means of piloting the questionnaire, a draft of the questionnaire was sent to the researcher's supervisory team for a thorough check. Subsequently, it was shown to each interviewee for comments. The Arabic version of the questionnaire was also checked by a translating office in Makkah, Saudi Arabia. All of these steps were carried out in an effort to make sure the final version of the questionnaire was clear and did not cause any confusion to respondents. Importantly, piloting questionnaires is a common practice that has been advocated, such as in the works of Kothari (2004) and Naoum (2012).

One comment was made by one of the interviewees regarding the amount of time each respondent would take to answer the questions. In an effort to deal with this issue, the respondents were given enough time to answer the questionnaire. In other words, the distributed questionnaires were collected after ten days from the date they were handed to respondents. Nevertheless, this issue was not a great concern since answering the questionnaire takes approximately 13–17 minutes.

➢ **Questionnaire Sampling**

The authors decided to choose respondents who had dealt with GACA projects, especially contractors and consultants; hence, a non-probability sample was implemented. This approach is recommended when the researcher intends to select respondents based on certain criteria (Knight & Ruddock, 2009).

The questionnaire was distributed amongst 95 respondents, who were grouped into three categories, namely clients, contractors and consultants. Of the 95 questionnaires distributed, 54 useable questionnaires were returned and analysed, as summarised in Table 3.10 below.

Table 3.10: The questionnaire respondents

Category	**Client**	**Contractor**	**Consultant**	**Total**
Distributed questionnaires	45	25	25	95
Returned questionnaires	34	17	19	70
Usable questionnaires	29	12	13	54

Once again, the respondents selected from GACA were project engineers and project managers, all of whom worked under the department of Project Management and Planning in Jeddah, Saudi Arabia. These respondents were selected as they have close involvement in GACA construction projects. The respondents selected from contractors were those who had been classified as high contractors by the GACA, as well as the main contractors in building and/or expanding GACA projects. The same criteria for selecting the contractor respondents were applied when selecting the consultant respondents; this explains not having a large number of respondents in this research. The selection of contractor and consultant respondents was also guided by the suggestions made by the six senior project managers' interviewees, who work for the GACA. With this noted, Gray (2013) refers to this technique as snowball sampling, where research participants make suggestions to the researcher to involve other participants (Davenport & Prusak, 2000).

3.1.1.3 Data Analysis Stage

Following the collection of data (raw data), the data passed through a process referred to as 'Data Processing'. Throughout the course of this process, the raw data were edited in terms of identifying and correcting any errors that may have been raised from the data collected in order to ensure the overall accuracy of the data. Following this, the edited data were assigned various types of symbol or number so that they could be assigned into groups; this is a process known as coding. Finally, the raw data were classified into homogeneous groups, taking into consideration the characteristics of the data (Kothari, 2004). Processing data is an important step in the research in choosing the type of analysis for the research (Naoum, 2012).

The two types of data analysis proposed for use by the researcher were qualitative data analysis and quantitative data analysis. The reason for selecting these two types was due to the mixed nature of the data gathered (quantitative and qualitative) in the data collection stage. On the one hand, the use of qualitative data analysis (or exploratory) was applied in an effort to deal with the qualitative data generated from the secondary data, literature and reports, as well as from the questions in the questionnaires adopting an open-ended form. The employment of this method was suggested by the researcher in this research owing to the ambiguity of the answers gathered from the interviewees on certain questions. Accordingly, again, the process of coding and answer classification can be presented through such a form of analysis (Naoum, 2012). A number of techniques were utilised for analysing the data generated from the 13 semi-structured interviews. Firstly, writing up the voice-recorded information as well as examining the notes taken during the interviews were both techniques which were used. After that, extracting, coding, and tabulating the generated information was undertaken.

The researcher has benefited from the use of content analysis as a method used for interview data. Content analysis is defined by Krippendorff (2004) as "a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use." It is one of the research methods that can be used for analysing qualitative data. The idea behind using this method comes from the fact that this method uses a set of procedures to have valid inferences from text and to quantify content in terms of predetermined categories (Weber, 1990). As was planned, the proposed structure of risks was determined before the interviews were conducted, which means that the levels and categories of risks were already decided on, but were evaluated and verified during the interviews. The detailed results of the risks which have been added to the structure of risks by the interviewees are discussed in Chapter four.

With regard to the questions concerning the allocation of risks within the GACA, with the use of a content analysis method a number of themes emerged such as: client authority to allocate risk, personnel experience, intuition, and absence of risk allocation guidelines. These themes were realised to form the basis of risk allocation practice used within the GACA, as they were mentioned frequently within the interviews that were obtained when interviewees were asked about risk allocation within the GACA. The researcher identified that, as he was going through the transcripts manually, noticeably, the answer to questions concerning the magnitude of time delays and cost overruns within the GACA, were analysed in a straightforward way using tabulation. In other words, the researcher took each project, from amongst the mentioned projects in the interviews and listed the issues related to it.

On the other hand, the use of quantitative data analysis (descriptive statistics) is centred on quantitative data gathered through structured interviews and closed-ended questionnaires. Subsequently, the results are presented in various ways, such as pie charts, bar charts, and so on. As stated in research Objective 3 "To Assess the importance of the identified risks", the analysis of the data generated in the questionnaires (Part B) was to rank the risks according to their relative importance index (RII) based on their importance in GACA projects from the respondents' perspectives, after calculating the impact and probability of occurrence for each risk. Many authors in relative studies, such as Ghosh and Jintanapakanont (2004), Braimah and Ndekugri (2008), and Azis (2012), have calculated the relative importance index (RII) by using the following equation:

$$\mathrm{RII} = \sum(x\ a)*100/5$$

where:

$$x = n / N$$

a = constant representing the weighting given to each response

- 1 (Very Low)
- 2 (Low)
- 3 (Medium)
- 4 (High)
- 5 (Very High)

n = frequency of responses

N = total number of responses

The weight average was calculated for each risk then divided by 5, which is the upper scale of the Likert-scale measurement.

As three groups of respondents were involved, the one way ANOVA test was employed. This test helps to determine whether there are any statistical differences amongst the answers of the respondents from the three groups (Fellows & Liu, 2015). This test was used twice in the analysis of the results (as presented in the following chapter): firstly, in determining the importance of risks; and secondly, in the actual allocation of risks.

In this research, the one-way ANOVA was completed by testing the null hypothesis of the samples in the three groups. The respondents of the questionnaire were asked the same questions, and were asked to choose answers from amongst the same set of alternatives on a five-point Likert scale. Consequently, based on the questionnaire, the following null hypothesis was formulated:

H0: There is no significant difference amongst the three groups of respondents (client, contractor, and consultant).

With risks that were identified as having a statistical difference, a different test is suggested, namely the Bonferroni correction (Engineering Statistics Handbook, 2013). This is based on a series of t-tests completed between two groups in an effort to determine where the significant difference exists.

3.1.1.4 Development Stage

In this stage, the development of the proposed framework of risk allocation for aviation projects in Saudi Arabia will be presented based on the data generated from the previous stages. The framework is derived from the literature. It aims to solve problems arising from the results of the collected data. As a means of practical validation, a number of interviews were conducted with senior project managers with a high level of experience in an effort to test the overall applicability of the framework within GACA projects. Finally, writing the final report (the thesis) is the last action carried out before submission.

3.2 Ethical Issues

The subject of ethical issues within the project is considered crucial to the research and the researcher, as has been acknowledged by many authors, such as Kothari (2004) and Gray (2013), amongst others. In this research, a number of issues were taken into consideration throughout the completion of the study. The first issue concerns the confidentiality of the data: as stated previously, the researcher mainly deals with a governmental organisation (GACA) and its contractors, meaning any data obtained from this organisation will be sensitive in nature; in addition, there needs to be compliance with any of the principles that would have been set by the GACA. Accordingly, in order to deal with this issue, the researcher assured the research participants that the data would be used only for the research purposes, with upfront permission obtained from the Robert Gordon University.

The second issue raised in the research centres on the inconvenience of the data revealed: for instance, some deficits and weaknesses may have been discovered in the strategy of risk allocation presently adopted by the GACA. This issue is considered with care in terms of presentation; in other words, the language used to represent the generated result is suitable.

3.3 Validity and Reliability

Gray (2013) identifies the term validity as 'the degree to which data in a research study are accurate and credible'. The validity of two aspects is tested in this research, as guided by Gray (2013), namely the methods used and results. As the interview method was adopted first, these were self-checking (internally validated), with validation employed, and for the questionnaires an external validation was employed by checking the first draft in the conducted interviews (piloting) and the benefit of translation services from experts for the Arabic version of the questionnaire. On the other hand, validation of the results was achieved by presenting the results to a number of interviewees who were interviewed before, as well as using these interviews in an effort to validate the proposed framework for risk allocation.

When testing the reliability of tools used for data collection, the researcher included three different groups of participant for the conducted interviews and questionnaires. All of the participants were asked the same questions in the interview, as well as answering the same questions in the questionnaire. According to Yin (1994), this ensured that a reliable method was employed through the presence of different individuals, who were asked the same questions and answered with the same answers. Furthermore, in order to obtain reliable data, an Intra-Judging method was used to test reliability (as suggested by Gray, 2013), which entails taking a number of the answers given by two or more different respondents and judging the consistency of their answers. This was done in the present work through the completion of one way ANOVA test, which helps to achieve reliable data from different participants from different organisations involved in the research.

3.4 Chapter Summary

This chapter presents the methodology through which the research is undertaken. It has provided a theoretical discussion on the research pyramid and its applicability to the research, with consideration of its inclusion of four different levels. Subsequently, the research design—which is undertaken in four stages, namely the planning stage, data collection stage, data analysis stage, and development stage—is presented. A mixed-methods approach has been adopted in the research, which began with the completion of 13 interviews, followed by the distribution of 95 questionnaires. The respondents were selected using a non-probabilistic technique as the researcher set a number of criteria for their selection.

The two types of analysis used in this research have been clearly discussed in this chapter, namely qualitative and quantitative. The reason for employing these two types is due to the same nature of the methods used for collecting, as well as the results generated. The one way ANOVA was used in the analysis of quantitative data due to the fact that a number of different groups of respondents were involved. Hence, there were statistical differences amongst the three groups of respondents. A clarification concerning the ethical issues encountered when completing the study, and how they were dealt with, is presented. Finally, the chapter ends by showing how the researcher attempted to achieve both validated and reliable tools and data.

Chapter Four: Analysis of the Research Results

4.0 Introduction

Naoum (2012) describes the results analysis chapter as the core part of the thesis as it demonstrates the findings of the research presented in different ways, such as through the form of discussion, tables, figures and diagrams, etc. Hence, this chapter is divided into two sections, dealing with the analysis of the results generated from the conducted interviews and the distributed questionnaires. The first section presents the analysis of the results generated from the 13 semi-structured interviews with the senior project managers, all of whom have wide experience with the GACA and contractors and consultants, working or having worked in GACA projects. The results then are analysed qualitatively from the saved and typed dialogues of each interview; all were saved on the researcher's space in the IT system of Robert Gordon University.

The second section of the chapter demonstrates the results of the 54 returned questionnaires, focusing on the risks associated with GACA projects and their significance; this is determined through the analysis of the values resulting from each risk's likelihood of occurrence, multiplied by each risk's impact. Furthermore, as the second part of the questionnaire dealt with the actual allocation of the 54 identified risks, this chapter reveals the allocation of each risk to each party involved in GACA projects from the perspective of the questionnaire respondents. The researcher benefited from the use of descriptive analysis with regard to the analysis of the risk likelihoods, impacts, importance and allocation.

4.1 Analysis of Interviews

Thirteen semi-structured interviews were carried out to allow verification of the proposed risk structure by the researcher. For the same reasons, interviews were used as a supporting technique to identify risks in construction projects in different studies, such as those by Sweis *et al*. (2008) and Assaf *et al*. (1995), amongst others. Furthermore, the interviews were also conducted to evaluate and confirm the existence of overruns and delays in the cost and time of GACA construction projects on a wider scale in terms of different projects. Finally, the researcher used the interviews as a tool to investigate the way in which risks are allocated within GACA projects.

The 13 interviewees were selected based on their experience in GACA projects—10 or more years. Five interviewees work for GACA, four interviewees were contractors, and four interviewees were consultants, all of whom have been involved in GACA projects. Moreover, the diversity of projects was a criterion for selecting the sample, as the interviewees have been involved in different GACA projects. The interviewees were asked a number of questions and given the opportunity to list any relevant risks encountered.

4.1.1 Risk Identification

A total of 10 new risks were added to the 44 risks initially suggested by the researcher as a result of asking the interviewees about the risks encountered throughout the course of GACA projects in which they had been involved. Tables 4.1 summarises the 10 risks added by the interviewees.

Tables 4.1: The 10 new risks identified by the interviewees

	The risk	Client (out of 5)	Contractor (out of 4)	Consultant (out of 4)	Total (out of 13)
1	Changing demands	3	2	4	9
2	Project-specific type know-how skills for contractor	3	-	-	3
3	Project-specific type know-how skills for subcontractor	3	-	-	3
4	Project-specific type know-how skills for designer	3	-	-	3
5	Project-specific type know-how skills for consultant	3	-	-	3
6	Inadequate risk management plan	1	3	2	6
7	Poor coordination between project parties	2	2	2	6
8	Floods	-	-	1	1
9	Issue of sustainability	-	-	1	1
10	Inadequacy of requirements	-	-	1	1

- **Changing Demands**

The risk of changing demands was mentioned by 100% of the client interviewees, 50% of the contractor interviewees, and 75% of the consultant interviewees. The issue of the GACA changing the scope and type of project (mainly the domestic airport) was clear, as indicated by the interviews carried out with a variety of participants. One example was the changing commands in terms of converting the entire airport operations during the construction of a project, such as the case of Al-Qassim airport and Arar. It must be mentioned that some of the interviewees referred to this risk as a 'change of orders', with several calling it a 'change of scope'. However, the use of 'changing demands' was considered more comprehensive, as it covers both order change and changing scopes.

- **Project-specific Type Know-how Skills for Contractors, Subcontractors, Designers and Consultants**

Project-specific type know-how skills for the contractor, subcontractor, designer and consultant are a risk described by 60% of the client interviewees. However, this risk was not mentioned by any of the interviewees in the other two groups. To clarify this risk, CL1 stated that 'the problem with our contractors, subcontractor, designers, and consultants is despite the fact that they may be big names in the market but when it comes to design or construct an airport … you will see them struggle'. However, the classification of this risk for these four groups, and its place within the proposed risk structure, must be carried out according to each risk source. For example, the risk of project-specific type know-how skills for a contractor must fall within the first category, 'internal risks', and then 'contractor-related risks', with the same holding true for the subcontractor, designer and consultant.

- **Inadequate Risk Management Plan**

This risk was mentioned by 20% of the client group interviewees, 75% of the interviewees in the contractor group and 50% of the client group interviewees. It is not surprising to see that this is regarded as a risk, as risk management and its principles are not well applied in the construction industry, as claimed by many authors, including Mead (2007).

- **Poor Coordination between Project Parties**

The risk of poor coordination between parties was mentioned by 40% of the client interviewees, 50% of the contractor interviewees and 50% of the consultant interviewees. This risk involves communication, coordination and cooperation between the managers of the GACA projects and the participants in their projects, including contractors and consultants. Although Assaf & Al-Hejji (2006) classified this risk under those falling within the responsibility of the consultant, it has been classified under the category of 'internal risks' and 'client-related risks' in this research because, in numerous GACA construction projects, especially domestic projects, the role of the consultant is usually played by members of GACA staff, with the actual consultants (designers) having less influence than any GACA member. Moreover, the contractor interviewees also agree that this risk is primarily client-related.

- **Floods**

Although this risk was mentioned by just one consultant of the 13 project managers interviewed, it appears realistic to note this whilst discussing the potential risks associated with GACA construction projects. Recently, the Kingdom of Saudi Arabia has witnessed an enormous amount of rain, resulting in floods that have affected its infrastructure, as well as causing deaths in different regions of the country. In this research, this risk is classified as an 'Act of God' risk.

- **Issue of Sustainability**

This risk also was mentioned by only one consultant of the 13 interviewed. However, an understanding of the issue of sustainability and how it relates to construction (Holcim Foundation, 2014) explains the ways in which buildings contribute to increasing the phenomenon of sustainability by meeting the contemporary needs of any construction projects without affecting the needs of subsequent generations. This is achieved by incorporating various elements of economic efficiency, environmental performance and social responsibility, making its greatest contribution when architectural quality, technical innovation and transferability are involved. Therefore, in the opinion of the sole interviewee who viewed this as a risk, it appears that the issue of sustainability has not been considered, but could count as one of the risks associated with GACA construction projects; however, the results of the questionnaire will certainly clarify the existence of this risk.

- **Inadequacy of Requirements**

Again, this risk was mentioned by only one consultant of the 13 interviewed. The claim here is that GACA construction projects are inadequate when they set their requirements for their own projects, which can lead to subsequent time delays, cost overruns and/or conflicts. The consultant provides an example of such a requirement in one of the GACA projects in which he was involved—notably a project that required a manager with 30 years' experience and 15 years' experience in airport projects; this was viewed as realistic in this consultant's opinion. It has been decided that this risk should be classified under 'internal risks' and 'client-related risks' in this research.

As a result of a simple descriptive statistical analysis performed to present the risks frequently mentioned by the interviewees, 54 risks have been outlined; the interviewees added ten additional risks (highlighted in red in Table 4.2) to the initial proposed structure of risks, which contained 44 risks (highlighted in black in Table 4.2). Such risks have been classified into three levels: an internal level comprising risks that fall within the control of project participants as they are the ones who generate the risks; an external level consisting of risks that partially fall beyond the control of project participants but nonetheless encompass some influence over their control; and, finally, force majeure risks, consisting of those risks that are outside the control of any project party. Each of these levels of risk subsequently was classified into a number of sub-classifications, based on their source. The classifications and sub-classifications of the identified risks were used in this study to facilitate the process of analysing the risks in a further study.

Hence, for the first level of risks (internal), five sources of risk were outlined—client, designers, contractors, subcontractors and consultants—as those representing the main participants in GACA construction projects. On the other hand, the external risk level consisted of four sources of risk: political, social, financial and natural risks. Lastly, the force majeure risk level consisted of two sources of risk: natural phenomena and weather issues falling beyond any project participant's control.

Table 4.2: The structure of risks associated with GACA construction projects

A-Internal Level

Client-specific risks:
1. Payment delays
2. Tight schedule set by client
3. Inappropriate intervention by client
4. Design changes by client
5. Inadequate scope
6. Site access delays
7. Contract breaching by client
8. Client financial failure
9. Lack of experience of client
10. Obtaining/issuing required approval
11. Issue of sustainability
12. Inadequacy of requirements
13. Poor coordination
14. Changing demands

Designer-specific risks:
15. Design errors
16. Incomplete design
17. Design constructability
18. Poor quality of design
19. Project type know-how skills

Contractor-specific risks:
20. Poor quality of construction
21. Lack of experience of contractor
22. Contractor financial failure
23. Low or poor contractor work productivity
24. Errors during construction
25. Accidents and safety issues
26. Quality and control assurance
27. Contractor breaching by contractor
28. Project type know-how skills
29. Inadequate risk management plan

Subcontractor specific risks:
30. Poor subcontractor work productivity
31. Subcontractor breaching contract
32. Subcontractor financial failure
33. Material availability
34. Material quality
35. Project type know-how skills

Consultant specific risks:
36. Inadequacy of specifications
37. Lack of experience
38. Quality assurance
39. Project type know-how skills

B-External Level

Political risks
40. Bureaucratic problems
41. Threat of war
42. Labour issues
43. Corruption
44. Changes to laws

Social risks
45. Crime rate
46. Cultural differences

Financial risks
47. Inflation
48. Currency fluctuation

Natural risks
49. Poor site conditions
50. Pollution

C-Acts of God

Natural phenomena
51. Earthquakes
52. Fires
53. Floods

Weather issues
54. Severe weather conditions

4.1.2 Impact of Risks in GACA Construction Projects

The interviewees highlighted a number of projects seen to have been affected by risks and their consequence in terms of time delays, cost overruns and overall quality. All of the aforementioned risks have negatively affected GACA projects in terms of time, cost and/or quality. The clarification of such impacts is thought to give a better understanding of how risks can affect GACA projects. Table 4.3 below highlights the impact of ten risks on 16 different airports in terms of time delays, cost overruns and poor quality, according to 11 (of 13) interviewees, which has also been documented by Baghdadi and Kishk (2015).

Table 4.3: Risks and their impact on a number of GACA construction projects

The risk	**The project**	**Project type**	**The impact**
Poor site conditions	Jizan	Regional	Late start of the project (time delay)
Changing demands	Hail	Regional	Several stops (time delay)
Poor quality of design	Najran	Domestic	Quality of the project
Changes in design during construction	Construction of Al-Qassim Airport (stage 2)	Regional	6 months' delay in project delivery (time delay)
-Changes in design during construction -labour issues	Construction of Al-Qassim Airport (stage 3)	Regional	6 months' delay in project delivery (time delay)
-Changes in design -Poor quality of design -Changing demands	Design of Al-Qassim Airport	Regional	-10% added to the total cost (cost overrun) -4 months' delay in project delivery (Time delay)
-Changing demands -Design changes	Development and enhancement of a number of airports (stage 3) including: 1-An expansion in the capacity of Al-Taif Airport. 2-An expansion in the capacity of Hail Airport 3-An expansion in the capacity of Jizan Airport	 Regional Regional Regional	

Poor coordination between project parties	Al-Ola Airport	Domestic	12 months' delay in project delivery (time delay)
-Poor site conditions Absence of risk management plan	Jizan Airport Al-Qassim Airport (stage 1)	Regional Regional	Late start of the project (time delay) Delay in project delivery (time delay)
Errors during construction	Al-Qassim Airport (stage 1)	Regional	Delay in project delivery (Time delay)
Errors during construction	Albahah Airport	Regional	Delay in project delivery (time delay)
-Changes in design during construction -Inadequate scope	Hafer Albaten Airport	Domestic	Delay in project delivery (time delay)
Changing demands	Aljouf Airport	Domestic	Late start of the project (time delay)
Inadequate scope	Design of Al-Qassim Airport	Regional	Late start of the project (time delay)
-Inadequate scope -Obtaining the approvals -Threats of war	Araar Airport	Domestic	Delay in project delivery (time delay)

These projects encompassed six domestic airports, namely Najran, Al-ola, Aljouf, Hafer Albaten, Albahah and Araar, nine regional airports, namely Jizan, Hail, construction of Al-Qassim airport (stage 1), construction of Al-Qassim airport (stage 2), construction of Al-Qassim airport (stage 3), design of Al-Qassim airport, expansion of Taif airport, expansion of Hail airport and expansion of Al-Qassim airport. A total of 10 risks appear to be the cause of time delays, cost overruns and poor quality in the projects; there follows a description of these.

The risk of **changing demands** caused time delays to six projects: Hail, design of Al-Qassim airport, expansion of Taif airport, expansion of Hail airport and expansion of Al-Qassim and Aljouf airports; a cost overrun amounting to 10% of the total cost also was caused. The risk of **design changes** caused time delays to seven projects: expansion of Taif airport, expansion of Hail airport, expansion of Al-Qassim airport, construction of Al-Qassim airport (stage 2), construction of Al-Qassim airport (stage 3), Hafer Albaten and design of Al-Qassim airport.

Inadequate scope caused time delays to at least six projects, including the design of Al-Qassim, Hafer Albaten and Araar airports. The risk of **poor site conditions** caused time delays at Jizan airport, and also resulted in poor quality of construction at Najran airport. **Poor coordination between projects parties** caused time delays at Aloula domestic airport.

Inadequate risk management plan caused time delays for the construction of Al-Qassim airport (stage 1). **Obtaining issuing required approva**l caused time delays to Araar, construction of Al-Qassim airport (stage 1) and Albahah Airport. **Errors during construction** risk caused time delays in the construction of Al-Qassim airport (stage 1) and Albahah. **Labour issue** risk caused time delays in the construction of Al-Qassim airport (stage 3). Finally, **Threats of war** also caused time delays in the construction of Araar.

4.1.3 How Risks are Allocated to Parties

Interviewees were asked to comment on the current process of risk allocation completed within GACA projects. It was thought that this would enable the researcher to gain an improved understanding of the current situation in order to create a solution. The responses of the interviewees with regard to how risks are being allocated within GACA projects are shown in Table 4.4.

Table 4.4: Interviewees' responses with regard to the current way of allocating risks within GACA construction

	Client power authority	Experience from previous projects	Personnel intuition	Incompliance with contract conditions	Not based on a proper risk analysis
1	✓				
2			✓		
3		✓			✓
4	✓			✓	
5			✓		
6	✓				
7	✓				
8		✓	✓		
9	✓				
10			✓	✓	
11					✓
12	✓				
13					

The interviewees were given six different criteria on how risks are allocated to parties in GACA projects. The allocation of risks with the use of power of authority from GACA staff has been indicated as the top factor upon which GACA base their decisions when allocating risks. The use of authority in the allocation (as in the case of some GACA projects) is one of the construction client's rights (Nielsen, 2007). However, the decision surrounding the allocation of such a risk is crucial, and therefore must be taken into consideration on the basis of a proper analysis of risks so as to ensure that the client is or is not the best party to manage the risks (Swanson, 2006); in the case of GACA, this has not been shown to take place.

Secondly, the factor of personnel intuition is one the criteria the GACA uses to build the decision of allocating risks. This factor is subjective in nature, and is not based on any fair factors in the making of a decision. One of the interviewees argued that 'it all depends on the GACA project manager who can make decision based on his intuition, which can be different from another project manager work for GACA too'. Similarly, the allocating of risks based on experience from previous projects was also indicated by interviewees as one of the common practices by the GACA in the allocation of risks. Clear reasons can be given for the decision not to adopt a subjective approach: every project is unique and is different when compared with other projects; projects involve different elements of size and complexity, with GACA projects differing, which requires optimised management of all projects.

Moreover, there are two factors upon which the GACA bases their decisions about risk allocation, which can be regarded as general practice for allocating risks, including: incompliance with contract conditions, which means not sticking to the contract statements when allocating risks by GACA staff and allocating risks that are not based on a proper risk analysis. All in all, the interviewees agreed that identification and analysis have not been considered for utilisation across GACA projects; rather, the GACA relies on the above-mentioned criteria in the allocation of risks.

4.2 Analysis of Questionnaires

This section reveals the results of the questionnaires distributed and returned from a number of respondents, including GACA projects managers, contractors and consultants involved in GACA projects. As the questionnaire is divided into three main parts, namely personal information about the respondents, risk importance, and the actual allocation of risks, the following provides an analysis of each part.

4.2.1 Analysis of the first Part of the Questionnaire

The first part of the questionnaires focuses on the personal information of the respondents themselves, including their age, experience and role in GACA projects. These data are analysed and presented below.

- **Number of Respondents**

The questionnaire was distributed amongst 95 respondents, including 50 clients (GACA members), 25 contractors and 20 consultants, as shown in Table 4.5 below.

Table 4.5: The number of respondents involved in the questionnaires

Respondents	Sent Questionnaires	Actual Respondents
Client respondents	50	29
Contractor respondents	25	12
Consultant respondents	20	13
Total number of respondents	95	54

A total of 54 respondents responded to the questionnaires, with those respondents divided as follows: 29 clients (GACA members), 12 contractors, and 13 consultants, as shown in Table 4.5 above.

- **Roles of Respondents**

The 54 respondents were analysed according to their own roles within the GACA or its projects. The results are shown in Figure 4.1 below. Most of the respondents were project engineers working for GACA (28%); this was followed by 24% of the overall respondents acting as project managers working for the GACA. Contractors made up 22% of all respondents. Designers and consultants represented 13% and 11% of the respondents, respectively. Lastly, only 2% of the roles of the overall respondents were classified as others. Noticeably, as is shown, the majority of the respondents were from the client side (GACA), which gives a clear indication of how responsive and welcoming they are. Whereas, reaching staff who work for private agencies such the GACA's contractors and consultants was a more difficult task. However, as one of outcomes of conducting the preliminary study (Chapter Three), the researcher was able to build contacts with key people in the GACA, which then were used to facilitate the process of reaching other personnel especially from amongst the GACA's contractors and consultants.

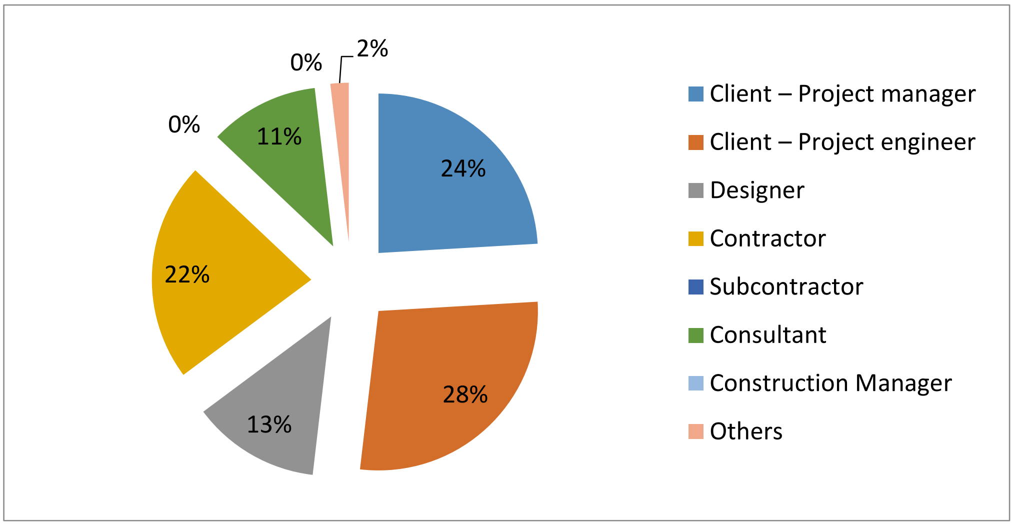


Figure 4.1: Analysis of the roles of the overall respondents

- **Educational Background of Respondents**

The 54 respondents were analysed according to their own educational background. The results are shown in Figure 4.2 below. Almost one-third (33%) of all respondents were found to have an architectural background, with 31% of the respondents having a background in civil engineering. Electrical and mechanical engineer respondents consisted of 17% and 15% of the overall respondents, respectively. Finally, only 4% of the 54 respondents were classified as others. The means they did not have an academic background in the listed specialities. The results seem to be in alignment with findings for other governmental agencies in Saudi Arabia, particularly when it comes to the educational backgrounds of the employees of the project management departments, where the majority of them have architectural and civil engineering backgrounds. Again, this is attributed to the fact that the Saudi university graduates from these two fields have been taught project management and construction management. Hence, they have become more favourable for Saudi governmental agencies for work in construction departments.

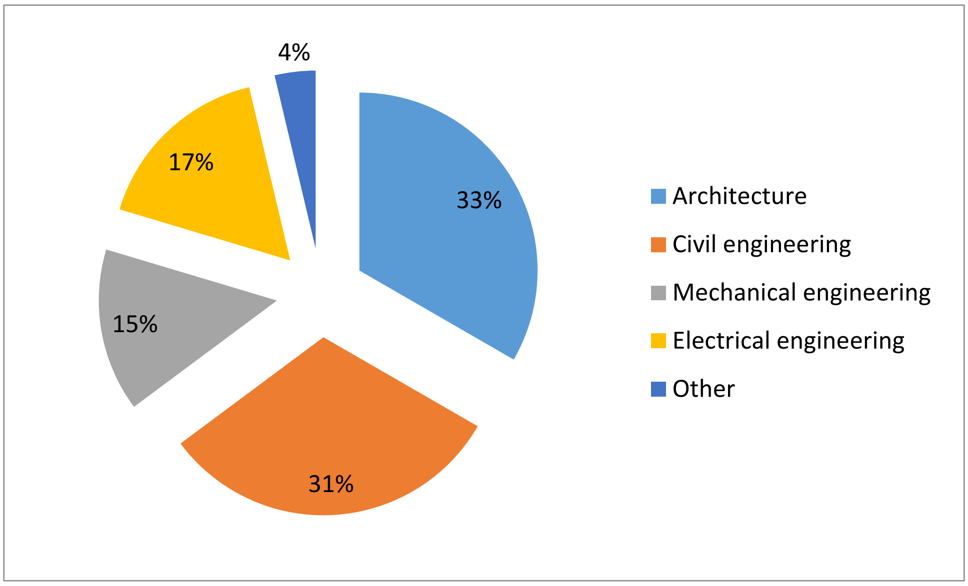


Figure 4.2: The educational backgrounds of the respondents

- **Work Experience of Respondents**

The 54 respondents were analysed according to their own experience within the GACA or its projects. The results are shown in Figure 4.3 below. More than half (52%) of the overall respondents had 5–15 years' experience, whilst 20% of the total respondents had less than 5 years' working experience. Similarly to the last percentage, 19% had between 16 and 25 years' experience. Only 9% of the overall respondents had more than 25 years' working experience.

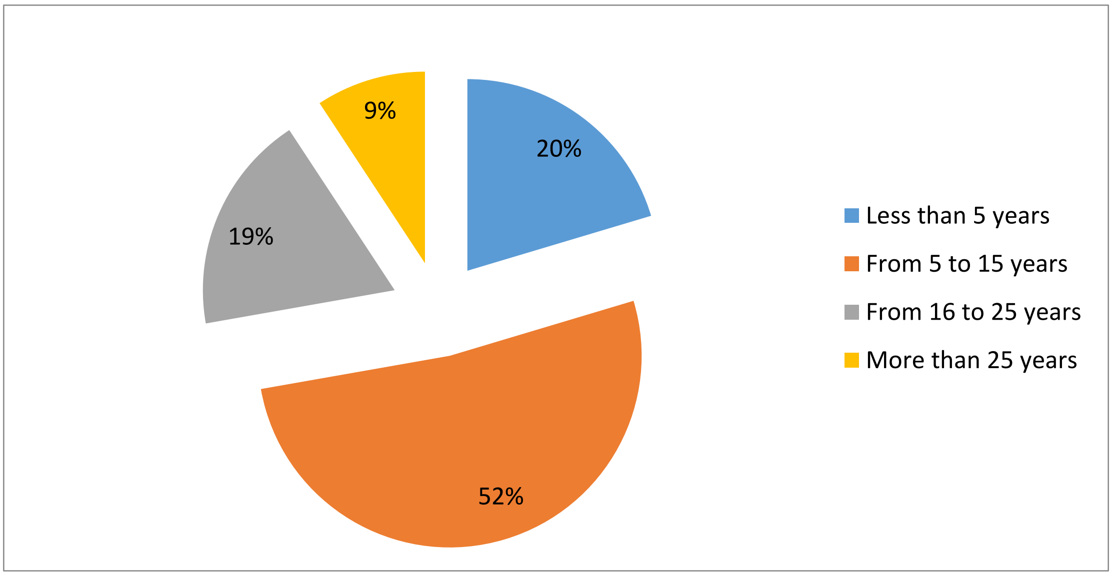


Figure 4.3: The work experience of respondents

However, the three categories of respondent—client, contractor and consultant—show a clear difference regarding the experience of each group of respondents. Figure 4.4 shows the three categories of respondents' experiences and the differences amongst them.

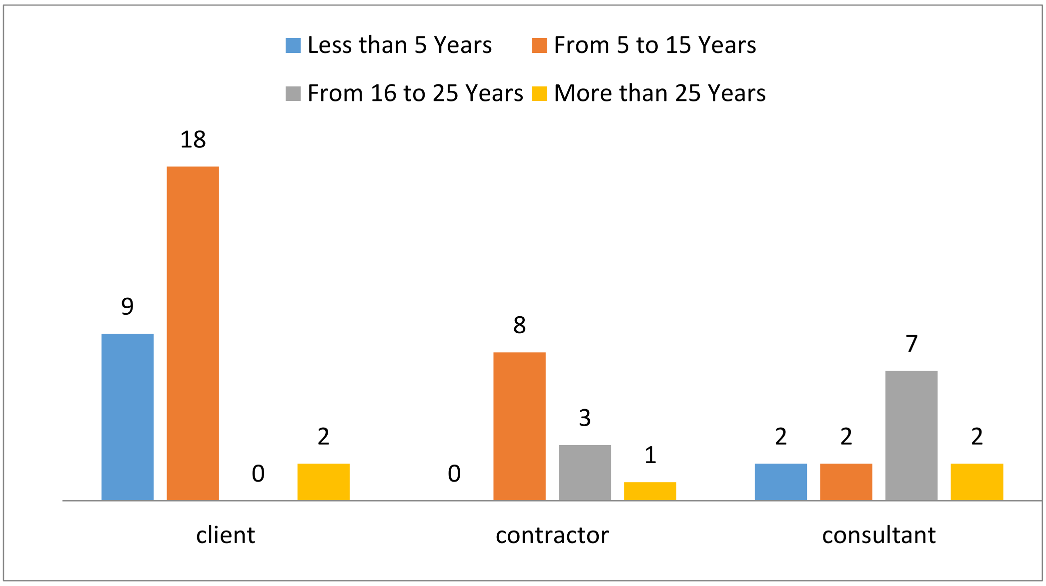


Figure 4.4: The differences in the three categories of respondents' experience

As seen in Figure 4.4, the client category has the highest number of respondents with five or fewer years' work experience (9 out of 29), which is followed by the consultant group, with two respondents out of 13. The contractor group does not have any respondents with experience of less than 5 years. On the other hand, the consultant and client groups of respondents have the highest number of respondents with more than 25 years' working experience per group; however, the contractor group has one respondent only. The client group has the highest number of respondents with 5–15 years' experience (18 out of 29), followed by the contractor group (8 out 12) and then the consultant group (2 out of 13). Finally, the consultant group was found to be the highest in terms of having respondents with experience ranging from 16–25 years (7 out of 12), followed by the contractor (3 out of 12) and client (0 out of 29) groups, respectively. Notably, the result of having more inexperienced staff within the GACA was attributed to the fact that the

GACA stopped hiring new staff for almost ten years, but they have started taking newer fresh graduates again recently. According to one of the GACA's senior managers, this has created a gap amongst people who have been working with the GACA for many years and the newer employees, which can result in some undesirable consequences; such as: assigning projects to new project managers with low experience, poor communication between the old GACA and the new staff.

4.2.2 Analysis of the Second Part of the Questionnaire

The 54 risks identified have been assessed in respect of their importance to GACA projects. The probability (P) and impact (I) was calculated (as shown in the Appendices 5 and 6), and accordingly multiplied in order to determine the importance (I) of each risk associated with GACA projects individually, according to the three groups of respondents' opinions, as shown in Table 4.6. The Impact of each identified risk was calculated and provided in Appendix 5. Likewise, the probability of each risk occurring was calculated and provided in Appendix 6. However, the following formula Importance of risk (IM) = Probability of risk occurrence (P) x Impact of risk (I) is used to determine the importance of each identified risk.

Table 4.6: The Importance of the 54 risks associated with GACA projects

Risk Number	Risk	Number of Respondents	Mean score	Std
1) Internal level				
A- Client-related risks				
R1	Payment delays	44	2.97	0.91
R2	Setting tight schedule by client	36	2.93	0.87
R3	Inappropriate intervention by client	38	2.81	1.18
R4	Design changes by client	47	3.34	1.36
R5	Inadequate scope	26	2.63	0.96
R6	Site access delays	35	2.51	0.93
R7	Contract breaching by client	20	2.48	1.19
R8	Client financial failure	10	1.88	1.3
R9	Lack of experience of client	23	2.83	1.2

R10	Obtaining/issuing required approval	41	3	1.07
R11	Issue of sustainability	19	1.89	1.44
R12	Inadequacy of requirements	21	2.34	1.12
R13	Poor coordination	37	2.56	1.1
R14	Changing demands	38	2.88	1.38
B- Designer-related risks				
R15	Design errors	43	3.01	1.05
R16	Incomplete design	25	3.08	1.11
R17	Design constructability	13	3.17	1.39
R18	Poor quality of design	26	3.02	1.19
R19	Project type know-how skills	21	3.21	1.42
C- Contractor-related risks				
R20	Poor quality of construction	37	2.94	1.29
R21	Lack of experience of contractor	35	2.76	1.11
R22	Contractor financial failure	26	2.54	1.22
R23	Contractor low or poor work productivity	35	2.55	1.21
R24	Errors during construction	43	2.73	1.23
R25	Accidents and safety	36	2.34	1.06
R26	Quality and control assurance	32	2.34	1.18
R27	Contractor breaching by contractor	23	2.30	1.35
R28	Project type know-how skills	26	2.84	0.99
R29	Inadequate risk management plan	31	2.78	1.2
D- Subcontractor-related risks				
R30	Subcontractor poor work productivity	39	2.68	0.91
R31	Subcontractor breaching contract	28	2.38	1.17
R32	Subcontractor financial failure	26	2.29	1.04
R33	Material availability	36	2.41	1.07
R34	Material quality	35	2.27	0.82
R35	Project type know-how skills	25	2.38	0.73
E- Consultant-related risks				
R36	Lack of experience of consultant	36	2.81	1.25
R37	Inadequacy of specifications	36	2.58	1.29
R38	Quality assurance	35	2.57	1.14
R39	Project type know-how skills	28	2.81	1.22
2) External risks				
A- Political risks				
R40	Bureaucratic problems	46	2.92	1.21
R41	Threats of wars	12	2.20	1.65
R42	Labour issues	46	3.39	1.09
R43	Corruption	42	3.24	1.49
R44	Changes of law	29	3.05	1.45
B- Social risks				
R45	Crime rate	9	1.67	1.51
R46	Cultural differences	22	2.11	1.22
C- Financial risks				
R47	Inflation	19	2.36	1.09
R48	Currency fluctuation	16	2.04	1.19
D- Environmental risks				
R49	Poor site conditions	33	2.63	0.99
R50	Pollution	20	2.06	1.13
3) Acts of God				
A- Natural phenomena				
R51	Earthquakes	12	2.22	1.63
R52	Fires	26	2.67	1.15
R53	Floods	33	2.46	1.05
B- Weather issues				
R54	Severe weather conditions	30	2.49	0.99

Table 4.6 summarises the 54 identified risks related to GACA construction projects with reference to their mean value of scores for their importance according to the respondents’ views. The results presented in Table 4.6 are the results of multiplying the mean scores of each risk regarding the probability of occurrence by its impact, divided by 5, because a scale ranging 1–5 (Likert) has been used in the questionnaire to assess the probability of occurrence and the impact of each risk (with 1 seen to have the lowest and 5 the highest).

Moreover, Table 4.6 shows three levels of risk: internal, external, and acts of God; there also are 11 classifications, including client-, designer-, contractor-, subcontractor- and consultant-related risks for the internal level, political, social, financial, and environmental risk for the external level, and natural phenomena and weather issues for the acts of God level. The use of levels and categorisations is adopted in this research in an effort to facilitate the allocation of each of the identified risks, as it provides the source of each risk. A similar study looked at the risks inherent in the UAE construction industry—notably that of El-Sayegh (2008)—which also adopted the use of risk levels and classifications according to the source of risks. Moreover, a study carried out by Khodeir & Mohamed (2015), centred on investigating the risks in construction projects in Egypt, using the idea of risk level; however, the risks were not classified into any further categories.

Nevertheless, Table 4.7 below summarises the ten most important risks according to the respondents' opinions following the completion of a descriptive analysis, including the mean values, standard deviation and ranking. However, the researcher assumed that, in order for such a risk to be significantly important, it needs to have a mean value score equal to or more than three as this number is almost equivalent to LOW on the 1–5 scale used in the questionnaire for assessing risk impact and probability of occurrence. Table 4.7 also shows the level and category of risk to which each risk belongs.

Table 4.7: The 10 most important risks to GACA projects

Risk	Mean Value Score	std	Rank	Level	Category
Labour issues	3.39	1.09	1	External	Political
Design changes by client	3.34	1.36	2	Internal	Client-related
Corruption	3.24	1.49	3	External	Political
Project type know-how skills for designers	3.21	1.42	4	Internal	Designer-related
Design constructability	3.17	1.39	5	Internal	Designer-related
Incomplete design	3.08	1.11	6	Internal	Designer-related
Changes of law	3.05	1.45	7		Political
Poor quality of design	3.02	1.19	8	Internal	Designer-related
Design errors	3.01	1.05	9	Internal	Designer-related
Obtaining/issuing required approval	3.00	1.07	10	Internal	Client-related

From Table 4.7, it is clear that seven important risks are within the internal level of risks, whilst three are within the external level. However, no risks within the acts of God level are realised within the top 15 most important risks to GACA projects. Five risks are within the client-related category of risks, with just one risk in each of the following categories: designer-related and contractor-related. On the other hand, all of the three risks within the external level are related to political risks.

The labour issue is ranked first in terms of its importance to GACA project. The problem can be attributed to the Ministry of Labour, which contributes to this issue by imposing strict rules that require that the construction company adhere to guidelines decreasing the number of non-Saudi workers. Again, this issue is widely realised in the construction literature, with many studies in different contexts having ranked this risk as one of the most important affecting construction projects, as in the works of Assaf *et al*. (1995), Assaf & Hejji (2006) and Al-Kharashi & Skitmore (2009), amongst others, as carried out in the Saudi context, as well as Kartam & Kartam (2001) in Kuwait and Sweis *et al*. (2008) in Jordan. This result is in alignment with the recommendations made by the Anti-Corruption Committee in Saudi Arabia, which identified the labour issue as one of the top factors contributing to project delays in the country (Okaz, 2013). In addition, design changes, as implemented by the client, is ranked as the second most important risk, with this risk appearing to occur in the majority of GACA construction projects and with a high impact on these projects. Moreover, this risk was also frequently addressed with almost all of the interviewees across the interviews. The result was also in alignment with a number of studies completed in different contexts: for instance, the contractor respondents of a study on large buildings in Saudi Arabia by Assaf *et al*. (1995) ranked the risk amongst the top three most important risks. This risk was also ranked amongst the top 10 most important risks in a study on the Pakistani construction industry, completed by Choudhry & Iqbal (2012). It was also ranked first by Alnuuaimi & AlMohsin (2013) in a study centred on Omani construction projects.

Corruption was found to be the third most important risk to GACA projects. This issue has not been widely discussed in the literature in the context of Saudi construction projects, with only one study—notably that by Ikediashi *et al*. (2014)—realising this risk within the study context. Moreover, Choudhry & Iqbal (2012) also acknowledged the issue of corruption and its importance within Pakistani construction projects, as it was ranked the first most important one among the top 10. The project-type know-how skills for designers' risk was ranked fourth. As previously stated in this chapter, this risk was added by one of the senior project managers interviewed.

Design constructability is the fifth most important risk to GACA projects. This risk has not been found in the Saudi context or in any other studies reviewed in this research to be amongst the most important risks. In addition, incomplete design is another designer-related that was found to be important to GACA projects, as it is ranked sixth. Changes of law came in as the seventh most important risk to GACA projects. Also, poor quality of design is ranked as the eighth most important risk according to the questionnaires' respondents.

Design errors were found to rank as the ninth most important risk to GACA projects. There are a number of reasons to explain why this issue occurs, according to one of the senior project manager interviewees; it is attributed to the lack of compliance amongst designers to the documents of the GACA design requirements, as well as the lack of experience of some designers. The result does not seem to be aligned with what it is happening in the Saudi Arabian context generally, as only the client respondents in one study conducted by Assaf *et al*. (1995) on large buildings ranked this risk as amongst the most important. However, the contractor and consultant respondents did not consider this risk to be amongst the top risks in the study. Moreover, obtaining/issuing the necessary approval was ranked as the tenth most important risk to GACA projects. This also referred to the lengthy process of getting approval issued or the slow speed of the owner in making decisions, as established by Assaf *et al*. (1995). Again, this risk is also addressed widely in the literature in a number of contexts. In Saudi Arabia, the respondents of the survey carried out by Al-Khalil & Al-Ghafly (1999) ranked this risk as being the third most important. It was also ranked second most important by contractor respondents in a work carried out by Al-Kharashi & Skitmore (2009). Errors arising throughout the construction phase were ranked as the eighth most important risk, according to the questionnaire respondents. This issue has not been realised in the context of Saudi construction projects or in any other context as being amongst the most important risks associated with construction projects.

In conclusion, the current results of this research concerning the top 10 most important risks to GACA projects do not seem to be in a complete alignment with the Saudi Arabian context. Despite the fact that four of the most important risks found in this research seem to match risks that have been realised in the Saudi Arabian context, including the risks of design changes, labour issues, obtaining/issuing required approval, these four risks have been well identified and highly ranked in the Saudi context by a number of other authors, as in the cases of Assaf & Hejji (2006), Al-Kharashi & Skitmore (2009), Albigamy *et al*. (2013) and others.

Notably, it has been found that all the risks included in the designer-related category have been recognised as amongst the most important risks to GACA projects, according to the questionnaire respondents. This result emphasises the importance of designer-related risks for GACA projects, with higher levels of impact and the likelihood of occurrences shown when compared to other identified risks.

In Table 4.8, a further analysis of the risk categories and levels of each group is presented, as well as the ranking of these groups in respect of their importance to GACA projects, according to respondents' opinions.

Table 4.8: The importance of the categories of risk for GACA projects

Level of risk	**Category of risk**	**Mean**	**std**	**Rank**
Internal	Designer-related risks	3.27	0.14	1
Internal	Client-related risks	2.91	0.81	2
Internal	Consultant-related risks	2.71	0.12	3
Internal	Contractor-related risks	2.59	0.30	4
Acts of God	Natural phenomena	2.56	0.31	5
Acts of God	Weather issues	2.49	0.99	6
Internal	Subcontractor-related risks	2.38	0.10	7
External	Environmental risks	2.37	0.44	8

External	Political risks	2.36	0.47	9
External	Financial risks	1.94	0.46	10
External	Social risks	1.62	0.06	11

Table 4.8 summarises the categories of risk according to their importance. The level of each group, mean values of scores, standard deviation, and ranking are all provided in Table 4.8. As a result, the five most important subcategories of risks include:

- **Designer-related Risks**

This category has been ranked as the most important group of risks for GACA projects. The result confirms the findings of a study conducted in the context of Saudi Arabia by Arain *et al*. (2006), which involved 45 risks related to design, which were seen to cause inconsistencies between design and construction. Moreover, the results matched findings garnered through a similar study conducted in Florida State in the USA—notably that by Ahmed *et al*. (2002)—which found the design-related group to be the most significant amongst six groups of risks. Likewise, Akintoye *et al*. (2008) identified design risks as the most important risks associated with UK PFI projects.

- **Client-related Risks**

Although this category has been ranked by only nine respondents, it is ranked as being the second most important category of risks to GACA projects. This result confirms the importance of the risks generated by the client for GACA projects, and has the highest impact and overall likelihood of occurrence. In contrast, it has been found that, in the Saudi Arabian construction context, contractor-related risks have the highest importance amongst others parties, including the client. This has been realised by a number of authors, including Al-Khalil & Al-Ghafly (1999), Albigamy *et al*. (2013), and Ikediashi *et al*. (2014) amongst others.

On the other hand, client-related risks are recognised as the most important category of risks in similar studies conducted in different contexts. For instance, in a study conducted by Kartam & Kartam (2001) in Kuwait, it was found that the client is the major party causing risks in the context of the study; however, the sample chosen for the study involved only contractors. Moreover, Alnuuaimi & AlMohsin (2013) realised that client-related risks are the main source of delay in construction projects in Oman.

- **Consultant-related Risks**

Although no risk of those involved in this category are highlighted in Table 2 as being amongst the top 10 most important risks, this category is ranked as the third most important group of risks for GACA projects. This result could be attributed to the fact that, in the majority of GACA projects, designer companies are the consultant themselves. Furthermore, since the designer-related category is ranked first—which indicates the risks generated from design are important to GACA projects—it is no wonder then that the consultant-related risks category is amongst the top five most important categories.

- **Contractor-related Risks**

This category is ranked as the fourth most important category of risks for GACA projects. This result provides a clear contradiction with similar studies carried out in different contexts. In Saudi Arabia, for example, Al-Khalil & Al-Ghafly (1999), Al-Kharashi & Skitmore (2009), Albigamy *et al*. (2013), and Ikediashi *et al*. (2014) determined contractor-related risks as being the most important category to have caused delays in different construction projects in the country. Likewise, Zou *et al*. (2007) examined the risks inherent in the Chinese construction industry, and accordingly identified contractor-related risks, coupled with owner-related risks, as being the most significant factor causing delays. The same conclusion was drawn in Sweis *et al*. (2008) in Jordan, Khoshgoftar *et al*. (2010) in Iran, and Gündüz *et al*. (2012) in Turkey.

Hence, the current result, with the contractor-related risks category ranked fifth and client-related risks first in this research, could mean that the client is the major and most important source of risk, whilst the contractor is a much less important source of risk. This completely differs from what has been realised in past works in the Saudi context, as well as in other contexts.

4.2.2.1 Significant Difference between Respondents' Opinions on the Importance of the Identified Risks Associated with GACA Projects

The reason for completing this analysis is centred on statistically validating respondents' opinions on the importance of the identified risks associated with GACA projects. Since the number of groups of participants was three (more than two), namely client, contractor, and consultant, the One-way ANOVA test was used to statistically determine the significant difference between the three groups of participants' opinions.

Therefore, Table 4.9 shows the results of the completed one way ANOVA test for the identified 54 risks' F ration and P-values. If the result of the P-value for any risk is <0.05, this means a statistical difference amongst the groups of respondents' results is present.

Table 4.9: One way ANOVA test for the 54 identified risks

Risk	Risk	Respondents	F	P
R1	Payment delays	44	1.11	0.34

R2	Setting tight schedule by client	36	0.85	0.43
R3	Inappropriate intervention by client	38	1.38	0.27
R4	Design changes by client	47	2.12	0.13
R5	Inadequate scope	26	0.66	0.53
R6	Site access delays	35	1.83	0.18
R7	Contract breaching by client	20	1.42	0.27
R8	Client financial failure	10	1.22	0.33
R9	Lack of experience of client	23	5.59	0.01
R10	Obtaining/issuing required approval	41	0.20	0.82
R11	Issue of sustainability	19	4.13	0.04
R12	Inadequacy of requirements	21	1.20	0.32
R13	Poor coordination	37	2.99	0.06
R14	Changing demands	38	2.52	0.09
R15	Design errors	43	1.57	0.22
R16	Incomplete design	25	1.06	0.36
R17	Design constructability	13	0.04	1.00
R18	Poor quality of design	26	2.71	0.09
R19	Project type know-how skills	21	1.08	0.36
R20	Poor quality of construction	37	2.86	0.07
R21	Lack of experience of contractor	35	2.34	0.11
R22	Contractor financial failure	26	2.18	0.13
R23	Contractor low or poor work productivity	35	0.14	0.87
R24	Errors during construction	43	2.66	0.08
R25	Accidents and safety	36	0.99	0.38
R26	Quality and control assurance	32	0.80	0.46
R27	Contractor breaching by contractor	23	3.02	0.07
R28	Project type know-how skills	26	0.69	0.51
R29	Inadequate risk management plan	31	0.24	0.79
R30	Subcontractor poor work productivity	39	1.89	0.16
R31	Subcontractor breaching contract	28	2.98	0.07
R32	Subcontractor financial failure	26	2.60	0.09
R33	Material availability	36	0.94	0.40
R34	Material quality	35	1.43	0.25
R35	Project type know-how skills	25	0.43	0.66
R36	Lack of experience of consultant	36	0.58	0.56
R37	Inadequacy of specifications	36	2.25	0.12
R38	Quality assurance	35	0.05	0.95
R39	Project type know-how skills	28	0.82	0.45
R40	Bureaucratic problems	46	4.70	0.01
R41	Threats of wars	12	0.09	0.91
R42	Labour issues	46	0.81	0.45
R43	Corruption	42	0.11	0.89
R44	Changes of law	29	0.46	0.63
R45	Crime rate	9	0.20	0.82
R46	Cultural differences	22	1.30	0.30
R47	Inflation	19	0.09	0.91
R48	Currency fluctuation	16	0.47	0.64
R49	Poor site conditions	33	1.31	0.29
R50	Pollution	20	0.04	0.97
R51	Earthquakes	12	0.24	0.79
R52	Fires	26	1.06	0.36
R53	Floods	33	0.83	0.45
R54	Severe weather conditions	30	0.35	0.71

Statistical differences between groups were found to occur only with three risks (as highlighted in red). This means the P-value of these risks was <5%, as this test was performed with significant P-value 5% (0.05). These three risks are: lack of client experience (P=0.01<a=0.05), the issue of sustainability (P=0.04<a=0.05), and bureaucratic problems (P=0.01<a=0.05). A further test was used to identify the differences between the three groups of respondents; however, none of the risks included amongst the 10 most important risks to GACA projects showed a statistical difference between the three respondent groups.

As a result of the presence of the significant difference between respondents' views on the changes of law risk, a post-hoc Bonferroni t-test was used to determine where the significant difference existed across the three groups of respondent views, as shown in Table 4.10 below.

Table 4.10: Bonferroni t-test results

Risk	Comparison of mean values of respondent groups		P-value	Is P-value < 0.0167?
Lack of experience of client	Client (3.89)	Contractor (2.30)	0.011	√
	Client (3.89)	Consultant (2.47)	0.344	x
	Contractor (2.80)	Consultant (2.47)	0.709	x
Issue of sustainability	Client (2.71)	Contractor (1.40)	0.069	x
	Client (2.71)	Consultant (0.60)	0.012	√
	Contractor (1.40)	Consultant (0.60)	0.109	x
Bureaucratic problems	Client (2.42)	Contractor (3.55)	0.011	√
	Client (2.42)	Consultant (3.25)	0.040	x
	Contractor (3.55)	Consultant (3.25)	0.504	x

As shown in Table 4.10, the Bonferroni t-test is performed by providing a set of comparisons of the mean values of the three respondent groups for the three risks found to have a significant difference. The difference amongst the mean values of the three respondents' groups (P-value) and a result of whether the resulted P-value is less than the 95% (0.05) divided by the number of the conducted comparisons (3) gives a result 0.0167.

Accordingly, regarding the risk of lack of experience of client, a significant difference is shown between the responses of the client and contractor groups as the P-value (0.011) is less than 0.167. The second risk found to have a significant difference was the issue of sustainability, which was identified between the client and the consultant group as the P-value (0.012) was less than 0.167. Lastly, with regard to the bureaucratic problems risk, a significant difference was identified between the client and contractor respondents. This is statistically confirmed as the P-value of 0.011 was less than 0.167. This difference can be attributed to the fact that the GACA does not consider this risk to be as important as the contractors do because it does not affect the GACA directly.

4.2.3 Analysis of the Third Part of the Questionnaire

The third part of the questionnaire concerns the allocation of the previously identified 54 risks, as derived from the three groups of respondents' point of views. However, the analysis of this part is based on the percentages of the total number of respondents who selected the actual party of GACA projects who has the responsibility for taking the risks or whether or not the risk is shared amongst project parties.

As a matter of fact, there are two parties who can take responsibility for project risks, namely the client and contractor. As the nature of involved projects in this research, the GACA takes responsibility for appointing the designer and the consultant (they are always the same company) for their own projects; on the other hand, the contractor—who is appointed separately—selects the subcontractor. Accordingly, any risk allocated to the designer or the consultant is recognised as being allocated to the client (GACA); however, any risk to be allocated to the subcontractor is considered as being allocated to the contractor. Nevertheless, in the case that a risk is shared, its responsibility is shouldered by the client and the contractor equally.

The approach of using two parties in the allocation of risks has been adopted by a wide variety of studies, including Al-Salman & Al-Mahasheer (2005), El-Sayegh (2008), and Perera *et al*. (2009), amongst others. However, Seraj Aldeen (2006) argues for the sharing of all of a project's risks, by all involved, including designers and the subcontractor, with every party taking responsibility for risks, especially those that are within their control.

The following is the result of conducting a subjective and an objective analysis of the results from the respondents' perceptions of actual allocation from the questionnaire. The use of different types of analysis ensures the reliability of the results, as suggested by Andi (2006).

4.2.3.1 Subjective Analysis of the Result of Actual Allocation

Table 4.11 reports the results of the analysis concerning the allocation of each risk identified in this research. Since the number of overall respondents is not very large (54 respondents), the researcher subjectively assumes that a risk is allocated to such a party if the overall percentage of respondents is equal to or greater than 70%. A similar percentage was applied in a study conducted in Kuwait by Kartam & Kartam (2001); however, Andi (2006), Hameed & Woo (2007), and El-Sayegh (2008) assumed lower percentages to risks to be allocated to a party. This can be considered to be owing to the fact that the number of respondents in these studies is larger than that in the current research. However, if a risk has not been scored 70% or more by respondents, its allocation is then considered to be undecided.

Table 4.11: The allocation of the 54 risks identified according to the questionnaire respondents

ID	Risk	Client (%)	Contractor (%)	Shared (%)	Allocation
1. Internal risks					
A) Client-related risks					
R1	Payment delays	53.70	20.37	25.93	Undecided
R2	Setting tight schedule by client	64.81	37.48	3.7	Undecided
R3	Inappropriate intervention by client	74.07	18.52	7.41	client
R4	Design changes by client	85.19	9.26	5.56	client
R5	Inadequate scope	72.22	20.37	7.41	client
R6	Site access delays	70.37	14.81	14.81	client
R7	Contract breaching by client	77.78	14.81	7.41	client
R8	Client financial failure	75.93	20.37	3.7	client
R9	Lack of experience of client	87.04	1.85	11.11	client
R10	Obtaining/issuing required approval	75.93	14.81	9.26	client
R11	Issue of sustainability	74.07	14.81	11.11	client
R12	Inadequacy of requirements	79.63	18.52	1.85	client
R13	Poor coordination	72.22	18.52	9.26	client
R14	Changing demands	81.48	16.67	1.85	client
B) Designer-related risks					
R15	Design errors	94.44	1.85	3.7	client
R16	Incomplete design	98.15	0	1.85	client
R17	Design constructability	94.44	0	5.56	client
R18	Poor quality of design	90.74	7.41	1.85	client
R19	Project type know-how skills	88.89	9.26	1.85	client
C) Contractor-related risks					
R20	Poor quality of construction	12.96	79.63	7.41	contractor
R21	Lack of experience of contractor	18.52	75.93	5.56	contractor
R22	Contractor financial failure	12.96	83.33	3.7	contractor
R23	Contractor low or poor work productivity	18.52	75.93	5.56	contractor
R24	Errors during construction	16.67	75.93	7.41	contractor
R25	Accidents and safety	7.41	87.04	5.56	contractor
R26	Quality and control assurance	16.67	75.93	7.41	contractor

R27	Contractor breaching by contractor	9.26	90.74	0	contractor
R28	Project type know-how skills	16.67	83.33	0	contractor
R29	Inadequate risk management plan	18.52	77.78	3.7	contractor
D) Subcontractor-related risks					
R30	Subcontractor poor work productivity	5.56	88.89	5.56	contractor
R31	Subcontractor breaching contract	7.41	90.74	1.85	contractor
R32	Subcontractor financial failure	5.56	92.59	1.85	contractor
R33	Material availability	3.7	96.3	0	contractor
R34	Material quality	7.41	85.19	7.41	contractor
R35	Project type know-how skills	5.56	87.04	7.41	contractor
E) Consultant-related risks					
R36	Lack of experience of consultant	90.74	1.85	7.41	client
R37	Inadequacy of specifications	92.59	5.56	1.85	client
R38	Quality assurance	96.3	1.85	1.85	client
R39	Project type know-how skills	94.44	1.85	3.7	client
2. External risks					
A) Political risks					
R40	Bureaucratic problems	74.07	18.52	7.41	client
R41	Threats of wars	81.48	7.41	11.11	client
R42	Labour issues	14.81	66.67	18.52	Undecided
R43	Corruption	70.37	12.96	16.67	client
R44	Changes of law	79.63	14.81	5.56	client
B) Social risks					
R45	Crime rate	50	37.04	12.96	Undecided
R46	Cultural differences	51.85	37.04	11.11	Undecided
C) Financial risks					
R47	Inflation	51.85	35.19	12.96	Undecided
R48	Currency fluctuation	51.85	35.19	12.96	Undecided
D) Environmental risks					
R49	Poor site conditions	55.56	31.48	12.96	Undecided
R50	Pollution	44.44	38.89	16.67	Undecided
3. Force majeure					
A) Natural phenomena					
R51	Earthquakes	31.48	53.7	14.81	Undecided
R52	Fires	22.22	61.11	16.67	Undecided
R53	Floods	24.07	59.26	16.67	Undecided
B) Weather issues					
R54	Severe weather conditions	24.07	59.26	16.67	Undecided

As shown in Table 4.11, the questionnaires' respondents allocated a number of 25 risks to the client, 16 risks to the contractor, and 13 risks within the category of undecided. However, no risk has been reported as shared amongst the overall views of the questionnaires' respondents in terms of its allocation.

Generally, the respondents allocated risks within the internal level of risks to their sources. In other words, risks are allocated to the party who generates the risks in most cases. However, the allocation of two risks in the client-related classification, namely payment delays and the setting of a tight schedule by the client, are within the category of undecided allocation. On the other hand, mostly the allocation of risks within the external level of risks has been found to be undecided, since the allocation of seven risks has been scored as being less than 70% by the respondents. This is true for all the allocations of risk involved in the social, financial, and environmental groups. However, all the allocations of risk involved in the political group show a tendency towards the client apart from one risk only, the labour issue, which has been allocated as undecided according to the overall respondents of the three groups. However, the client takes the responsibility for four risks that belong to political risk classification, namely: bureaucratic problems, threats of wars, corruption, and changes of law. Nevertheless, the allocation of the force majeure risks has shown a tendency towards the undecided category, since the allocation of all of the risks within this level of risks has been scored as less than 70% by the respondents.

In comparison with similar studies, the present results of this research have shown a clear difference in the way the client seeks to allocate as many risks as possible to other parties, which is common practice. In Kuwait, Kartam & Kartam (2001) found that half of the 26 identified risks were allocated to the contractor, whereas the client was responsible for only five risks. A similar portion of risks was allocated to the contractor (16 risks out of 42 identified risks) in the UAE by El-Sayegh (2008), with the owner only having two risks to bear; however, there also was a tendency for risks to be shared, as shown in the last mentioned study by El-Sayegh (2008). Furthermore, in the case of Indonesian construction projects, Andi (2006) reported that the contractor takes responsibility for 12 risks (of the 27 identified risks), whereas the client is responsible for only 4 risks.

In contrast, the findings of this research reveal that the client (GACA) is actually allocating a number of risks to themselves directly and is willing to accept risks, especially the majority of the client-related risks, designer- and consultant-related risks, and some of the majority of the political risks identified by this research. This result is in alignment with the conclusion that Seraj Aldeen (2006) came up with which emphasises the allocation of risks to the party which causes the risks itself. Also, the results are in agreement with Erikson (1979) and Porter (1981) who claimed that contractors are generally risk averse, and clients are risk-neutral. However, this result refuted the result established by Al-Salman & Al-Mahasheer (2005) in their study which considers the contractors' views on the allocation of construction projects in the Eastern Province of Saudi Arabia, which came to a conclusion that 'in practice, most of the risks are allocated to contractors and none to owners'.

As a result of the allocation of risks within the acts of God level of risks, which have not all been decided by the respondents, there are clearly conflicting opinions amongst authors with regard to their allocation. For example, Perera *et al*. (2009) found that these risks are actually shared amongst parties despite the fact that the client might allocate them to himself within the contract. However, Seraj Aldeen (2006) proposed that weather issues are supposed to be allocated to the client. But, he proposed that risks of acts of God should be shared between the contractor and engineers from the client side, as they should have forecasted any unexpected risks in an early stage of a project.

4.2.3.2 Objective Analysis of the Result of Actual Allocation

The majority of similar studies focused on subjectively analysing the allocation of risks from respondents' viewpoints, including in the cases of Al-Salman & Al-Mahasheer (2005), Hameed & Woo (2007), and El-Sayegh (2008) amongst others. However, Andi (2006) advocated for the adoption of both subjective and objective analysis in order to achieve reliability. Hence, an objective analysis is used in this research to achieve reliable data. Table 3 reports the results of completing a one way ANOVA test in order to determine any statistical difference amongst the answers from questionnaires' respondents on allocation. The null hypothesis (H0) showed no difference in proportion between the three categories of respondents.

Table 4.12: Results from conducting the one way ANOVA test on the respondents' views of the actual allocation

ID	Risk	Allocation	F	P-value
1) Internal Level				
A- Client-related risks				
R1	Payment delays	Undecided	0.81	0.49
R2	Setting tight schedule by client	Undecided	0.85	0.47
R3	Inappropriate intervention by client	Client (74.07%)	0.59	0.58
R4	Design changes by client	Client (85.19%)	0.38	0.70
R5	Inadequate scope	Client (72.22%)	0.65	0.55
R6	Site access delays	Client (70.37%)	0.86	0.47
R7	Contract breaching by client	Client (77.78%)	0.56	0.60
R8	Client financial failure	Client (75.93%)	0.57	0.60
R9	Lack of experience of client	Client (87.04%)	0.37	0.71
R10	Obtaining/issuing required approval	Client (75.93%)	0.64	0.56
R11	Issue of sustainability	Client (74.07%)	0.72	0.52
R12	Inadequacy of requirements	Client (79.63%)	0.44	0.66
R13	Poor coordination	Client (72.22%)	0.48	0.64
R14	Changing demands	Client (81.48%)	0.31	0.75
B- Designer-related risks				
R15	Design errors	Client (94.44%)	0.27	0.77
R16	Incomplete design	Client (98.15%)	0.24	0.79
R17	Design constructability	Client (94.44%)	0.28	0.76
R18	Poor quality of design	Client (90.74%)	0.32	0.74
R19	Project type know-how skills	Client (88.89%)	0.35	0.72
C- Contractor-related risks				
R20	Poor quality of construction	Contractor (79.63%)	0.42	0.67
R21	Lack of experience of contractor	Contractor (75.93%)	0.58	0.59
R22	Contractor financial failure	Contractor (83.33%)	0.43	0.67
R23	Contractor low or poor work productivity	Contractor (75.93%)	0.57	0.60

R24	Errors during construction	Contractor (75.93%)	0.65	0.55
R25	Accidents and safety	Contractor (87.04%)	0.39	0.70
R26	Quality and control assurance	Contractor (75.93%)	0.61	0.57
R27	Contractor breaching by contractor	Contractor (90.74%)	0.32	0.74
R28	Project type know-how skills	Contractor (83.33%)	0.42	0.67
R29	Inadequate risk management plan	Contractor (77.78%)	0.49	0.64
D- Subcontractor-related risks				
R30	Subcontractor poor work productivity	Contractor (88.89%)	0.35	0.72
R31	Subcontractor breaching contract	Contractor (90.74%)	0.30	0.75
R32	Subcontractor financial failure	Contractor (92.59%)	0.31	0.75
R33	Material availability	Contractor (96.3%)	0.28	0.77
R34	Material quality	Contractor (85.19%)	0.38	0.70
R35	Project type know-how skills	Contractor (87.04%)	0.35	0.72
E- Consultant-related risks				
R36	Lack of experience of consultant	Client (90.74%)	0.32	0.74
R37	Inadequacy of specifications	Client (92.59%)	0.29	0.76
R38	Quality assurance	Client (96.3%)	0.26	0.78
R39	Project type know-how skills	Client (94.44%)	0.29	0.76
2) External Level				
A- Political risks				
R40	Bureaucratic problems	Client (74.07%)	0.59	0.58
R41	Threats of wars	Client (81.48%)	0.53	0.62
R42	Labour issues	Undecided	0.94	0.44
R43	Corruption	Client (70.37%)	0.70	0.53
R44	Changes of law	Client (79.63%)	0.46	0.65
B- Social risks				
R45	Crime rate	Undecided	1.63	0.27
R46	Cultural differences	Undecided	1.48	0.30
C- Social risks				
R47	Inflation	Undecided	1.14	0.38
R48	Currency fluctuation	Undecided	0.97	0.43
D- Environmental risks				
R49	Poor site conditions	Undecided	1.39	0.32
R50	Pollution	Undecided	1.91	0.23
3) Acts of God				
A- Natural phenomena				
R51	Earthquakes	Undecided	1.53	0.29
R52	Fires	Undecided	1.43	0.31
R53	Floods	Undecided	1.53	0.29
B- Weather issues				
R54	Severe weather conditions	Undecided	1.53	0.29

As per the results shown in Table 4.12, since no P-Value for any allocation of risks scored less than 0.05, it is stated that no allocation has been found to make any significant difference, from respondents' viewpoints, on actual risk allocation. Hence, statistically, this means that the results from the views of respondents on the actual allocation of risks in GACA projects are reliable. Furthermore, it may be stated that the above-conducted subjective analysis is decisive in determining the actual allocation.

4.2.3.3 Undecided Allocation Risks

Table 4.13 reveals the risks in terms of their actual allocation, and how these have been under the category of undecided. A total of 13 risks were found to be undecided in respect to their actual allocation, according to the questionnaire respondents. Moreover, the differences amongst each group of individual respondents, including the client, contractor and consultant groups, are shown.

Table 4.13: The allocation of undecided risks from the three groups of respondents' views

Risk	Client			Contractor			Consultant		
	client	contractor	shared	client	contractor	shared	client	contractor	shared
Payment delays	65.52%	17.24%	17.24%	75%	25%	0%	84.26%	0%	15.38%
Setting tight schedule by client	51.72%	37.93%	10.34%	58.33%	41.67%	0%	100%	0%	0%
Labour issues	44.83%	48.28%	6.90%	16.67%	75%	8.33%	61.54%	23.08%	15.38%
Crime rate	48.28%	31.03%	20.69%	25%	66.67%	8.33%	76.92%	23.08%	0%
Cultural differences	44.83%	48.28%	6.90%	58.33%	25%	16.67%	61.54%	23.08%	15.38%
Inflation	58.62%	20.69%	20.69%	16.67%	75%	8.33%	69.23%	30.77%	0%
Currency fluctuation	58.62%	20.69%	20.69%	8.33%	83.33%	8.33%	69.23%	30.77%	0%
Poor site conditions	58.62%	17.24%	24.14%	41.67%	58.33%	0%	38.46%	53.85%	7.69%
Pollution	34.48%	37.93%	27.59%	25%	75%	0%	76.92%	15.38%	7.69%
Earthquakes	44.83%	37.93%	17.24%	8.33%	91.67%	0%	23.08%	53.84%	23.08%
Fires	31.03%	48.28%	20.69%	8.33%	91.67%	0%	23.08%	53.84%	23.08%
Floods	41.38%	37.93%	20.69%	8.33%	91.67%	0%	15.38%	61.54%	23.08%
Severe weather conditions	55.17%	24.14%	20.69%	8.33%	91.67%	0%	15.38%	61.54%	23.08%

As can be seen in Table 4.13, the client group were never decisive in terms of the allocation of the 13 risks listed as they have not reached the percentage agreed by the researcher, with 70% on risks to be allocated to a certain party or shared. On the other hand, respondents in the contractor group were very certain about the allocation of eight risks, including payment delays (client 75%), labour issues (contractor 75%), inflation (contractor 75%), currency fluctuation (contractor 83.33%), pollution (contractor 75%), earthquakes (contractor 91.67%), fires (contractor 91.67%), floods (contractor 91.67%), and severe weather conditions (contractor 91.67%). However, the respondents from the consultant group were certain regarding the allocation of four risks, including payment delays (client 84.26%), setting tight schedule by client (client 100%), crime rate (client 76.92%), and pollution (client 76.92%).

The results from Table 4.13 show a clear disparity between the questionnaire respondents from each group on the allocation of the abovementioned risks. It can be said that, in most cases, contractors try to blame the client for allocating risks so that clients are not really sure of their actual allocation. This is true for the following risks: labour issues, inflation, currency fluctuation, pollution, earthquakes, fires, floods, and severe weather conditions; however, consultant respondents conflicted with the contractor on the allocation of pollution as they allocated it to the client rather than the contractor, who allocated the risks to themselves. Moreover, the allocation of the two financial risks; inflation and currency fluctuation were noticed to be allocated to the contractor by the contractor respondents themselves. However, consultant respondents allocated these risks to the client, although the allocation of these risks has not been very decisive within the consultant group, as the score of their allocation for these risks (69.23%) towards the client is very close to the percentage set by the researcher (70%) for risks to be allocated to such a party.

As can be seen from these results, it may be that there is a blaming relationship between two parties of respondents, namely the contractor and consultant, who represent the client in this case. Such a relationship was also realised by the research during the interviews, as being completed with different parties representing different bodies. On the other hand, there was an agreement between two groups (contractor and consultant) on the allocation of payment delays, with respondents from both groups allocating this to the client. Surprisingly, the client respondents were not sure of the allocation of such a risk.

It can be noticed that all the allocation of risks under the level of acts of God level were undecided; this can be attributed to the fact that these risks are out of the control of any project party and they are not frequently faced in GACA projects. Moreover, a number of risks from the external level of risks were also undecided. For example: financial, social, and environmental risks. In fact, these risks are also out of any project party's control, but they are caused by some external force such as economy and market. Hence, it is also difficult for parties to agree on such an allocation.

It is also noticeable that no shared allocation has been realised by any group of respondents regarding the risks and their allocation listed in Table 4.13. This implies that any risks that happen to occur in a GACA project involves only party paying for this risk occuring, as the sharing relationship does not exist in GACA projects. This also contradicts Seraj Aldeen's (2006) and other authors' suggestions that some risks should be shared by more than one party. All in all, these results show a great difference in the number of risks with an undecided allocation. The undecided allocation has been seen in different studies such as El-Sayegh (2008) and Kartam and Kartam (2001); however, the number of these risks is smaller than the number found in this research (13 risks out of 54).

4.2.3.4 The Allocation of the Most Important Risks Associated with GACA Projects

As mentioned previously, a number of risks have been acknowledged as the most important risks associated with GACA projects, specifically in terms of both their likelihood of occurrence and impact. This section focuses on the allocation of these risks in particular, and also will show how the allocation of these risks varies in regard to the respondents' perspectives. As has been shown previously in this chapter, an objective criterion has been set by the researcher for risks to be allocated to such a party, with the overall score of respondents' answers needing to be equal to 70% or more. Taking this into consideration, the following table (Table 4.14) emphasises the differences between the opinions of the overall respondents versus each group of respondents individually on the allocation of the most important risks in GACA projects.

Table 4.14: The allocation of the most important risks according to the questionnaire respondents VS each group of respondents' views

	Risk	Overall Allocation	VS	Client's Allocation	Contractor's Allocation	Consultant's Allocation
R42	Labour issues	Undecided		Undecided	Contractor	Undecided
R4	Design changes by client	Client		Client	Client	Client
R43	Corruption	client		Undecided	Undecided	Client
R19	Project type know-how skills for designers	Client		Client	Client	Client
R17	Design constructability	Client		Client	Client	Client
R16	Incomplete Design	Client		Client	Client	Client
R44	Changes of Law	Client		Client	Undecided	Client
R18	Poor quality of design	Client		Client	Client	Client
R15	Design errors	Client		Client	Client	Client
R10	Obtaining/issuing required approval	Client		Undecided	Client	Client

Table 4.14 reveals that the respondents have agreed on the allocation of nine risks, including design changes by the client (to be allocated to the client), corruption (to be allocated to the client), design error (to be allocated to the client), project type know-how skills for designers (to be allocated to the client), design constructability (to be allocated to the client), incomplete design (to be allocated to the client), changes of law (to be allocated to the client), poor quality of design (to be allocated to the client), error during construction (to be allocated to the contractor),and obtaining/issuing required approval (to be allocated to the client).

Despite the overall allocation of the abovementioned risks, differences amongst the groups' responses have been found in the allocation of three risks: firstly, corruption risks, with only the consultant group allocating this risk to the client. However, client and contractor groups were not certain about the allocation of this risk. Secondly, the risk of changes of law has been allocated as undecided by the contractor group, whereas, both the client and consultant group allocated this risk to the client. Thirdly, obtaining/issuing required approval risks were allocated by both the contractor and consultant group to the client, which matches the overall allocation of this risk. However, the client respondents denied this by being uncertain about the allocation of this risk.

On the other hand, the respondents had only one disagreement about the allocation of risk relating to the labour issue. The overall allocation of this risk is undecided, as the overall score of the allocation has not reached 70% for client or contractor. The labour issue has been allocated as undecided by two groups of respondents, namely the client and consultant. However, the respondents from the contractor group agreed that this risk is allocated to the contractor. The overall allocation of this risk reflects what has been reflected by the different interviewees—that each party blames the other for causing the risk—which clearly explains why such an undecided allocation has been achieved.

4.4 Chapter Summary

This chapter has dealt with the two types of data generated from the research. Firstly, a descriptive analysis was performed on the data collected, which was achieved by conducting the 13 interviews; secondly, the analysis of the distributed questionnaires was completed statistically, benefiting from the use of 2013 Microsoft Excel. The analysis of data has been performed so as to obtain the importance of each of the 54 risks associated with GACA projects, as well as to determine the allocation of these risks according to the views of the respondents through subjective and objective types of analysis. A one way ANOVA and post-hoc (Bonferroni) tests were also performed to achieve reliability in the results. This is due to the fact that the respondents were representing three different groups. The next chapter will explicitly discuss all the research outcomes, and will further outline the development of the risk allocation framework.

Chapter Five: Achievement of the Objectives and Development of the framework

5.0 Achievement of the Objectives

The study focused on the current process of risk allocation within GACA projects in order to devise a solution centred on replacing the process. The reason for selecting GACA and construction was based on the importance of aviation as a very dynamic sector in the Kingdom of Saudi Arabia. The Saudi government has invested millions into the development of this sector with regard to building new airports and expanding other existing ones; however, the outcomes still do not succeed in meeting the main objectives expected by the government. This makes the situation even worse. This provides the basis for the completion of this study.

However, the allocation of risk is a very important process that lies within the process of risk management; if applied properly, this should lead to project success. The preliminary study, which was conducted in the very early stages of the research at the head department of the General Authority of Civil Aviation (GACA) in Jeddah, Saudi Arabia, was very helpful in detecting the research problem. It was indicated during the study that risks are not allocated to the right part within GACA projects. Accordingly, the achievement of this research's objectives comes as follow:

- The **First Objective (O1)** was "To carry out a comprehensive literature review of aviation construction project risks". As a result, a number of similar studies were critically reviewed. The studies were classified according to their contexts (the locations where they were conducted), with a greater focus on the Saudi contexts. Each study's weaknesses, strengthens, results, limitations and methodology were highlighted. Noticeably, there was a lack of studies on aviation construction projects and risks associated in the context of Saudi Arabia and the other outlined contexts. The reviewed studies varied in their methods of identifying risks, whereby some of them used interviews and others used questionnaires. Only a few used a combination of those two methods (triangulation), as in this research.

- The reviewed studies also varied in the classification of risks. The majority of these studies have a two level classification of risks, namely: internal and external. The studies classified risks according to the nature of their sources. However, a few studies did not have any classifications of risk at all, and risks were just listed.
- Conducting the literature review allowed the researcher to propose a structure of risks that might be associated with GACA projects. The structure was literature-based and involves 44 risks classified into three levels, those are: internal, external, and acts of God. The internal level involves risks that project parties have complete control over, the external level involves risks that the project team has less control over, and the acts of God involves risks that no party has any control over. Under these levels a total number of 11 subcategories were outlined which relate risks to their main sources.
- The **Second Objective (O2)** was "To identify the risk factors associated with GACA projects". In total, 13 interviews were conducted with senior GACA project managers, contractors, and consultants to verify the proposed structure of risks. The main criteria for selecting these interviewees was based on the number of years' experience each interviewee had working in GACA projects (10 Years or more for GACA interviewees, and 15 years or more for contractors and consultants). As a result, 54 results were found to be associated with GACA projects. The final structure of risks was agreed on by the interviewees.

- The **Third Objective (O3)** was "To assess the overall importance of the identified risks". It is known that risk importance (RI) is calculated quantitatively by multiplying the impact of risk (I) by the likelihood of occurrence (L). Based on that, this research focuses on calculating these two variables individually from each of the 54 identified risks and then, multiplying them to achieve the importance of each risk. Hence, the questionnaire was designed and verified (during the interview sessions) to determine the above mentioned two variables. A 1-5 Likert scale was used to determine the values scored by each respondent. The questionnaire was sent to 95 respondents, distributed as follows: 45 for GACA, 25 for contractors and 25 for consultants. The researcher obtained 70 (74%) questionnaires, from the following participants: 34 (76%) GACA, 17 (68%) contractors, and 19 (76%) consultants. However, only 54 (57%) questionnaires were usable and complete questionnaires included: 29 (64%) GACA, 12 (48%) contractors, and 13 (52%) consultants.
- It was also shown that 64% of the respondents were either architects or civil engineers. This result has given the researcher a good indication that the specialties of the majority of the people involved in the study are project management- and risk management-related. In Saudi Arabia, architecture and civil engineering are the two major specialties that allow their holders to lead a construction project. Moreover, the university graduates of these two specialties (the researcher is one of them) are open to construction project management related courses and risk management accordingly. However, 36% of the respondents' educational backgrounds were divided between electrical engineering, mechanical engineering, and others.
- A very important aspect of the respondents that was acquired was information on their experience level. Noticeably, 62% of the respondents

from GACA had from 5-15 years' experience. Only 2 (7%) GACA respondents had more than 25 years of experience. Therefore, from these results, GACA cannot be regarded as a highly experienced client. On the other hand, 70% of the consultant respondents were within the categories of 16 to 25 years and more than 25 years of experience. Again, this confirms the previous results whereby the GACA cannot be regarded as a highly experienced client, though their consultants are experienced bodies. However, the contractor respondents were also regarded as not being experienced to a medium level, since 67% of them were within the category of having 5-15 years of experience. Overall, these results reflect the fact that the GACA and their project teams are capable of undertaking aviation projects since they have the required expertise within and outside their organisation. Indeed, this is what is needed for achieving the vision of the GACA and the Saudi government to expand investment in the aviation sector by 2020.

- The overall ranking of risks is shown in Table 5.1 below. The way the importance of each risks is calculated is shown in Chapter Four.

Table 5.1: The overall ranking of risks

Risk	Level	Category	Importance out of 5	Ranking
Labour issues	External	Political	3.39	1
Design changes by client	Internal	Designer-related	3.34	2
Corruption	External	Political	3.24	3
Project type know-how skills for designer	Internal	Designer-related	3.21	4
Design constructability	Internal	Designer-related	3.17	5
Incomplete design	Internal	Designer-related	3.08	6
Changes of law	External	Political	3.05	7
Poor quality of design	Internal	Designer-related	3.02	8
Design errors	Internal	Designer-related	3.01	9
Obtaining/issuing required approval	Internal	Client-related	3.00	10
Payment delays	Internal	Client-related	2.97	11
Poor quality of construction	Internal	Contractor-related	2.94	12

Setting tight schedule by client	Internal	Client-related	2.93	13
Bureaucratic problems	External	Political	2.92	14
Changing demands	Internal	Client-related	2.88	15
Project type know-how skills for contractor	Internal	Contractor-related	2.84	16
Lack of experience of client	Internal	Client-related	2.83	17
Inappropriate intervention by client	Internal	Client-related	2.81	18
Lack of experience of consultant	Internal	Consultant-related	2.81	19
Project type know-how skills for consultant	Internal	Consultant-related	2.81	20
Inadequate risk management plan	Internal	Contractor-related	2.78	21
Lack of experience of contractor	Internal	Contractor-related	2.76	22
Errors during construction	Internal	Contractor-related	2.73	23
Subcontractor poor work productivity	Internal	Subcontractor-related	2.68	24
Fires	Acts of God	Natural Phenomena	2.67	25
Poor site conditions	External	Environmental	2.63	26
Inadequate scope	Internal	Client-related	2.63	27
Inadequacy of specifications	Internal	Consultant-related	2.58	28
Quality assurance	Internal	Consultant-related	2.57	29
Poor coordination	Internal	Client-related	2.56	30
Contractor low or poor work productivity	Internal	Contractor-related	2.55	31
Contractor financial failure	Internal	Contractor-related	2.54	32
Site access delays	Internal	Client-related	2.51	33
Severe weather conditions	Acts of God	Weather issue	2.49	34
Contract breaching by client	Internal	Contractor-related	2.48	35
Floods	Acts of God	Natural Phenomena	2.46	36
Material availability	Internal	Subcontractor-related	2.41	37
Project type know-how skills for subcontractor	Internal	Subcontractor-related	2.38	38

Subcontractor breaching contract	Internal	Subcontractor-related	2.38	39
Inflation	External	Financial	2.36	40
Inadequacy of requirements	Internal	Client-related	2.34	41
Accidents and safety	Internal	Contractor-related	2.34	42
Quality and control assurance by contractor	Internal	Contractor-related	2.30	43
Contractor breaching by contractor	Internal	Contractor related	2.30	44
Subcontractor financial failure	Internal	Subcontractor-related	2.29	45
Material quality	Internal	Subcontractor-related	2.27	46
Earthquakes	Acts of God	Natural Phenomena	2.22	47
Threats of wars	External	Political	2.20	48
Cultural differences	External	Social	2.11	49
Pollution	External	Environmental	2.06	50
Currency fluctuation	External	Financial	2.04	51
Issue of sustainability	Internal	Client-related	1.89	52
Client financial failure	Internal	Client-related	1.88	53
Crime rate	External	Social	1.67	54

- The labour issue was regarded as the most important risk that affects GACA projects followed by the following risks: Design changes by client, Corruption, Project type know-how skills for designers, Design constructability, Incomplete design, Changes of law, Poor quality of design, Design errors, and Obtaining the required approvals consecutively. The respondents were agreed on the ranking or importance of risks and no statistical difference was found amongst the three groups of respondents. Surprisingly, no contractor-related risks were found amongst the top ten important risks for GACA projects. On the other hand, client, design, and political-related risks are the sources of the top risks. In this, the results of this research differ from other studies conducted in Saudi and other contexts.

- The ranking of the subcategories of risks also confirms the above results, where client-related and designer-related categories are the top two important categories.
- The risks of Crime rate, Client financial failure, Issue of sustainability, Currency fluctuation, Pollution, and Cultural difference were ranked 54th to 49th most important risks to GACA projects. These risks were agreed upon again by all of the three groups of respondents. This was confirmed after the one way ANOVA test had been conducted, which reveals that no statistical difference was realised amongst the three groups. Unsurprisingly, these results were found to be the lowest risks to GACA projects in terms of importance, as they were related to financial, social, and environmental aspects. The financial and social aspects are considered to be two of the strengths of the Kingdom of Saudi Arabia. Saudi is considered to be a strongly stable country and government, as well as having low percentages of social misbehaviour, such as crimes and murders, and so on.
- The **Fourth Objective (O4)** was "To find out the basis on which risks are allocated to parties in the context of GACA projects". The interviewees agreed that the allocation of risks associated with GACA projects was based on five issues: client power authority, experience from previous projects, personal intuition, incompliance with contract conditions, and not based on any risk analysis. Accordingly, this result reflects the common norm that is known in construction projects that there are no rules to allocate risks as clients have the benefit of control over the allocation (El-Sayegh, 2008). It can be realised that these factors are subjective in nature, as they do not represent any reliance on solid analysis of risks. Moreover, the interviewees emphasised the absence of guidelines or principles that lead to fair and proper allocation of risks. This is believed to confirm what the problem of the research was all

about. Risks principles are well-defined and presented in the literature and should be guiding the process of allocating risks. Again, this was clearly absent in the GACA context.

- The **Fifth Objective (O5)** was "To investigate the perception of risk allocation performed in the context of GACA projects". The questionnaire was the main tool for achieving this objective. The 54 risks were listed again and their actual allocations were investigated from the respondents' points of view. The analysis used for determining the allocation of risks was divided into two: objective analysis, where the allocation of risks should be decided upon if the overall score of the respondents was 70% or more, and subjective analysis, where a one way ANOVA test is conducted to find any statistical difference between the three groups of respondents. The results revealed that 13 risks were reported to have an 'Undecided' allocation. In other words, these risks had not met the subjective analysis criteria set for their allocations, where each risk was scored at less than 70% of overall participants. It was also revealed that, the allocation of the majority of the external level of risks were 'Undecided', apart from four political risks, namely Bureaucratic problems (allocated to the client), Threats of wars (allocated to the client), Corruption (allocated to the client), and Changes of law (allocated to the client). In addition, the allocation of all of the risks identified in the acts of God level was 'Undecided' too. Clearly, this is an indication of misallocation and demonstrates an absence of such guidelines for the allocation of risks within GACA projects. It is also another confirmation of what has been realised in the preliminary study, where the researcher concluded that risks are not allocated properly.
- Interestingly, no risk allocation has been found to be shared amongst the two main projects parties, namely the client and contractor. Sharing risks

has been found in the all reviewed studies in the literature. The magnitude of risks shared is left to the clients as they place the allocation of risks in the first instance. For example, a study was conducted in Pakistan in 2007 by Hameed & Woo, during which the authors identified 11 risks to be shared out of 31. The result of this research can reflect the unwillingness of risk sharing within the GACA.

- Regarding the transferability and the generalisation of the research results for other types of GACA project, the following three points are discussed:

  1- As stated previously in Chapter One, the scope of the study which covers only domestic and regional airports is totally different from what has been going in other airports, particularly, in terms of the delivery method that is adopted in regional and domestic airports, which is a traditional method of delivery; whereas, international airports are undertaken through different types of delivery method, such as PPP, and construction difference. Hence, that difference makes it difficult to generalise the current results for other types of project within the GACA.

  2- The participants of the current research are independent personnel and do not participate in other types of GACA projects. This is true for GACA staff, contractors and consultants. This means, in order to be able to generalise such results for international airports, participants from those projects need to participate in this study to confirm such a generalisation. Hence, as the scope of the current research excludes international airports, this not a valid point to investigate.

  3- The transferability of these findings to findings from other studies conducted in Saudi Arabia into different types of construction project; the following points have been realised:

- Design risks are shown to be the most important risks in GACA domestic and regional contexts, which differs from what has been realised in the Saudi construction context. This adds to the difficulties of generalising the current findings for the Saudi construction context.
- The client is shown to have responsibility for the majority of risks identified in this research, whereas the Saudi studies on construction have shown different trends for allocating risks, where contractors are allocated the biggest portion of project risks.

  4- In terms of complexity, the construction of domestic and regional airports is less complex than the construction of international airports. This is obvious since the cost of international airports is much greater than domestic and regional ones. For example: the new international airport in Jeddah cost 27 billion Saudi riyals (SR), whereas the renovation and expansion of six domestic and regional airport cost 325,233,855.58 SR, including: Wejh, Arar, Gassim, Guriat, Hail, Nejran, and Taif airports (Almabani, 2011). Moreover, cost is not the only determinant of complexity, the sizes of the two different categories differ as well. For instance, for the above six domestic airports the total area covered is 1,741,194 sqm, whereas, the new international airport in Jeddah will cover an area of 720,000sqm (Almabani, 2011).

➢ Regarding the transferability and the generalisability of the research results for similar studies in different contexts (outside Saudi Arabia), the following two points are discussed:

- The lack of studies on risks in aviation projects (Chapter Two) can play a major part in enhancing the transferability of the current results to similar projects outside Saudi Arabia.

- Regarding the transferability of these findings to the findings of other studies conducted outside Saudi Arabia on different types of construction projects, the following points have been realised:

  - Differences in results have been realised, particularly, between the most important risks, which have been explained in Chapter Four, and the ones that have been shown in studies undertaken within different contexts (outside Saudi Arabia). This adds to the difficulties in generalising the current findings to other construction projects conducted outside the Saudi Arabian context.
  - With regard to the allocation of risks, the current results of this research are not in alignment with what have been realised elsewhere. Again, this can hinder the transferability of the current risks to other contexts.
  - The **Sixth Objective (O6)** was "To develop a framework for suitable risk allocation within GACA projects". There have been many attempts to come up with such a model or framework for risks to be allocated in different contexts. Only Nielsen (2007) made an effort to focus on the allocation of risks in the context of aviation projects in China. His framework was translated by the researcher into a flow chart to make it easier and concise to follow. From the above discussion, the need for proper intervention by the researcher is seen to replace the current practice of risks allocation performed by the GACA with a proper strategy that takes into account well-defined risk allocation principles. Hence, a framework for proper risk allocation was developed as follows.

5.1 The Development of the Framework

The idea behind the proposed framework is originally based on the framework that Nielsen (2007) developed for risks to be allocated properly in Chinese airports projects. In the framework, the roles that are played by both owner and contractor are realised and considered to be crucial steps to the formulation of the framework. Sound risk management by the owner is performed in the first instance. Based on that, a comprehensive risk allocation strategy is introduced following Abednego & Ogunlana's (2006) development of a complete risk allocation. There are four questions which need to be answered by the owner in order to satisfy the requirements of the abovementioned risk allocation strategy. If risk is allocated to the contractor eventually, he needs to perform his own risk management anyway. This will help him determine whether or not he should bid for the project. Nevertheless, the use of flowcharts to present an idea that involves a number of processes has been realised by Builder Resources (2016), particularly in the construction industry, as it is recommended to be a good way of showing reliance on orderly developed steps. Hence, since the framework comprises a number of processes that should be conducted sequentially, it has been decided that the framework will be presented in the form of a flowchart. This was also supported by the fact that flowcharts could easily simplify a group of complex steps which involve decisions being presented (SmartDraw, 2016). Although, the difficulty of altering flowcharts and redrawing them when they have errors has been argued by Tech ICT (2016), the researcher benefits from the use of Microsoft Word to facilitate making any changes when errors occur, as it has a simple tool for dealing with the drawing of charts. According to the above summary of the proposed framework, the following are the steps included in its formulation:

A- Risk Identification by Owner

This is the first step to be played by GACA, as it helps them to come up with a structure of risks inherent in their own projects eventually. Hence, a list of risks is an expected result from the process of identifying risks associated with GACA projects. Then, risk sourcing is another process that the GACA needs to perform in addition to the list of risks previously identified. Within the risk sourcing, the GACA needs to relate risks to their own sources, for instance client-related risks, and contractor-related risks and so on. This process will help the GACA to classify risks into levels and categories which is necessary later on as the framework moves forward. Eventually, to finish the risk identification step a complete structure of risks needs to be issued based on the abovementioned steps. This structure includes: risks associated with GACA projects, and the sources of each identified risk. The process is summarised below in Figure 5.1.

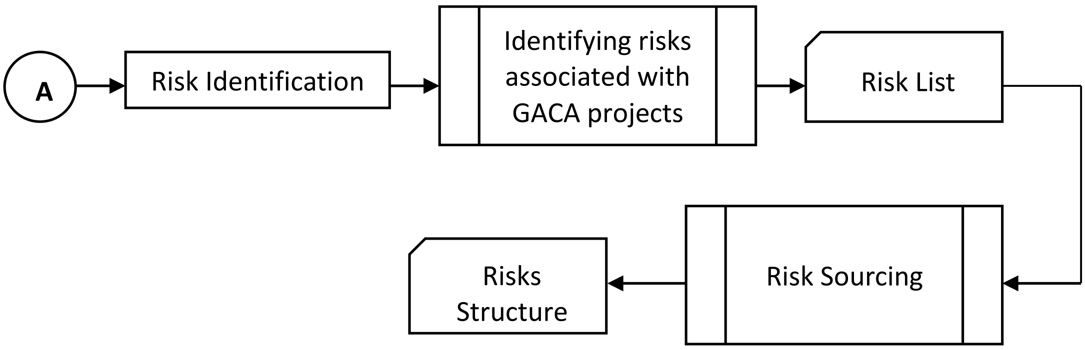


Figure 5.1: Risk identification by owner

B- Risk Analysis by Owner

This is a very crucial step which needs to be performed by the owner again and is mainly dependent on the previous step of risk identification. The impact from each of the identified risks is measured here at first. This is followed by measuring the likelihood of each of the identified risks too. As a result, the importance of each risk is generated as can be seen in Figure 5.2. One way of doing that is by multiplying the measured impact from each risk by the measured likelihood of each risk. This step is important as it helps the GACA to prioritise their identified risks based on their importance, which will be needed later on as the framework progresses.

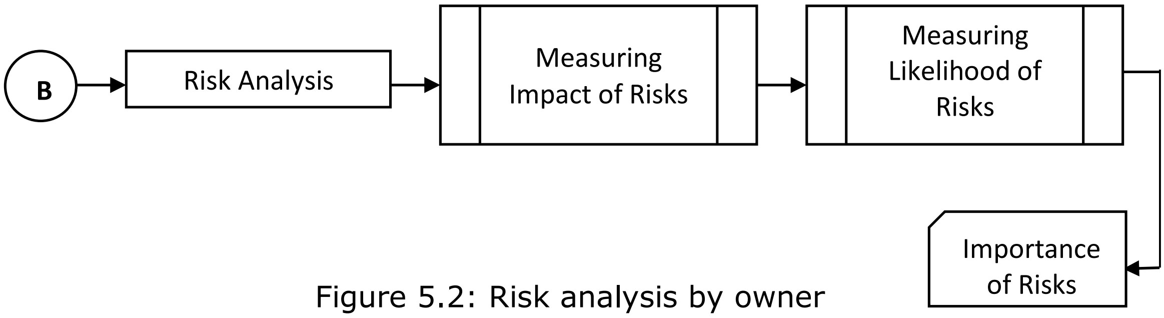


Figure 5.2: Risk analysis by owner

C- Risk Allocation Strategy

This strategy has been introduced by the author as it replaces the risk response process developed by Nielsen (2007). A comprehensive risk allocation strategy was first developed by Abednego & Ogunlana (2006), which is introduced here, and consists of four questions. These are:

C1) What are the risks?

The preparations for answering this question should have been made earlier on in Steps A and B. An inclusive classification process of risks associated with GACA projects is performed which aims to classify and categorise the identified risks. Subsequently, all of the risks identified go through a process of prioritising with regard to their importance. A scale of risk importance can be developed to determine the importance of risks such as a (1–5) Scale as it represents the importance values (Very Low, Low, Medium, High, Very High), which have already been provided earlier in this chapter (see Tables 5.1, 5.2, 5.3, 5.4, and 5.5). Once that is developed, the following question is raised: is the risk's importance Low or Very Low? If the answer to this question is Yes, this implies that the GACA needs to retain this risk, as it does not represent great importance in terms of impact and likelihood. Accordingly, retaining such a risk is preferable. The whole process is summarised in Figure 5.3 below. However, if the answer to this question is No—which means the risk's importance is Medium, High or Very High—the following step is introduced.

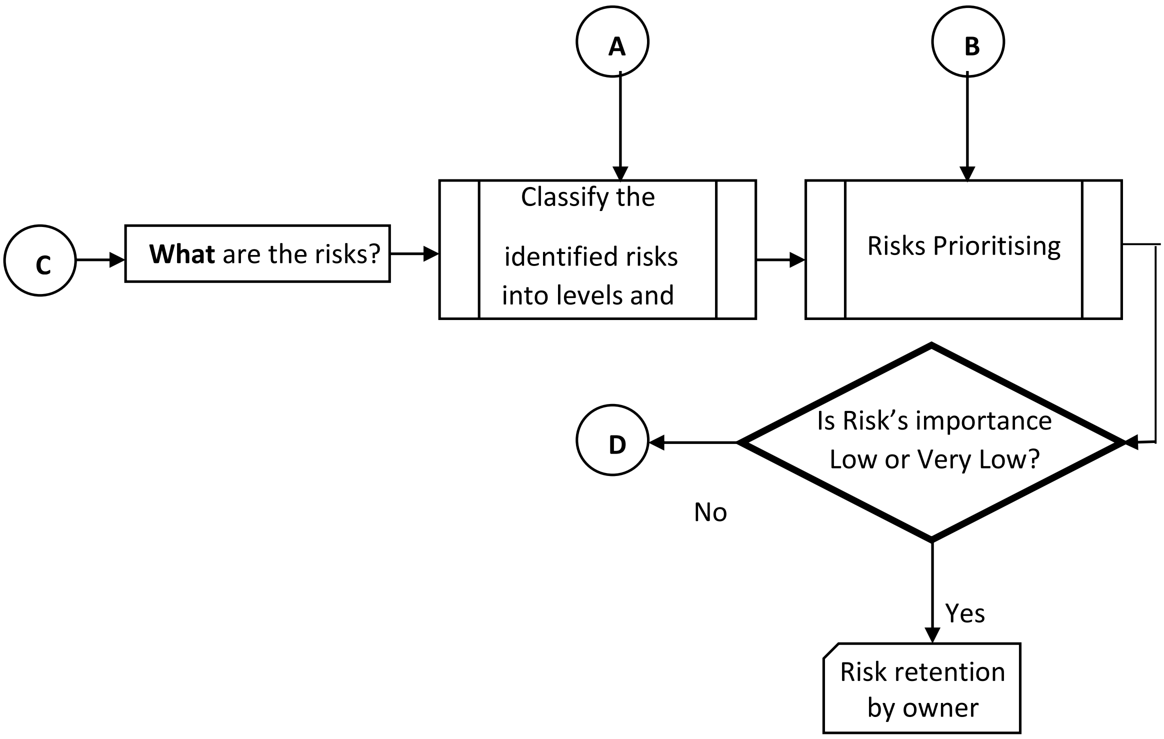


Figure 5.3: What are the risks?

C2) Who takes the risks?

The answer to this question will facilitate the GACA in properly determining the party to whom risk should be allocated. Hence, there are four criteria that are summarised from previous studies on risk allocation criteria: firstly, the GACA need to ask themselves if they are in the best position to control the risk or not; this criterion is generated by the well-known condition for risk to be allocated to such a party: 'risk is allocated to the best party who control it'. If the answer is No, another question should be raised here before moving on to transferring the risks to the contractor; this question is related to whether the risk can be shared by the GACA and their contractor. If the answer for the risk sharing question is Yes, then risk can be shared. However, if the answer is No, risk should be transferred to the contractor.

On the other hand, if the answer to the question about the GACA and their position to control the risk is Yes, then the following question is formulated: 'Is the GACA financially and technically able to bear the risk?' Again, this question combines two very important aspects of risk allocation criteria that have been mentioned in the subject related literature, these are: 'the party who bears the risk should be financially able to bear the risk' and 'the party who bears the risk should be financially able to bear the risk'. If the answer is NO, the same procedures that were performed for answering No to the previous question are performed here again. Whereas, a Yes answer means the following question is asked: 'Is risk transference economically beneficial to the GACA?' Answering this question will ensure that, in the case of risk transfer to the GACA contractor, the process is economically beneficial to the GACA. In other words, the decision that is made about transferring risks to the GACA contractor or the GACA retaining risks is economically significant to the GACA. Hence, answering this question with No means that the GACA has to question the sharing of a risk with the contractor, and then consider transferring the risk to the contractor, as happens for the two previous questions.

However, if the answer is Yes, this means another question is raised again. That is, 'Is the GACA willing to accept the risk?' Again, answering No to this question means the same procedures for answering No to the previous three questions is repeated, while answering Yes to this question means the risk should eventually be retained by the GACA. The whole process is summarised in Figure 5.4 below.

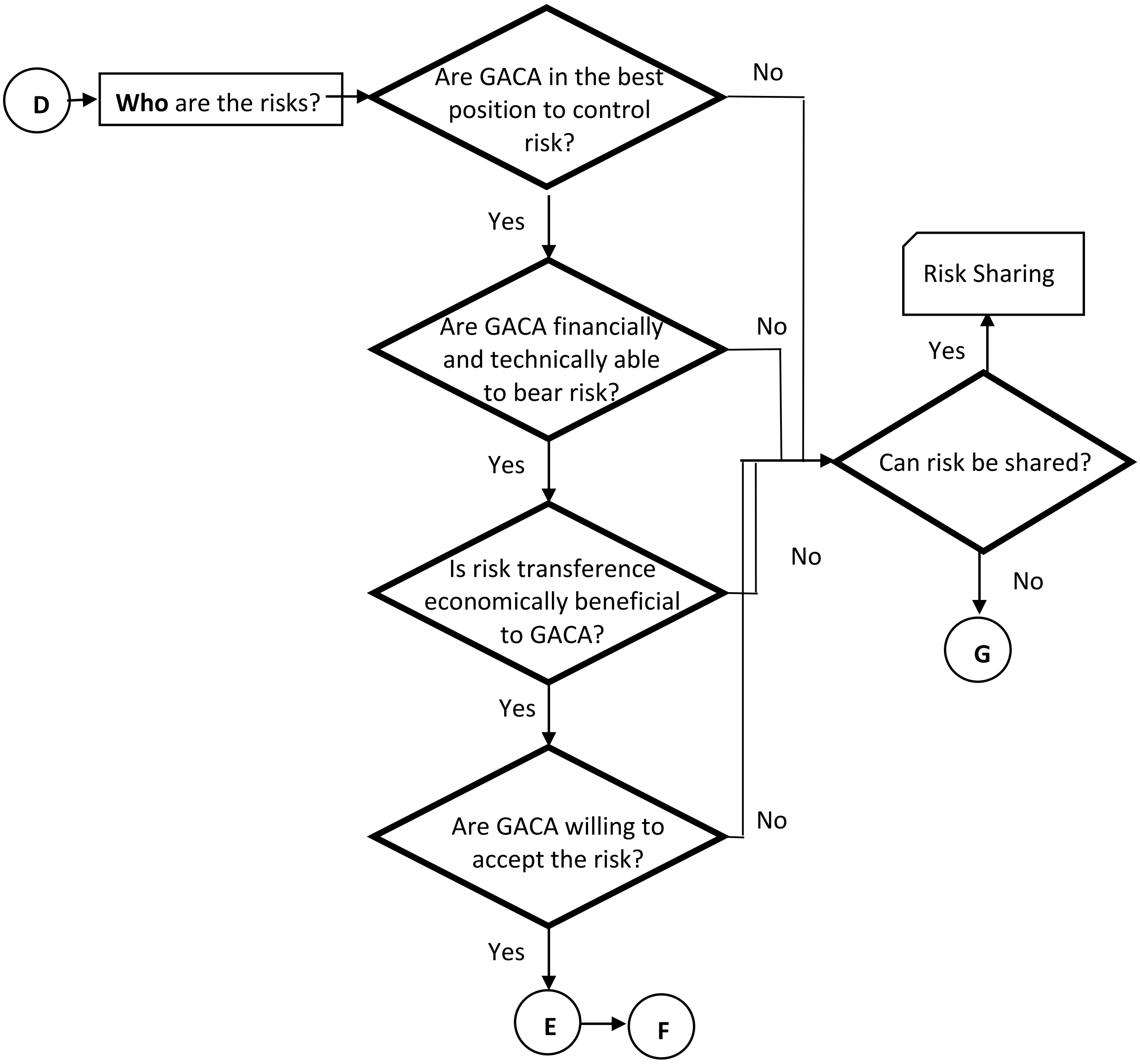


Figure 5.4: Who takes the risks?

C3) When is Risk Allocated?

This process deals with the third aspect of the proposed risk allocation strategy, which is the time that risk should be allocated to any party. This step mainly depends on the first step taken by the owner, which is risk identification. The identification of risk will help the owner to determine when a particular risk could occur. As a result, the owner could have the opportunity to allocate the risk before it occurs suddenly.

C4) How is Risk Allocated?

This is the fourth and last aspect of the comprehensive risk allocation strategy. The way to react to or respond against risk, which has been allocated to the owner, is based on the analysis of the identified risks and their importance. The researcher benefited from the options that have been provided by the literature on risk response, which are risk acceptance, risk reduction, and risk avoidance. Hence, if the risks' importance is found to be very high and the risk is to be allocated to the owner, then a reduction strategy should be undertaken here unless risk avoidance can be sought, which could result in a better outcome. The risk reduction strategy aims to reduce both the likelihood of a risk's occurrence and its impact.

Similarly, for risks that are allocated to the owner with HIgh importance, risk reduction actions should be utilised, which aim to reduce either the likelihood of the risk's occurrence or the risk's impact. Likewise, risks that have been found to be allocated to the owner and have Medium importance, should be dealt with by reducing either their impact or likelihood of occurrence. Otherwise, risk avoidance is still the first option for the owner to utilise.

Finally, risks with Low or Very Low importance and allocated to the owner are dealt with acceptance if they cannot be avoided. These risks should be monitored closely as the acceptance strategy does not require the risk taker (the GACA) to react against risks. This is due to the fact that the risk impact and likelihood are low. Figure 5.5 summarises the process that has been explained above.

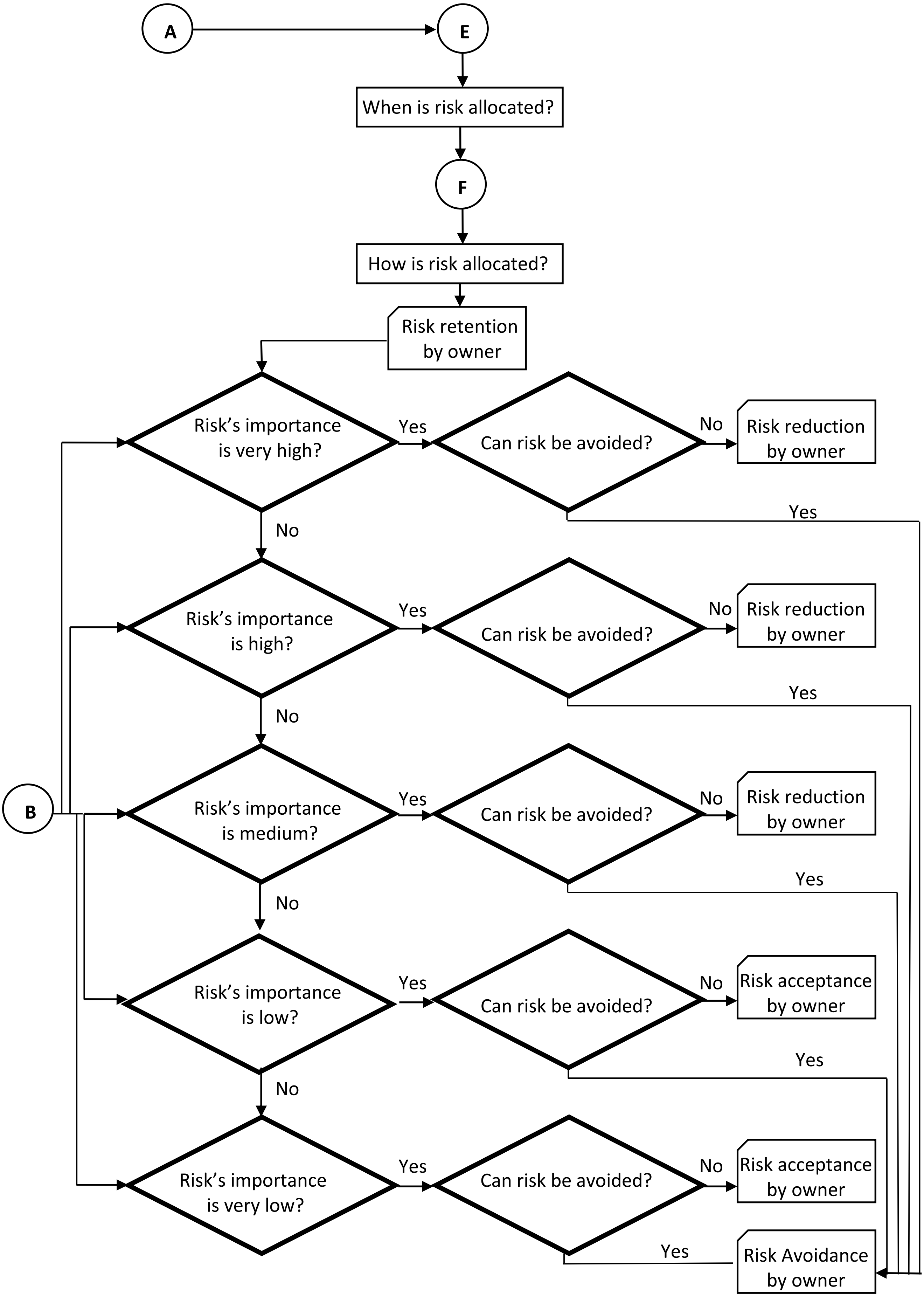


Figure 5.5: How is risk allocated?

D- Sound Risk Management by contractor

Once risks are allocated to a contractor, the contractor needs to perform sound risk management in the bidding stage. This begins with the process of identifying risks, which is similar to that performed by the owner. An important question the contractor should ask himself is, 'Does the contract include all the risks that the contractor has identified?' If the answer is No, the contractor then needs to return to the owner and negotiate on the risks the contract does not include. However, if the answer is Yes, a risk analysis process is carried out. Again, the process is performed in the same way that it has been performed by the owner, whereby the risks' impact and likelihood are all assessed.

After assessing the allocated risks to the contractor, the contractor should respond to these risks. Hence, the contractor may accept such an allocation if the risk is within his control. On the other hand, if the risk is not within his control, he might add a contingency or an extra premium for taking a risk. The premium must be agreed by the owner in order to allow the contractor to go ahead and assume the risk. If the contingency is not agreed by the owner, this means the contractor should withdraw from bidding for the project. Through this process, the contractor has applied a risk avoidance strategy which prevents him from entering into a troublesome project. These steps are summarised in Figure 5.6 below.

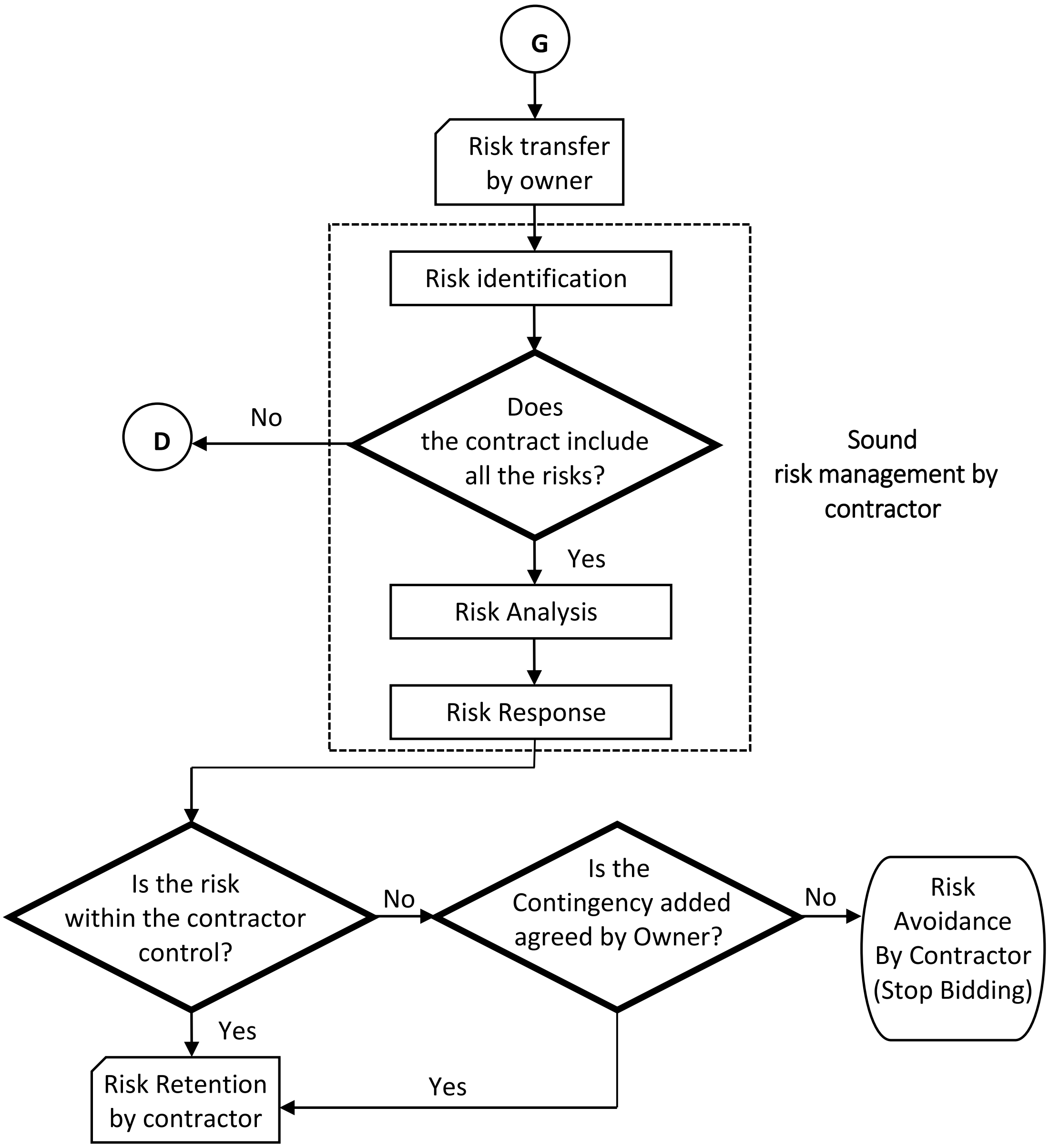


Figure 5.6: Sound risk management by contractor

5.2 Validation of the Proposed Framework

In order to validate the framework developed above, five senior project managers were interviewed. These five individuals were GACA staff (totalling three), and one contractor and one consultant. The interviewees involved in the validation interviews had been interviewed previously for data collection purposes (see Chapter 4). Again, the basis upon which these interviewees were selected was that they had all worked for/with the GACA for 15 years or more. This was thought to positively and strongly impact on the framework in the sense that any weaknesses or missed points might be picked up by them and dealt with, due to the experience of these individuals. Each interview lasted almost 60 minutes, and involved both discussion of the results of the study and an introduction to the proposed framework (presented earlier on in this chapter). The nature of these interviews was semi-structured since a general comment on each step from the interviewees was involved, and yes or no answers were showed for questions on the applicability of this framework to GACA projects. The interviews showed the framework's strengths and weaknesses, as discussed below.

- **Contractor Interviewee**

The results of the research following the analysis of the data were discussed with the interviewee, and a general acceptance was achieved. Then the proposed framework was introduced by the researcher and presented in a printed copy with the results so that the steps of the framework could be followed one by one and commented on. The interviewee stressed that any risk associated with GACA projects, even if it was allocated to a contractor solely, has an impact on the GACA. As a result, the project time and costs will be impacted, which is of concern for the GACA, with time and cost being very crucial to the GACA. Accordingly, the consequences of the risks are shared again, between client and contractor even if the risk is formally a contractor risk.

Regarding the applicability of the proposed framework, the interviewee was assured that the framework could be applied and replace or at least enhance the current practice that the GACA has been stuck with for more than 20 years for dealing with risks and their allocation, which obviously causes the majority of the issues that hinder their projects.

The interviewee stressed the way that the framework starts with a proper identification of risks and more importantly the classifications according to their sources and then shows the importance of each of the identified risks, is a very good start for dealing with GACA projects. He thought that if the framework is applied as shown it will facilitate the response towards risks and the allocation.

A very important point was made by the interviewee that, as current practice by the GACA does not require the GACA to formally identify and analyse the process of risk, it is important that this framework does involve the GACA in these processes.

Regarding the roles played by the contractor in the proposed framework, the interviewee considered withdrawal from the bidding if there is no agreement achieved on allocation as a crucial step. However, in reality the majority of GACA contractors accept the bidding as it is and would find themselves in a big conflict with the GACA as projects progress further.

One of the issues that the interviewee added that he thought could hinder the application of the framework related to cooperation between the GACA and their contractors. This could be seen especially in the expansion projects when the GACA refuses to provide contractors with the complete as-built drawings, and this results in a big loss for both the GACA and contractors.

One of the points the interviewee considered was that the proposed framework is unique and different to the current practice employed by the GACA with regard to risk-sharing. As sharing risks does not exist in GACA projects, the interviewee pointed out various informal remedies that the GACA could employ when a risk is caused by a contractor, such as allowing extra time or benefiting from the overall contingency, which does not exceed 10% of the overall budget of the project, as a role already set by the Ministry of Finance.

- **Client Interviewee 1**

The results generated from the study were discussed with the interviewee, and a question was raised with regard to the nature of the analysis of the data. The researcher clarified that both subjective and objective analysis were used; the reason for using subjective analysis was due to the fact that the results were subjective in nature as the opinions of the respondents and interviewees were both obtained; an objective analysis was employed in statistical test form in an effort to decide on the risks' importance and rankings, as well as the employment of the statistical tests used to find the statistical difference between the three groups of respondent. Following this, the framework was introduced to the interviewee by providing a hard copy detailing the framework's steps and processes, and their expansion, along with a copy of the results of risks being classified and prioritised according to their importance. The interviewee began by stressing the problem of the absence of qualified personnel who can deal with risks in the GACA, which he recognises as being responsible for the current issues in GACA projects.

The interviewee made a comment on the first two steps, A and B, in the framework, which were centred on identifying and analysing risks: he stated that, if we applied them well, we would possibly be able to manage, avoid and allocate risks properly. He believed that the presence of well-structured risk assessment, such as that proposed by the researcher, would facilitate the following steps as they mainly depend on this output.

He was confident that good practice such as that provided in the proposed framework would enhance current practice, which mainly depends on project managers' experience and differs from one project to another. Furthermore, he stressed the generalisation of the steps mentioned in the framework to all projects with which the GACA is dealing.

Regarding the role of the contractor in the proposed framework, the interviewee argued that GACA contractors, despite the fact that the majority of them are graded highly, still show incompetence in the way they deal with risks in GACA projects. With regard to Step D mentioned in the framework on who takes the risk, the interviewee admitted that the majority of risks are generated by the GACA, which seems in alignment with the results that are shown in Chapter 5. However, the interviewee made it clear that the GACA never gives any indemnity in the form of money to their contractors.

Also, the interviewee was questioned on the sharing option in Step 3 of the framework and whether the GACA could consider that, as the current results showed that no risk has been shared between the GACA and their contractors; he argued that sharing risk should always be an option upon agreement between the two parties on a reasonable fair. He proposed that the agreement should be made to give the contractor more time since no money can be given back to the contractor as stated earlier.

The interviewee was asked about when risks should be allocated as this question is considered to be one element of the proposed framework; he answered by saying that the initiation phase is always the best phase for identifying, assessing, and making the response plan for risks; however, that is obviously not what happens here in the GACA. He thought the client should be the only party who should be concerned with answering the question (when), as the time factor is one of the priorities.

Regarding the question about how risks are allocated, which forms one of the framework's elements, the interviewee came up with the idea of imposing a time frame for the response to risks, since some risks require a quicker response than others.

The interviewee proposed a way of introducing the proposal to the GACA by asking the researcher to hold a workshop with their department staff, led by the researcher, to see how they could benefit from it. He believes a risk plan like this would cost the GACA a fortune if it was to be performed by a consulting company.

The interviewee was confident when he was asked about the applicability of this framework to GACA projects, with at least the first two steps mentioned in the framework as having a huge impact if they were applied properly, regardless of the framework as a whole. He thought, in line with what the framework says, that understanding of the allocation of risks would change. Lastly, the interviewee pointed out one of the constraints that could hinder the proposed framework from being applied: the governmental practice does not accept any new changes, even if the change is intended to enhance the system.

- **Client Interviewee 2**

Again, the results of the data were discussed with the second interviewee, and then the proposed framework was introduced. After explaining the first step in the framework—identifying risk—the interviewee argued that the contractors are not aware of risks, even if the client has made an effort to identify them. An example was given by the interviewee of the risk of safety which is always shown and identified by clients by imposing term and conditions to be followed by the contractor on site. The interviewee claimed that our contractors are not fully aware of the types of risk, and that penalties are imposed upon them all the time. Accordingly, this is a significant constraint potentially facing this framework, according to the interviewee.

As a comment on the second process that the researcher proposes in the framework—that of risk analysis—the interviewee emphasised the importance of considering the risks' likelihoods and impacts, as the GACA is the only entity to hold responsibility for airports in the county. Furthermore, it is always important to remember that there are two priorities when an expansion project is in place: the safety of travellers and planes. Moreover, with the current practice of allocating this risk, insurance is always in place.

Regarding allocating the Low and Very Low risks to the GACA, which was proposed in the framework, the interviewee pointed out a significant point that should be edited in the framework, which is the reliance on risk-sourcing. An example was given after the interviewee looked at the results of the study, namely that of the crime rate risk; this was classified as a Low risk in term of its importance; however, the interviewee refused the allocation of such a risk to the GACA, despite the fact that it is Low, suggesting looking at the source of risks and liabilities of each party in the allocation of risks, even if they are Low or Very Low. Accordingly, the proposed framework should be edited.

The interviewee was questioned about who takes the risks; his answer was that risks are always allocated to a contractor in practice. However, the interviewee, as a project manager himself, added that he works with the 80–20 plan; this means that, even though a risk is allocated to a contractor, they still have responsibility for supervising how the contractor deals with that risk. By applying this plan, the risk would be shared with the contractor; however, this is very informal. What the framework proposes in Process D, nonetheless, is a very fair form of risk-sharing as the GACA first needs to make sure they are not the best party for taking risk before allocating it to a contractor or otherwise sharing it with him.

When to allocate the risk was also another question answered by the interviewee, who stated that risk should be properly identified and assessed (as in the first two steps in the framework). He considered that deciding when to allocate risks should be considered in the early phase of the project (planning phase), meaning every party would know their liabilities.

For the last step in the framework, the interviewee stressed that it has become a requirement that the contractor provides a risk plan before the commencement of the project work; this is still performed, albeit very poorly, and they do not reflect the real risks. He considered that the framework details the required steps for the contractor to avoid these issues.

Lastly, the interviewee emphasised that the framework is a very important tool if it is used in projects, and has the ability to bring about positive consequences for GACA projects, as GACA policies suffer from a lack of professionalism in dealing with such risks.

- **Client Interviewee 3**

The results of the research were introduced to the interviewee and he was satisfied with the overall structure and ranking of risks associated with GACA projects. Then, the researcher introduced the proposed framework to the interviewee. The interviewee suggested that the first step (risk identification) could be performed formally instead of the current practice that has been taking place, which is based on the intuition of each project manager individually. Also, the same should happen when risks are assessed in the second instance in the framework. By this he means that some methods are required to be employed for risks by the project team at an early stage of the project lifecycle to identify risks and analyse them, such as brainstorming.

Subsequently, the interviewee was questioned on the first element about deciding on the allocation of risks, namely what are the risks. He pointed out that risk sourcing is also an important factor to be considered when we ask what. Again, as the previous interviewee spotted this weakness in this step, the framework was edited and risk sourcing was considered in this step.

The interviewee suggested, like the other interviewee did, that the answer to when risks are allocated should be as early as the step deciding who takes the risk. In other words, the planning phase of any project should provide conclusive answers to these questions.

The question of who takes the risk has also been commented on and was considered very crucial by the interviewee. He also supported the idea of risk sharing which has been proposed in this process. He considered risk sharing to be an initiative for GACA contractors to accept more risks, even if they were produced by the GACA. He criticised the current practice that some project managers at GACA follow, in which contractors are forced to take risks that they cannot control or are unable to manage just because the project manager wants that.

Dealing with how the risks are allocated (the fourth element of the framework) is very important; as the risks differ, the responses should logically differ too, he stressed. He was confident that responding to risks in the light of their importance, as the framework states, is a good thing to do.

With regard to the last step of the proposed framework, in which clients have to go over risks identification and analysis and prepare a risk response plan, he considered these actions to be protective and that they could stop the contractor from entering a project that is not economically favourable to the contractor. At the same time, through these actions, some risks could be raised that the GACA has not picked up on in the first instance, thereby resulting in the resolution of the allocation of these risks before the contract is even signed.

Lastly, As the interviewee agreed on the benefits that might be obtained from applying this framework to GACA projects especially in terms of cost and time, he regarded governmental practice in dealing with projects to be a major constraint of this framework. He found that as a reason for project manager from being creative and productive in their project. The contract and roles have been out there for a long time. The same contract is used for projects A, B etc.

- **Consultant Interviewee**

The researcher introduced the results of the data analysis by giving a hard copy of the risks' structure, ranking, prioritising and allocation. The interviewee had questions on the in which the researcher came up with the actual allocation of the identified risks, and he was answered. Subsequently, the proposed framework was introduced to him, also in hard copy form, with each step and process in the framework explained. After giving the interviewee some time to read through the given papers (upon his request), he asked about the role of the consultant in the proposed framework. The researcher made it clear that, as the GACA deals with a traditional type of procurement, the role of the consultant is always adopted by GACA designers, as the GACA prefers not to appoint any external consultant. Accordingly, the role of consultant in the proposed framework is thought to support the client (GACA) in achieving the processes mentioned in the framework, as adopted by the client, with consultants thought to have wider experience in the management of project risks.

The interviewee agreed with the first two steps (A and B) in the framework, where risks are identified and assessed. Moving to Process C, the interviewee was trying to establish a link between the risks that are prioritised (Very Low to Very High) and the last outcome of this step (Risk retention by owner). He gave an example of client financial risks, which was prioritised as Low risk, stressing that such a risk will never be completely retained by the GACA: the contractor sharing this risk means the GACA will never give the contractor anything that he spent on a project that has been cancelled or delayed by a higher authority (Ministry of Finance). Hence, to reflect this point in the proposed framework, the last outcome in this step (Risk retention by owner) needs to be adjusted accordingly.

In the following process (D), the interviewee regarded the option to share risks that have not met the criteria for risk retention by the GACA as a very fair step. It does make the projects more attractive to the contractor when they see that the GACA is willing to share risks rather than allocating them all to the contractors. Regarding the questions in Process E, the interviewee proposed that these questions be moved one step ahead. He claimed that the answer to this question should be prepared at an earlier phase of the project and accordingly linked to the last step of how to allocate risk. For example, if the GACA decides to reduce one of the risks they need to have a plan for that in a very early stage of the project.

The last step mentioned in the framework, where a contractor has to deal with the risk allocated by the GACA witnessed a debate between the researcher and interviewee. The point centred on what if an agreement on such a contractor allocated risk is not agreed. The researcher pointed out the option for avoiding this by not bidding for the project; however, the interviewee insisted that there should be room for negation.

In general, the interviewee was confident that the proposed framework could add value to the current practice implemented by the GACA, which deals with the allocation of risks. He was sure that the criteria of risk allocation applied in this framework was based on fairness rather than using the authority to allocate risks. The only concern held by the interviewee centred on obstacle potential obstacle to applying this framework: qualified project managers. Furthermore, he finally proposed the introduction of good practices, such as the ones upon which the framework is based, so as to educate project managers.

5.3 Changes Made to the Developed Framework

One significant comment was made after having the framework evaluated by five interviewees. This was realised during the second evaluation interview with a senior project manager working for the GACA. The comment was made on the risk prioritising process and the way the Low and Very Low risks are dealt with in the framework, where Low and Very Low risks are potentially allocated to the client as shown in Figure 5.3. The interviewee suggested that even Low and Very Low risks should go through the rest of the processes mentioned in the framework, rather than allocating them directly to the client. Hence, this implies two major changes which should be made to the framework. These two changes are explained in Table 5.2 below. One more change has also been added, which is the description of the symbols used in the developed framework.

Table 5.2: Changes made to the developed framework

Comment	**Change made to the last version of the framework**
Low and Very Low risks should not be allocated directly	1- Question about Low and Very Low that come after prioritising process has been removed. 2- All the risks should go through process D, regardless of their level of importance.
Unfamiliarity with the symbols used in the framework	3- Table 5.6 provides a full description of used symbols.

Therefore, Figure 5.7 shows the complete version of the developed framework for the suitable allocation of risks for GACA projects, which involves the previous explained steps. In addition, Table 5.3; which comes after Figure 5.7, provides a description of the symbols used in the framework.

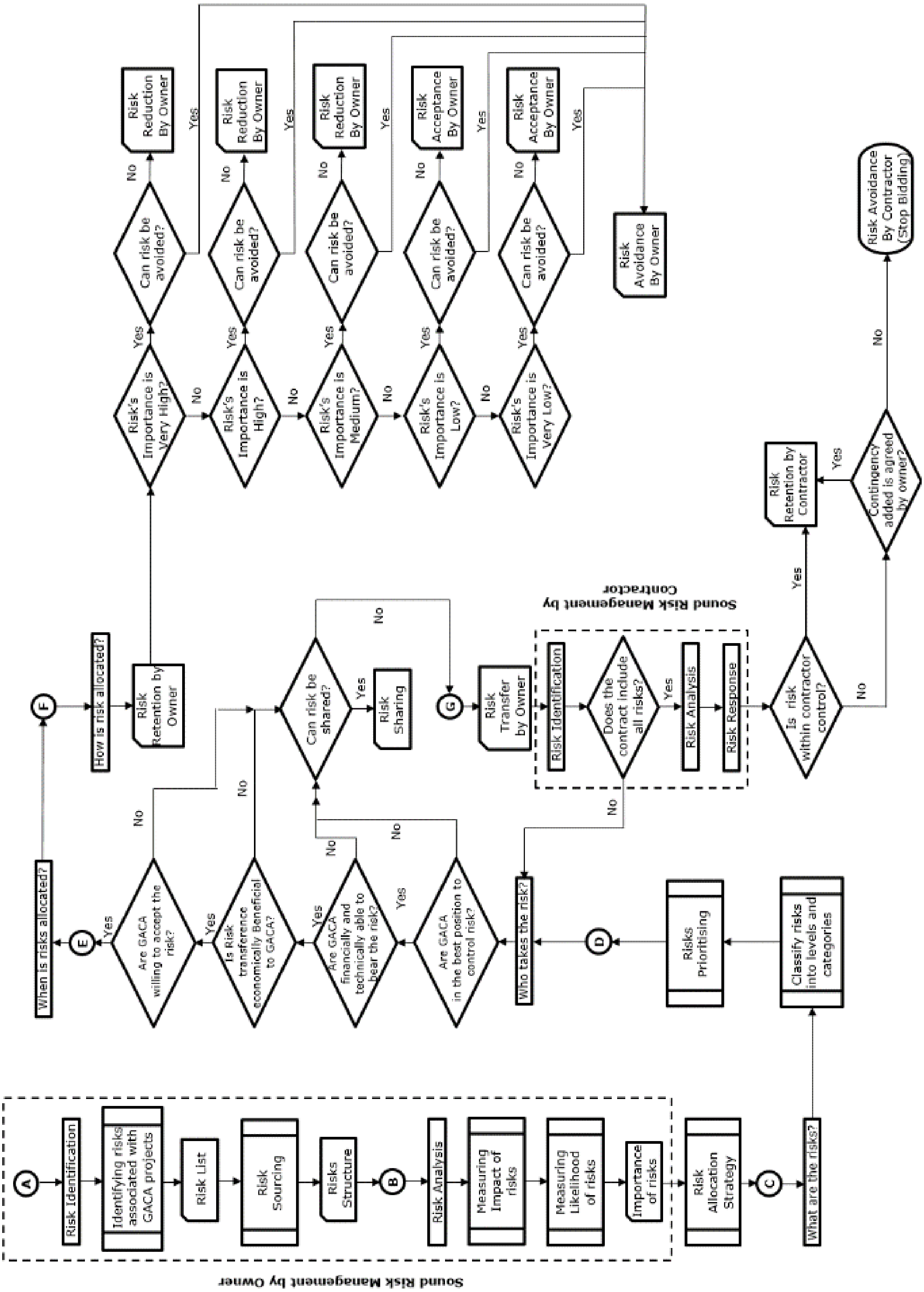
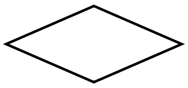
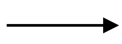


Figure 5.7: The complete version of the developed framework

Table: 5.3 Description of symbols used in the flowchart (ConceptDraw, 2016)

Sypomle	**Shape Name**	**Symbol Description**
	Terminator	Shows start of a flowchart or its end.
	Process	Shows a process or action step. Indicates any processing function.
	Decision	Indicates a decision point between two or more paths in a flowchart.
	Subroutine	Indicates a predefined (named) process, such as a subroutine or a module.
	Card	Can represent any type of data in a flowchart.
	Flow line (arrow, connector)	Flow line connectors show the direction that the process flows

Chapter Six: Summary, Conclusions and Recommendations

6.0 Summary

The aim of this research, which underpins the entire thesis, was developing a framework for proper risk allocation to be used by the General Authority of Civil Aviation (GACA) in Saudi Arabia to allocate risks associated with their projects. A lack of similar studies on risks in the case of aviation construction projects was found. Moreover, a lack of information with regard to the GACA and their construction projects was realised. On the other hand, many delays in the GACA have been repeatedly reported in news; this is coupled with cost overruns in some GACA airports.

Hence, a wide review of literature was carried out, which resulted in 44 risks being associated with GACA projects. The studies reviewed were undertaken in different construction contexts, including Saudi Arabia, the Arabic Gulf Area, the Middle East, Asia, Africa, Europe and America, covering a wide range of construction projects, such as railways, road, utilities and building projects, and so on. This is thought to enhance the researcher's understanding of risks inherent in construction projects on a global scale. Understandably, the focus of the reviewed studies was on the research that has been carried out in the Saudi context, as it is the same context as that considered in the current research. Throughout the course of the literature review, a short preliminary field visit was performed by the researcher in the first year (2013/2014) of completing this research. This was done to enhance overall understanding of the research problem, and it was confirmed that there has not been any guidance for risks to be allocated properly in the context of the research.

It also was found that time delays and cost overruns are common outcomes in most GACA projects.

Subsequently, an interview method was employed with 13 interviewees, who were involved in GACA projects as senior project managers from three groups, namely client, contractor and consultant. The interviews revealed 10 risks in addition to the previous risks associated with GACA projects, which totalled 54 risks associated with GACA projects. During the completion of the interviews, a first draft of the questionnaire was introduced to each interviewee in an effort to enhance the overall accuracy of the data involved in the questionnaire, as well as to achieve validation. The 44 risks were divided into three levels, namely Internal, External and Force Majeure, and 11 sub-categories were devised to show where the risks were sourced from. This classification of risks was thought to be beneficial for the current research since it relies on each risk's source, which makes it easier later on when these risks are allocated.

Hence, a total of 95 questionnaires were distributed amongst GACA project managers, contractors and consultants in order to obtain each of the identified risk's importance. This was done through the calculation of each risk's likelihood of occurrence, multiplied by the impact of each risk. Moreover, the same was done to determine the most important categories of risk. The usable questionnaires returned amounted to only 54. In order to achieve reliable data in this research, a one way ANOVA test at 0.05 alpha level was used. This was due to the fact that three groups of respondents were involved. Moreover, a statistical test (post hoc test) was used to find exactly WHERE the significant difference occurred amongst the three groups.

The current practice of risk allocation in construction projects was also investigated through the literature. The principles of risks to be allocated to particular parties in construction projects were listed. A clear gap of knowledge was identified: although these principles are well-established and could lead to proper risk allocation, they are not well applied in real life. Thus, in order to investigate the current practice applied in the GACA regarding the allocation of risks, interviews were used.

Another point that the review of literature covered was the perception of the allocation of risks in construction projects in different contexts. Studies from different contexts were reviewed on the magnitude of risks allocated to each project's parties. It was recognised that these studies only took into consideration a subjective analysis of the results; in other words, each author assumes a fixed percentage (50% or 60%) of the overall respondents to be allocated to such a party, neglecting any differences amongst the groups of respondents. Only Andi (2006) applied both subjective and objective analysis so as to improve reliability. Subsequently, questionnaires were used to decide on the actual allocation of risks in GACA projects.

The actual results generated from this research, in terms of the current practice of risk allocation and the actual parties to whom risks are allocated, were compared to the results generated from the literature. With regard to the analysis of the data generated from the questionnaires on the actual allocation of risks in GACA projects, this research adheres to the steps performed by Andi (2006). Therefore, two types of analysis were employed so as to determine the actual allocation. The first one was subjective analysis where a risk is considered to be allocated to a party if the respondents' score is 70% or more. The second type of analysis is objective, where a one way ANOVA test is employed to realise if there is any significant statistical difference amongst the three respondents from the three above-mentioned groups.

The last point covered when reviewing the literature was concerned with introducing risk allocation frameworks that have been applied in different contexts. A critical review of each one of those frameworks was performed to test its applicability and appropriateness to GACA projects. Each framework was assessed on the basis of its application of risks principles. A very clear knowledge gap was identified to show that, although many authors have attempted to come up with frameworks to allow risks to be allocated to the right party, no framework has been found to incorporate a clear risk allocation strategy, such as that developed by Abednego & Ogunlana (2006), whilst also adopting well-defined principles of risk allocation.

From the results generated in this research, the need to have a detailed framework to allow for risks to be allocated to the GACA was established, with the current practice indicating an absence of such a clear framework. Therefore, the last step phase of the research was centred on proposing a framework to allocate risks associated with GACA projects, whilst also validating this framework with the GACA. The researcher made use of the framework proposed by Nielsen (2007) for allocating risks in Chinese aviation projects; that is, based on a sound risk management by both owner and contractor separately. As the researcher found it important to incorporate a well-established risk allocation strategy, an adoption of the risk allocation strategy, developed by Abednego & Ogunlana (2006), was devised. Furthermore, as the framework lacks the application of risk allocation principles, it benefited from the use of the principles adopted by them (2007).

The framework was produced in flowchart form in a series of processes starting from the client (GACA) performing sound risk management, including risk identification and analysis. Then, the risk allocation strategy was introduced by requiring the client to answer four questions related to the allocation of risks. The idea of risk sharing was also introduced, since the results of the research revealed no risks were found to be shared between the GACA and their contractors.

Generally, the framework was believed to provide the GACA with a basis upon which to rely in order to overcome the issue of allocating risks improperly.

In order to validate the proposed framework practically and accordingly test its applicability in the case of GACA projects, five interviews were conducted with three senior project managers from the GACA, one GACA contractor senior project manager, and one GACA consultant. The interviewees were carried out on the applicability of the proposed framework to GACA projects. The individuals were also asked to comment on the framework itself and to highlight any point they felt had been missed or ignored.

6.1 Conclusions

An extended literature review of risks in construction projects in different contexts was carried out; there was neither any previous study on risks associated with aviation projects found in the Saudi Arabian context nor in other contexts. This research reveals that various risks—namely labour issues, design changes and corruption, project type know-how skills for designers, and design constructability—are amongst the top most important risks concerning GACA projects. This was based on the views of this research's participants, including: project managers from GACA, their contractors, and consultants who have been involved in GACA projects. The results of risk importance were calculated by multiplying each risk's impact by its likelihood of occurrence, using a 1–5 Likert scale to represent the results. The first objective (O1), second objective (O2), and third objective (O3) (presented in the first chapter) were then achieved.

Noticeably, aside from two external risks, namely labour issues and corruption, the rest of the most important risks were found to be within the internal level. In addition, the designer- and client-related categories were found to be the most important risk categories. This confirms that the GACA and their designers are the main sources of risk with a high level of importance. On the other hand, crime rates and client financial failures are amongst the lowest risks in terms of importance. This is a reflection of both financial and safety stability within the country.

The findings from the results of this research are partially in alignment with what has been found in the literature. This is attributed to the difference in contexts, as this research was conducted in an area never before examined.

The achievement of the fourth objective (O4) and fifth objective (O5) were also done in two ways: through the completion of interviews, where it was established that risks in GACA projects are poorly allocated and the process of allocation relies on irrational factors, such as the experience of project managers, authority and intuition. Furthermore, questionnaires were also used to obtain the actual magnitude of risks allocated to each party. Accordingly, it has been found that no risk was found to be shared amongst the two parties, and the allocation of some risks could not be decided due to conflicts in respondents' opinions; hence, these results confirm the improper allocation of risks associated with GACA projects.

The results produced in research, specifically concerning the perception of the GACA as a client, towards risks and their allocation, were aligned with what has been found in the literature to suggest that various principles or strategies for risk allocation are not fully represented and applied in reality. This is true for GACA projects.

Therefore, an action is needed to address that problem, which is achieved in the following sixth objective (O6). A framework (presented in Chapter Six), in which risks associated with the GACA can be allocated properly, has been designed in flow chart form. The framework is believed to provide an incorporated tool for risk allocation strategy that is based on well-defined principles. It induces the GACA and their contractors to perform a sound risk management process in order to go ahead with the allocation of risks. The client should initiate the framework's processes by identifying risks in order to produce a structure of risks that is well levelled and categorised. Following this, an accurate analysis of the identified risks should be performed, again by the client. This will lead to a list of identified risks and their importance in regard to GACA projects. Clearly, the first two steps were carried out by the researcher.

A well-developed risk allocation strategy is introduced in the framework, which encourages the GACA to answer four questions: what are the risks? The GACA has to refer to the previous two processes adopted before in order to prioritise the risks according to their importance. The second question: who takes the risk? Risk principles are outlined in the form of questions; however, any answer of No will automatically induce the risk-sharing option, which the GACA does not practice at all. The fourth question needing to be asked by the GACA is: when is risk allocated? The last question covering the developed strategy is: how is risk allocated? This requires that the GACA consider risk responses according to the importance of risk for those risks initially retained by the GACA.

As in the last step, GACA contractors have identified risks again in order to pick any risks that the GACA has not identified in the first instance, and also analyse the identified risks to respond to them accordingly. One of the valuable directions this framework offers is that of risk avoidance by the contractor, through which the contractor can stop bidding for the project and withdraw at any disagreement on a risk that is misallocated.

Finally, the framework was tested in real life: it was taken to the GACA and their contractors and consultants to obtain validation. An agreement amongst the participants was established on the importance of the framework. It was stressed that the framework could genuinely replace the current practice by GACA for risk allocation and further add good value to that process, as well as to projects. In this way, the research aim has been achieved and a contribution to knowledge has been realised.

6.2 Contribution to Knowledge

A lack of studies on risks and their allocation in aviation contexts was realised in the context of the Saudi Arabian construction industry. This was coupled with issues such as time delays and cost overruns. Accordingly, this research was carried out in order to address these problems, as well as proposing a solution. Moreover, the current practice of allocating risks has been criticised by the participants of this research, and regarded as, in part, causing the aforementioned consequences in the context of the research.

Therefore, an investigation was carried out by following a structured research methodology and making use of some of the methods and tools offered to researchers. A number of benefits were attained from the investigation. The most important benefit has been the development of the framework, which can solve the research problem. Moreover, the following have provided major contributions to knowledge:

- The added value with regard to the literature. This was clear in the development of the risk structure that has been provided in this research. Also, in the use of the methodology that has been used, as it was mainly guided by previous studies.

- The current practice of risk allocation that is used by the GACA does not rely on a clear strategy or principles that are based on appropriateness and logic.
- The lack of such a framework that incorporates a risk strategy and is based on risk allocation principles is realised in the literature also. Hence, the developed framework (adopted from Nielsen (2007)) is believed to fill that gap in the literature and the context of the study. This is achieved as the framework provides unique features, by incorporating a well-developed risk allocation strategy (adopted from Abednego & Ogunlana, 2006) and the principles adopted by it.
- The adoption of the provided frame can enhance the responses to the issues faced by the GACA in their projects with regard to risk allocation. This has been practically proved for the framework to be generalised within GACA contexts due to the added the value this framework can provide.
- As a step to encourage the academic bodies and professionals related to construction in Saudi Arabia to establish research in the area of aviation projects, a number of publications have been endeavoured. This was done by publication in peer-reviewed journals (see Appendix 4) and presented at subject-related international conferences (see Appendix 3).

6.3 Research Originality

The framework proposed for suitable risk allocation in the context of GACA projects, as designed by the researcher, represents a genuine contribution to the body of knowledge, as well as to GACA construction projects overall. This is due to the belief that the risks associated with aviation projects in Saudi Arabia and their suitable allocation has not been examined thus far.

The developed framework is believed to minimise the number of delayed construction projects, with such delays stemming from the improper allocation of risks in the field of Saudi aviation. Moreover, the developed framework is believed to help the GACA and their contractual parties to base their decisions regarding the allocation of such risks associated with their construction projects on a solid strategy that takes into consideration the identification of risks involved, the suitable assessment of risks, and well-defined risk allocation principles.

Moreover, the structure of risks associated with GACA aviation construction projects, as produced by the researcher, with their importance, were used as a tool to help achieve the research objectives. Importantly, this is recognised as the first study of its kind to be completed in this sector. Furthermore, making use of such a structure has enhanced the use of methods for data collection (interviews and questionnaires) purposed in this research. In this sense, another contribution has been made through the completion of the present work.

6.4 Limitations

During the research process, the researcher encountered a number of limitations, including:

- The conservation and preservation that are realised in some participants when they were interviewed and questioned on research related issues. This was even clearer with participants who re not working for the GACA such as contractors and consultants. This is a totally understandable situation especially from contractors and consultants as private bodies do no not want to show any weaknesses or faults in their works.
- The distance between the headquarters of the GACA and their project management department and the city where the researcher lives is almost

two hours by car. This was also true for GACA contractors and consultant who participated in the research.

- Due to the amount of work the GACA project managers and their contractors and consultants have, it was not possible to have focused group sessions, especially when the framework was shown to them. The researcher had to meet each participant individually.
- It was difficult to reach project managers who are responsible for the King Abdul Aziz International Airport (KAIA), as well as the contractors and consultancy team. Despite the fact that the project has been encountering a number of time delays and cost overruns, for the mentioned reasons it was excluded from the scope of the study.

6.5 Recommendations

- The framework should be applied to a real life GACA projects, which imposes the projects team, GACA, and their contractors and consultants to take a part. This requires early involvement from the team, as well as cooperation that is based on trust and transparency.
- As has been outlined by the participants in the validation of the framework, governmental policy and regulations is a constraint potentially facing the framework. This requires GACA to make an effort to persuade the higher authority (Ministry of Finance) to develop and improve the current regulations as it will improve the overall performance their projects, specifically in terms of dealing with risks and their eventual allocation.
- The framework is designed for GACA projects that have been undertaken via a traditional method of procurement, as the regional and domestic airports (Scope of the Study) are on that type. Any attempt to apply the framework

in a different project undertaken by a different type of field would need to be attempted as the allocation of risks differ from one type of procurement to another.

- To apply the framework in different contexts, amendments would need to be made as the solution was devised in mind of solving the specific problems encountered by GACA projects.
- In this research, only the risks inherent in construction phase are investigated. Any Further investigation can be conducted on different phases.
- GACA should make an effort to include the process of risk analysis (provided in this research), in terms of measuring the likelihood and impact of each identified risk, in the tender documents for their future projects.

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Appendix 1: The English Version of the Questionnaire

Dear Respondent

The current survey is part of PhD research undertaking under Scott Sutherland School at Robert Gordon University, Aberdeen, UK, which is concerning the *"Allocation of risks in construction projects in the context of Saudi Arabia Aviation Projects"*. The aim of this research is to develop a framework for adequate risk allocation strategy in specific consideration to GACA projects.

This questionnaire is an important step in the stage of data collection in the project. The questionnaire consists of three main parts. It takes approximately 20-25 minutes to answer the questionnaire. The outline of the questionnaire as follows:
Part A contains general questions about the respondent.
Part B deals with the identification of risks concerning GACA projects and their analysis.
Part C investigates the actual allocation of the risks within GACA project.

In order to get an accurate image of the area of risk allocation in GACA, it is important that the questionnaire be completed and returned. The questionnaire will be treated as strictly confidential and no reference will be made to companies or persons.

Thank you in advance!

Ahmad Baghdadi
PhD student, IDEAS, Scott Sutherland School
Robert Gordon University
Aberdeen, United Kingdom
E-mail: 1117661@rgu.ac.uk

Part A: General Information

1. Name : ………………………………………………………

2. Company / Organization : ………………………………………………………

3. Age : ………………………………………………………

4. Experience within company:

☐ Less than 5 Years

☐ 5-15 Years

☐ 16-25 Years

☐ More than 25 Years

5. What is your educational background?

☐ Architecture

☐ Civil engineering

☐ Mechanical engineering

☐ Electrical engineering

☐ Others: ………………………………..

6. Name of the project/s you have been involved in:

…………………………………………

7. Your role in the project/s :

Client – Project manager

Client – Project engineer

Designer

Contractor

Subcontractor

Consultant

Construction manager

Others: ……………………

Part B: Risk Identification and Analysis associated with GACA

B1. Have you encountered any of the following risks within GACA projects?

B2. To what extent do you measure the likelihood occurrences of these risks and their impacts on GACA projects?

	B1		B2									
Risk categories			Likelihood of Occurrence					Impacts				
	Yes	No	Very High	High	Medium	Low	Very Low	Very High	High	Medium	Low	Very Low
A. Internal Risks												
Client specific risks:												
Payment Delays												
Setting tight schedule by client												
Inappropriate intervention by client												
Design changes by client												
Inadequate scope												
Site access delays												
Contract breaching by client												
Client financial failure												
Lack of experience of client												
Obtaining / issuing required approval												
Issue of sustainability												
Inadequacy of requirements												
Poor coordination												
Changing demands												
Other : please specify 1. …………………………….. 2. …………………………….. 3.………………………………												
Designer specific risks:												
Design errors												
Incomplete design												
Design constructability												
Poor quality of design												
Project type Know-how skills												
Other : please specify 1. …………………………….. 2. …………………………….. 3.………………………………												
Contractor specific risks:												
Poor quality of construction												
Lack of experience of contractor												
Contractor financial failure												
Contractor low or poor work productivity												
Errors during construction												
Accidents and safety												
Quality and control assurance												
Contractor breaching by contractor												
Project type Know-how												
Inadequate risk management plan												
Other: please specify 1.……………………………….. 2. …………………………….. 3.………………………………												

Subcontractor specific risks:

Subcontractor poor work productivity
Subcontractor breaching contract
Subcontractor financial failure
Material availability
Material quality
Project type Know-how skills
Other : please specify
1. ………………………………..
2. ………………………………..
3.………………………………..

Consultant specific risks:

Lack of experience of consultant
Inadequacy of specifications
Quality assurance
Project type Know-how skills
Other: please specify
1. …………………………………………..
2. …………………………………………..
3.…………………………………………..

B. External risks

Bureaucratic problems
Threats of wars
Labour issues
Corruption
Changes of law
Crime's rate
Cultural differences
Inflation
Currency fluctuation
Poor site conditions
Pollution
Other : please specify
1. ………………………………..
2. ………………………………..
3.………………………………..

C. Acts of God risk

Earthquakes
Fires
Severe weather conditions
Fluids
Other : please specify
1. ………………………………..
2. ………………………………..
3.………………………………..

Please , add more categories and specific risks as applicable :

A.
1. …………………………………………..
2. …………………………………………..
3.…………………………………………..
4.…………………………………………..

Part C: The Actual Risk Allocation within GACA's projects

C1. Should the identified risks be allocated to the actual party who takes responsibility for the risks?

Risk categories	Client	Designer	Contractor	Subcontractor	Consultant	Construction manager in construction management method	Private sector in PPP method
A. Internal Risks							
Client specific risks:							
Payment Delays							
Setting tight schedule by client							
Inappropriate intervention by client							
Design changes by client							
Inadequate scope							
Site access delays							
Contract breaching by client							
Client financial failure							
Lack of experience							
Obtaining / issuing required approval							
Issue of sustainability							
Inadequacy of requirements							
Poor coordination							
Changing demands							
Other : please specify 1. ……………………………………………………							
2. …………………………………………							
3.………………………………………………..							
Designer specific risks:							
Design errors							
Incomplete design							
Design constructability							
Poor quality of design							
Project type know-how skill							
Other : please specify 1. …………………………………………							
2. …………………………………………							
3.………………………………………………..							
Contractor specific risks:							
Poor quality of construction							
Lack of experience of contractor							
Contractor financial failure.							
Contractor low or poor work productivity							
Errors during construction							
Accidents and safety							
Quality and control assurance							
Contract breaching by contractor							
Project type know-how skill							
Inadequate risk management plan							
Other : please specify							

Risk categories	Client	Designer	Contractor	Subcontractor	Consultant	Construction manager in construction management method	Private sector in PPP method
3…………………………………………..							
C2. Please , add other risks not specified above :							
A. 1. ………………………………………..							
2. ………………………………………..							
3…………………………………………..							
4……………………………………………							
B. 1. ………………………………………...							
2. ………………………………………..							
3…………………………………………..							
4……………………………………………							

Appendix 2: The Arabic Version of the Questionnaire

جزء أ: معلومات عامة

1- الاسم (اختياري):..

2- الشركة / المنظمة:..

3- العمر:..

4- عدد سنوات الخبرة:

☐ أقل من 5 سنوات

☐ من 5 – 15 سنة

☐ من 15 – 25 سنة

☐ أكثر من 25 سنة

5- ما هي خلفيتك الدراسية؟

☐ معماري

☐ مهندس مدني

☐ مهندس ميكانيكي

☐ مهندس كهربائي

اخرى:...................................

6- أسماء المشاريع المشارك بها مع الهيئة العامة للطيران المدني:...

7- دورك أو صفتك في المشاريع المشارك بها مع الهيئة العامة للطيران المدني:

☐ العميل (الهيئة العامة للطيران المدني) - مدير مشروع

☐ العميل (الهيئة العامة للطيران المدني) - مهندس مشروع

☐ مصمم

☐ مقاول

☐ مقاول باطن

☐ استشاري

☐ مدير تشييد

أخرى:.................................

2

جزء ب: تعريف المخاطر وتحليلها

ب 1: هل واجهت أي من المخاطر التالية لدى مشاركتك في أي من مشاريع تشييد هيئة الطيران المدني؟

ب2: اذا كانت إجاباتك بنعم لأي من المخاطر السابقة, لأي مدى يمكن قياس احتمالية وقوع هذه المخطر ولأي مدى يمكن قياس تأثيرها على مشاريع التشييد الخاصة بالطيران المدني؟

تصنيف المخاطرة	ب1		ب2 احتماليه وقوع المخاطرة					ب2 تأثير المخاطرة في حال وقوعها				
	نعم	لا	عالية جدا	عالية	متوسطة	منخفضة	منخفضة جدا	عالي جدا	عالي	متوسط	منخفض	منخفض جدا
1- المخاطر الداخلية												
- المخاطر الناشئة من المالك												
تأخير دفع المستحقات												
فرض جدول زمني ضيق												
تدخلات غير ملائمة من قبل المالك												
تغييرات على التصميم بعد الانتهاء منه												
إطار عمل غير ملائم من قبل المالك												
تأخيرات في الدخول للموقع												
خرق لأي من شروط العقد من قبل العميل												
ضعف المالك المالي												
قلة خبرة المالك												
صعوبة أو التأخير في الحصول على الموافقات والاعتمادات من قبل المالك												
الاستدامة وتحقيقها												
متطلبات مشروع غير مناسبة او ملائمة												
ضعف في التنسيق بين المشاريع												
متطلبات متغيرة												
اخرى: اذكرها من فضلك												
.1												
.2												
.3												
- المخاطر الناشئه من المصمم												
أخطاء تصميمية												
تصميم غير مكتمل												
تصميم غير قابل للتنفيذ												
جودة رديئة للتصميم												
عدم وجود إلمام بنوعية المشاريع للمصمم												
اخرى: اذكرها من فضلك												
.1												
.2												
.3												
- المخاطر الناشئه من المقاول												
جودة تنفيذ رديئة												

قلة خبرة المقاول												
إخفاق مالي للمقاول												
قلة إنتاجية من قبل المقاول												
أخطاء خلال التنفيذ												
الحوادث والأمان خلال التنفيذ												
ضبط جودة التنفيذ												
خرق لأي من شروط العقد من قبل المقاول												
عدم وجود إلمام بنوعية المشاريع للمقاول												
مخطط غير ملائم لإدارة المخاطر												
اخرى: اذكرها من فضلك 1. 2. .3												
ـ المخاطر الناشئه من مقاول الباطن												
قلة إنتاجية من قبل مقاول الباطن												
خرق لأي من شروط العقد من قبل مقاول الباطن												
إخفاق مالي لمقاول الباطن												
توفر مواد البناء												
جودة مواد البناء												
عدم وجود إلمام بنوعية المشاريع للمقاول												
اخرى: اذكرها من فضلك 1. 2. .3												
ـ المخاطر الناشئه من الاستشاري												
قلة خبرة الاستشاري												
وضع مواصفات غير ملائمة												
ضبط الجودة من قبل الاستشاري												
عدم وجود إلمام بنوعية المشاريع للاستشاري												
اخرى: اذكرها من فضلك 1. 2. .3												
2- المخاطر الخارجيه												
مشاكل الإجراءات الروتينية												
تهديدات الحروب												
مشاكل العمالة												
الفساد												
التغيرات في القوانين والتشريعات												
معدل الجريمة												
اختلاف الثقافات												
التضخم المالي												
تذبذب في سعر العملة												
ظروف الموقع السيئة												
التلوث البيئي												
اخرى: اذكرها من فضلك												

1.
2.
3.

3- ***المخاطر الخارجه عن الإرادة***

الزلازل
الحرائق
ظروف مناخية قاسية
مخاطر السيول
اخرى: اذكرها من فضلك
1.
2.
3.

من فضلك اضف اي تصنيفات ومخاطر اخرى لم تذكر اعلاه مع ذكر احتماليه حدوثها وتاثيرها:

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

جزء ج: تقسيم وتوزيع المخاطر الحالي بين اطراف مشاريع التعاقديه

ج1. انسب مسؤولية المخاطر التالية والمخاطر المضافة من قبلك ان وجدت الى الطرف الفعلي الذي يتحمل مسؤولية هذه المخاطر في مشاريع التشييد التابعة لهيئة الطيران المدني بالمملكة.

تصنيف المخاطرة	المالك	المصمم	المقاول	مقاول الباطن	الاستشاري	مدير التشييد(للمشاريع التي تتبع أسلوب إدارة التشييد في إدارتها)	القطاع الخاص لمشروع مطار المدينة الدولي
1- ***المخاطر الداخلية***							
- المخاطر الناشئة من المالك							
تأخير دفع المستحقات							
فرض جدول زمني ضيق							
تدخلات غير ملائمة من قبل المالك							
تغييرات على التصميم بعد الانتهاء منه							
إطار عمل غير ملائم من قبل المالك							
تأخيرات في الدخول للموقع							
خرق لأي من شروط العقد من قبل العميل							
ضعف المالك المالي							
قلة خبرة المالك							
صعوبة او التأخير في الحصول على الموافقات والاعتمادات من قبل المالك							
الاستدامة وتحقيقها							

متطلبات مشروع غير مناسبة او ملائمة							
ضعف في التنسيق بين المشاريع							
متطلبات متغيرة							
اخرى: اذكرها من فضلك							
.1							
.2							
.3							
ـ المخاطر الناشئه من المصمم							
أخطاء تصميمية							
تصميم غير مكتمل							
تصميم غير قابل للتنفيذ							
جودة رديئة للتصميم							
عدم وجود إلمام بنوعية المشاريع للمصمم							
اخرى: اذكرها من فضلك .1 2. .3							
ـ المخاطر الناشئه من المقاول							
جودة تنفيذ رديئة							
قلة خبرة المقاول							
إخفاق مالي للمقاول							
قلة إنتاجية من قبل المقاول							
أخطاء خلال التنفيذ							
الحوادث والأمان خلال التنفيذ							
ضبط جودة التنفيذ							
خرق لأي من شروط العقد من قبل المقاول							
عدم وجود إلمام بنوعية المشاريع للمقاول							
مخطط غير ملائم لإدارة المخاطر							
اخرى: اذكرها من فضلك 1. 2. .3							
ـ المخاطر الناشئه من مقاول الباطن							
قلة إنتاجية من قبل مقاول الباطن							
خرق لأي من شروط العقد من قبل مقاول الباطن							
إخفاق مالي لمقاول الباطن							
توفر مواد البناء							
جودة مواد البناء							
عدم وجود إلمام بنوعية المشاريع لقاول الباطن							
اخرى: اذكرها من فضلك 1. 2. .3							
ـ المخاطر الناشئه من الاستشاري							
قلة خبرة الاستشاري							
وضع مواصفات غير ملائمة							
ضبط الجودة من قبل الاستشاري							
عدم وجود إلمام بنوعية المشاريع للاستشاري							
اخرى: اذكرها من فضلك 1. 2.							

.3							

2- المخاطر الخارجيه

مشاكل الإجراءات الروتينية							
تهديدات الحروب							
مشاكل العمالة							
الفساد							
التغيرات في القوانين والتشريعات							
معدل الجريمة							
اختلاف الثقافات							
التضخم المالي							
تذبذب في سعر العملة							
ظروف الموقع السيئة							
التلوث البيئي							
اخرى: اذكرها من فضلك 1. 2. .3							

3- المخاطر الخارجيه عن الإرادة

الزلازل							
الحرائق							
ظروف مناخية قاسية							
مخاطر السيول							
اخرى: اذكرها من فضلك 1. 2. .3							

من فضلك انسب المخاطر المضافة سابقا (ان وجدت) الى الطرف الحالي المسئول عنها

.1							
.2							
.3							
.4							
.5							
.6							
.7							
.8							
.9							
.10							

Appendix 3: Refereed Conference Papers

1- Baghdadi, Ahmad, and Mohammed Kishk. "Saudi Arabian aviation construction projects: Identification of risks and their consequences." 2015 *Creative Construction Conference, June 2105, Krakow, Poland*.

2- Bgahdadi, Ahmad, and Mohammed Kishk 2016. 'Assessment of Risks Associated with Saudi Aviation Construction Projects and of the Risks' Importance'. The 7th International Conference on Construction and Project Management (ICCPM2016), August 24-26, 2016, Turku, Finland.

Appendix 4: Peer Reviewed Journal Publication

1- Baghdadi, A. and Kishk, M., 2015. Saudi Arabian aviation construction projects: Identification of risks and their consequences. *Procedia Engineering*, *123*, pp.32-40. (http://www.sciencedirect.com/science/article/pii/S1877705815031483)

2- Bgahdadi, A, and Kishk, M, 2016. 'Assessment of Risks Associated with Saudi Aviation Construction Projects and of the Risks' Importance*'. Accepted to be published in International Journal of Innovation, Management and Technology (IJIMT, ISSN: 2010-0248, DOI: 10.18178/IJIMT)*

Appendix 5: The Impact of the 54 identified risks on GACA projects

	Number of Respondents	Impact	Rank
1- Internal Level			
A) Client related			
Payment Delays	44	3.91	13
Setting tight schedule by client	36	3.78	20
Inappropriate intervention by client	38	3.68	27
Design changes by client	47	4.11	6
Inadequate scope	26	3.69	25
Site access delays	35	3.63	34
Contract breaching by client	20	3.6	39
Client financial failure	13	3.46	46
Lack of experience of client	23	3.61	37
Obtaining / issuing required approval	41	3.9	15
Issue of sustainability	19	3	54
Inadequacy of requirements	22	3.41	48
Poor coordination	36	3.64	31
Changing demands	39	3.69	25
B) Designer related			
Design errors	43	4.02	8
Incomplete design	26	4.12	5
Design constructability	13	4.31	2
Poor quality of design	26	3.85	16
Project type Know-how skills	21	4.05	7
C) Contractor related			
Poor quality of construction	37	3.92	12
Lack of experience of contractor	34	3.82	18
Contractor financial failure	28	3.68	27
Contractor low or poor work productivity	35	3.63	34
Errors during construction	43	3.81	19
Accidents and safety	36	3.44	47
Quality and control assurance	33	3.36	50
Contractor breaching by contractor	26	3.35	51
Project type Know-how skills	28	3.96	10
Inadequate risk management plan	31	3.77	21
D) Subcontractor related			
Subcontractor poor work productivity	39	3.74	22
Subcontractor breaching contract	29	3.52	44
Subcontractor financial failure	28	3.57	41
Material availability	36	3.61	37
Material quality	35	3.65	30
Project type Know-how skills	26	3.54	43
E) Consultant related			
Lack of experience of consultant	36	3.83	17
Inadequacy of specifications	36	3.64	31
Quality assurance	35	3.6	39
Project type Know-how skills	28	3.64	31
2- External level			
A) Political			
Bureaucratic problems	47	3.74	22
Threats of wars	13	3.62	36
Labour issues	46	4.22	4
Corruption	42	4.24	3
Changes of law	29	3.97	9
B) Social			
Crime's rate	9	3.56	42
Cultural differences	23	3.04	53
C) Financial			
Inflation	19	3.47	45
Currency fluctuation	16	3.31	52
D) Natural			
Poor site conditions	32	3.66	29
Pollution	20	3.4	49
3- Acts of God			
A) Natural Phenomena			
Earthquakes	12	4.33	1
Fires	26	3.96	10
Floods	33	3.91	13
B) Weather Issues			
Severe weather conditions	30	3.7	24

Appendix 6: The likelihood of occurrence of the 54 identified risks on GACA projects

	Number of Respondents	Probability of occurrence	Rank
1- Internal Level			
A) Client related			
Payment Delays	44	3.75	7
Setting tight schedule by client	36	3.83	3
Inappropriate intervention by client	38	3.66	15
Design changes by client	47	3.89	2
Inadequate scope	26	3.5	22
Site access delays	35	3.4	28
Contract breaching by client	20	3.3	34
Client financial failure	13	2.58	52
Lack of experience of client	23	3.74	8
Obtaining / issuing required approval	41	3.73	9
Issue of sustainability	19	2.79	50
Inadequacy of requirements	22	3.23	39
Poor coordination	36	3.39	30
Changing demands	39	3.67	12
B) Designer related			
Design errors	43	3.67	12
Incomplete design	26	3.65	16
Design constructability	13	3.69	11
Poor quality of design	26	3.81	4
Project type Know-how skills	21	3.81	4
C) Contractor related			
Poor quality of construction	37	3.59	18
Lack of experience of contractor	34	3.5	22
Contractor financial failure	28	3.29	36
Contractor low or poor work productivity	35	3.4	28
Errors during construction	43	3.44	26
Accidents and safety	36	3.25	38
Quality and control assurance	33	3.27	37
Contractor breaching by contractor	26	3.23	39
Project type Know-how skills	28	3.57	19
Inadequate risk management plan	31	3.52	21
D) Subcontractor related			
Subcontractor poor work productivity	39	3.49	25
Subcontractor breaching contract	29	3.21	42
Subcontractor financial failure	28	3.11	45
Material availability	36	3.22	41
Material quality	35	3.11	45
Project type Know-how skills	26	3.35	32
E) Consultant related			
Lack of experience of consultant	36	3.53	20
Inadequacy of specifications	36	3.36	31
Quality assurance	35	3.43	27
Project type Know-how skills	28	3.71	10
2- External level			
A) Political			
Bureaucratic problems	47	3.77	6
Threats of wars	13	2.77	51
Labour issues	46	3.91	1
Corruption	42	3.67	12
Changes of law	29	3.62	17
B) Social			
Crime's rate	9	2.22	54
Cultural differences	23	3.17	44
C) Financial			
Inflation	19	3.21	42
Currency fluctuation	16	2.88	49
D) Natural			
Poor site conditions	32	3.5	22
Pollution	20	2.9	48
3- Acts of God			
A) Natural Phenomena			
Earthquakes	12	2.42	53
Fires	26	3.35	32
Floods	33	3.09	47
B) Weather Issues			
Severe weather conditions	30	3.3	34

Appendix 7: The Initial Field work's (Preliminary Study) Questions

1. Tell me about the different types of construction projects undertaken in GACA?
2. Tell me about the procurement methods used to undertake those projects?
3. Tell me about the magnitude of time delays and cost overruns in your projects?
4. Is there any particular reason for such a delay in time and overruns in costs? What? Can you expand your answer please?
5. How would deal with those an issue/s?
6. How effective do you think the way you deal with risks in your department is?

Appendix 8: The Interviews' Questions

The selected interviewees were asked a number of questions and given the chance to list any relevant risks they have encountered. The questions included the following:

1. What are the projects that you have been involved with GACA?
2. What was your role?
3. What are the major risks in the projects that you have been involved in GACA projects? (taking into consideration the initial proposed structure of the risks by the researcher)
4. What is the impact/s of the mentioned risk/s in the project you have been involved with GACA?
5. To what extent do you measure the likelihood of these risks occurrences and impacts on the projects?
6. What is the approach used to allocate risks within the projects you have been involved in?